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

Refer to NMFS No: WCRO-2024-01554

December 12, 2025

Chandra L. Jenkins
Chief, 408 Permissions Section
Section 408 Coordinator
U.S. Army Corps of Engineers
1325 J Street
Sacramento, CA 95814-2922

Re: Endangered Species Act Section 7(a)(2) Biological Opinion and Magnuson–Stevens Fishery Conservation and Management Act Essential Fish Habitat Response for the Butte Slough Outfall Gate Repair Project.

Dear Ms Jenkins:

Thank you for your June 26, 2024, letter 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 proposal to permit the Butte Slough Outfall Gate Repair Project.

Thank you also for your request for essential fish habitat (EFH) consultation. NMFS reviewed the proposed action for potential effects on EFH pursuant to section 305(b) of the Magnuson-Stevens Fishery Conservation and Management Act (MSA), implementing regulations at 50 CFR 600.920, and agency guidance for use of the ESA consultation process to complete EFH consultation. We have concluded that the action would adversely affect EFH designated under the Pacific Coast Salmon Fishery Management Plan (PFMC 2005, 2014).

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

Please contact Kathryn Swick at the California Central Valley Office of NMFS at (301) 427-7812 or via email at Kathryn.swick@noaa.gov 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-WCR2024-SA00030
Michael Fong, USACE Section 408 Coordinator, michael.r.fong@usace.army.mil
Oren Ruffcorn, Environmental Compliance, Oren.M.Ruffcorn@usace.army.mil

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

Endangered Species Act Section 7(a)(2) Biological Opinion [and Magnuson–Stevens Fishery Conservation and Management Act Essential Fish Habitat Response]
Butte Slough Outfall Gate Project
NMFS Consultation Number: WCRO-2024-01554

Action Agency: US Army Corps of Engineers

Affected Species and NMFS' Determinations:

ESA-Listed Species	Status	Is Action Likely to Adversely Affect Species?	If likely to adversely affect, Is Action Likely to Jeopardize the Species?	Is Action Likely to Adversely Affect Critical Habitat?	If likely to adversely affect, is Action Likely to Destroy or Adversely Modify Critical Habitat?
Sacramento River winter-run Chinook salmon ESU (*Oncorhynchus tshawytscha*)	Endangered	Yes	No	Yes	No
Central Valley spring-run Chinook salmon ESU (*O. tshawytscha*)	Threatened	Yes	No	Yes	No
California Central Valley steelhead DPS (*O. mykiss*)	Threatened	Yes	No	Yes	No
sDPS 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 12, 2025

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.

1.1.1. Early History of Butte Slough Outfall Gates

In 1935, the U.S. Army Corps of Engineers (USACE) constructed an outfall gate facility to replace a prior dam that local landowners constructed to manage flooding on their property. The original Butte Slough Outfall Gates (BSOG) facility consisted of seven 66-inch-diameter corrugated metal pipes (CMP) with flap gates on the downstream side (Sacramento River), and slide gates attached to an overhead catwalk on the upstream side (Butte Slough). The CMPs were supported by timber piles driven into the ground (GEI Consultants 2024a).

A 1965 report by the California Department of Fish and Game (CDFG) included the following description of BSOG:

> A control structure known as the Butte Slough outfall is located at the mouth of the stream. This consists of a series of conduits that convey the flow of Butte Creek through the Sacramento River levee. The conduits are provided with flap gates that automatically close if the level of the Sacramento River is higher than the level of Butte Creek. One of the gates has been equipped with a manual control apparatus that can be operated to permit fish passage when all the gates would normally be closed (CDFG 1965).

BSOG was refurbished in 1985 by the Department of Water Resources (DWR) in the following ways:

- Installing seven new 60-inch-diameter steel pipe sleeves inside the previous 66-inch CMPs
- Grouting the annular space between the inner and outer pipes
- Constructing a concrete headwall on the outlet side to support the pipe ends
- Constructing individual concrete headwall faces on each pipe at the inlet side to support the slide gate frames and gates

The original catwalk was not improved, but retained to provide accessibility to the gate operation mechanisms. No modifications were made to the gates; the slide gates on the upstream side and the flap gates on the downstream side remain. The current BSOG retains the 1985 modification, but requires maintenance for function and operational safety (GEI Consultants 2024a).

1.1.1.1. BSOG background and operational history

BSOG is part of the joint Federal-State flood control system in the Central Valley known as the Sacramento River Flood Control Project (SRFCP). The State of California accepted responsibility from USACE to operate and maintain certain features of the SRFCP according to USACE's Operations and Maintenance Manuals (33 CFR 208.10). The facility is operated and maintained by DWR's Flood Maintenance Office, Sutter Maintenance Yard, and California Water Code Section 8361(d) and 12878 obligates DWR to maintain BSOG.

BSOG is operated and maintained to aid in flood risk reduction by managing flood discharges from Butte Slough into the Sacramento River during the flood season, and by maintaining stage elevation during the remainder of the year to provide a water supply for nearby agricultural landowners. The system provides positive closure from Sacramento River water entering Butte Slough and permits flows out of Butte Slough into the Sacramento River as congressionally authorized and operated (GEI Consultants 2024a). However, Ferrari and Buchanan (2022) concluded that the Butte Slough culverts do not function for flood control purposes in low water years given that Butte Slough does not gravity drain back to the Sutter Bypass, and low flow conditions generally produce Sacramento River stages lower than Butte Slough for several months of the year.

The facility regulates stage levels between the Sacramento River and the Butte Slough. Stage elevation in the Butte Slough is maintained at the approximate North American Vertical Datum 1988 (NAVD 88) of 42 feet, while stage elevation in the Sacramento River is approximately 40–65 feet NAVD 88 (Ferrari and Buchanan 2022). There are manually operated slide gates on the Butte Slough side of the facility. On the Sacramento River side, flap gates open and close based on stage differential, and the flap gates will open if the stage differential is one foot or more greater on the Butte Slough side than the Sacramento side. If the manually operated gates are in the open position, but the Sacramento River stage is greater than the Butte Slough stage, the flap gates will remain closed because of hydrostatic pressure. Both gates, which bookend the seven culverts in between, must be open in order for migrating fish to pass.

Occasional equipment inspections and maintenance are required at the facility, and are usually completed in a few days. Shutdown response falls under two categories: emergency repair and non-emergency repair, and DWR's project response varies depending on whether the outage occurs in the dry season versus the wet season. Emergency repairs occur at the time of the outage. Non-emergency repairs are conducted when water stages are at their low points (provided loss of the damaged culverts does not negate operational goals). Past mechanical failures have been on a single pipe, typically such that the six other pipes remain operational. The system remains submerged year-round, so there is not any scheduled annual shutdown of the entire system.

BSOG was not designed to operate as a fish passage facility, and the facility pre-dates the Endangered Species Act; however, fish passage has been documented (Garman 2018; McReynolds 2021; Notch *et al.* 2022). Further, available information supports the presumption that the Butte Slough was the primary upstream route for the adult migrating Butte Creek salmonid population (Hallock and Van Woert 1959; CDFG 1965; Bernard *et al.* 1996), and a 1965 CDFG report indicates that one of the gates was equipped with a manual control apparatus specifically to support fish passage (CDFG 1965). Only recently has the Sutter Bypass been acknowledged as a second common pathway for migrating Butte Creek salmon (NMFS 2016a,b; DWR 2022), perhaps because the 1985 upgrade to the facility (GEI Consultants 2024a) reduced the historic reliability of the gates for fish passage given that the modifications reduced the diameter of the outfall thereby increasing flow velocity in the culverts. Fish that are unable to pass through BSOG to migrate upstream would have to swim downstream in the Sacramento River for nearly 50 miles to access the route to Butte Creek through the Sutter Bypass confluence with the Sacramento River. This behavior is unlikely for an anadromous fish that is attempting to migrate upstream to spawn. As a result, delayed spawning, straying into other watersheds, spawning in less suitable habitat, decreased fecundity, and pre-spawn mortality have occurred (Garman 2018; Johnson 2021; Nichols 2022; McReynolds 2021; Rozden 2022).

According to the 2021 NMFS Guidelines for Salmonid Passage at Stream Crossings in California, the maximum average water velocity for fish passage through a culvert varies based on the length of the culvert, assuming a minimum 3-foot-wide diameter. For culverts 200–300 feet long, the maximum average water velocity should not exceed 3 feet per second (ft/s) (NMFS 2021a). Average flow velocities at BSOG are currently less than 4 ft/s when the stage differential is less than one foot (Ferrari and Buchanan 2022). This number exceeds the required safe flow velocity for culverts of this length; thus, passage through the facility is always dangerous for salmonids because the resulting decreased swimming capabilities through BSOG increases their risk of entrapment in the culverts.

It is difficult to determine, due to lack of monitoring, the number of fish that have entered or attempted to enter Butte Creek through BSOG. Three recent incidents documented by the California Department of Fish and Wildlife (CDFW) indicate that those numbers are in the tens (Garman 2018; Nichols 2022) to hundreds (McReynolds 2021). On March 22, 2018, CDFW responded to a report of dead adult Chinook salmon on the Sacramento River side of BSOG. In total, 48 dead fish were observed and examined. The fish were in an advanced state of decomposition and had a white-opaque tinge to them as if they had been deceased for some time and not exposed to ambient air conditions. While on site, CDFW noticed more Chinook salmon queuing at and attempting to enter the facility (Garman 2018). On March 3, 2021, at least 100 adult salmon were observed queuing at BSOG. DWR staff manually propped open flap gates on the Sacramento River side so that fish could escape the culverts if the slide gates were closed before fish passed through the facility. Fish were spotted less often through April, and daily checks concluded on April 22, 2021 (McReynolds 2021).

1.2. Consultation History

Additional information regarding the history of past consultations at BSOG can be found in Appendix A.

- August 17, 2020, NMFS received a request from USACE to initiate formal consultation to permit DWR for the Butte Slough Outfall Gates Rehabilitation Project.
- August 31, 2020, NMFS attended a coordination meeting with USACE and DWR and subsequently sent a letter requesting more information regarding the project.
- November 2, 2020, NMFS sent a notice of consultation hold (WCRO-2020-03018) to the USACE stating they should submit a new consultation request when DWR is ready with the necessary information in order to consult on the effects of the proposed action on listed species, critical habitat, and EFH.
- July 2023, GEI Consultants held a Resource Agency/Project Introduction Meeting with NMFS, USACE, and DWR, to discuss the proposed action and its potential effects on the species addressed in GEI Consultants' biological assessment (BA) for the project.
- October 3, 2023, GEI Consultants held a Resource Agency Update Meeting for the project.
- June 25, 2024, DWR released Draft Initial Study/Mitigated Negative Declaration (GEI Consultants 2024b) for a 30-day public review for the Butte Slough Outfall Gate Repair Project.
- June 26, 2024, USACE requested formal consultation to permit DWR for implementation of the proposed action.
- July 9, 2024, NMFS sent a request for more information to the action agency for clarification regarding project design features, including the proposed use of mitigation banking and proposed offsetting measures, the maximum permanent impacts of the project, and the Technical Memo outlining the modeling velocities mentioned in the BA.
- August 8, 2024, USACE responded to NMFS' request for additional information providing an updated BA and a Technical Memo from GEI Consultants dated August 12, 2021.
- August 19, 2024, NMFS sent a follow-up request for more information to USACE for a complete version of the Technical Memo from GEI Consultants dated August 12, 2021 (the previously provided memo was only a partial memo), clarification on whether dewatering will cease if mortality is noted during construction, and information on how DWR will address fish passage to meet NMFS' (2022) fish passage standards.
- September 23, 2024, USACE responded to NMFS' request for additional information providing an updated Technical Memo from GEI Consultants dated March 20, 2022, clarification that dewatering will cease if special status species are found, and a request that NMFS review the project as it is written without fish passage, given the assertion by USACE that they do not have the authority to require fish passage at BSOG.
- October 22, 2024, NMFS sent a follow-up request for more information to USACE regarding the availability of mitigation credits in the project area, provided information about in-lieu fee banking, and asked for an update on how DWR would plan to address their proposed offsetting purchase.

- November 6, 2024, USACE responded to NMFS' request for additional information explaining that DWR previously bought bulk credits at Bullock Bend and has enough available credits for the project.
- November 7, 2024, NMFS sent a follow-up request for more information to USACE for clarification on the frequency and timing of outages associated with inspection and maintenance of BSOG, and whether DWR will maintenance the outlet pipes during construction.
- November 13, 2024, USACE responded to NMFS' request for additional information detailing the expected maintenance timeframes and clarified that the outlet pipes would not need maintenance under the current proposal.
- November 13, 2024, NMFS sent an additional follow-up request for more information to USACE for clarification on the omission of the Rivers and Harbors Act permit request that was present in the 2020 draft BA. USACE responded the same day that the Rivers and Harbors Act is also included in the permit request.
- November 27, 2024, NMFS requested additional information to clarify what USACE meant when they stated in the BA, "non-emergency [inspections and maintenance] would be conducted… and planned during in-water work periods to reduce any environmental impacts." NMFS also asked for clarification on what DWR meant when they stated in the BA, "outlet gates [repairs] would allow for previously unattainable gate opening adjustments and accuracy." Lastly, NMFS requested more information about cement curing times.
- December 17, 2024, USACE responded that non-emergency facility inspections and maintenance would occur within the proposed in-water work window. USACE also clarified that facility updates to the monitoring system will allow for more efficient facility operations and accurate data collection. Finally, USACE indicated that the cement would cure long enough to prevent injury to fish associated with pH imbalance.
- December 18, 2024, NMFS requested that non-emergency inspections and maintenance occur between July 15 and October 31. NMFS also asked for clarification on whether gate automation would result in changes to how water flows through the facility.
- January 13, 2025, USACE responded that DWR would consider NMFS' suggested July 15–October 31 in-water work window for future maintenance actions. USACE also stated that automation of gate operation will allow for more efficient remote operation of the gates but is not expected to change the operational parameters that exist presently or change the way water moves through the facility.
- February 27, 2025, NMFS met with USACE to discuss outstanding questions including whether the BA's description of the proposed action mistakenly included operations and maintenance; if changes to operations could be employed to improve fish passage; and how the project should be categorized under the 2022 Memorandum of Understanding between NMFS and USACE regarding existing structures (2022 Structures MOU). USACE staff clarified that the proposed action should not have included operations and maintenance; that USACE would not support NMFS' recommended measures that would alter operations; and that USACE would seek clarification regarding the categorization of the project according to the 2022 Structures MOU.
- February 28, 2025, NMFS requested that DWR provide an analysis of the effect of operations and maintenance of the facility on listed species for analysis under the

environmental baseline and/or cumulative effects section of the consultation, as appropriate.

- March 19, 2025, NMFS requested that USACE provide clarification of its position as to the application of the 2022 Structures MOU to this consultation.
- April 30, 2025, USACE provided additional explanation of the Congressional enactments authorizing BSOG as part of the congressionally authorized Sacramento River Flood Control Project.
- May 6, 2025, NMFS determined that information provided by USACE and DWR to date, combined with publicly available data, was sufficient to perform analysis of operations and maintenance on listed species and that no additional information was needed; thus, NMFS informed the USACE that it was ready to initiate formal consultation. NMFS also requested early coordination with USACE for a possible extension of the consultation due date given agency constraints with staffing and resources.
- May 7, 2025, USACE stated that they could not voluntarily extend the regulatory timeline for this project.
- July 30, 2025, NMFS requested clarification on the formal request letter for consultation, which states that DWR is seeking USACE authorization under Clean Water Act (CWA) Section 404 and/or Rivers and Harbors Act (RHA) Section 10. USACE confirmed the same day that its proposed action includes CWA 404 and RHA 10 and 14.

Updates to the regulations governing interagency consultation (50 CFR part 402) were effective on May 6, 2024 (89 Fed. Reg. 24268). We are applying the updated regulations to this consultation. The 2024 regulatory changes, like those from 2019, were intended to improve and clarify the consultation process, and, with one exception from 2024 (offsetting reasonable and prudent measures), were not intended to result in changes to the Services' existing practice in implementing section 7(a)(2) of the Act. 89 Fed. Reg. at 24268; 84 Fed. Reg. at 45015. We have considered the prior rules and affirm that the substantive analysis and conclusions articulated in this biological opinion and incidental take statement would not have been any different under the 2019 regulations or pre-2019 regulations.

1.3. Proposed federal action

Under the ESA, "action" means all activities or programs of any kind authorized, funded, or carried out, in whole or in part, by federal agencies (see 50 CFR 402.02). Under the MSA, "federal action" means any action authorized, funded, or undertaken, or proposed to be authorized, funded, or undertaken by a federal agency (see 50 CFR 600.910). DWR (the applicant), requested authorizations for the repair of BSOG under Section 404 of the Clean Water Act and Section 14 and 10 of the Rivers and Harbors Act. USACE is the lead federal action agency for the purposes of this consultation.

At present, the applicant plans to restore BSOG for operation safety, function, and flood risk reduction. Proposed maintenance repairs include the installation of supplemental outlet headwall support, replacing the existing inlet catwalk, repairing the inlet slide gates, and the installation of water flow/condition monitoring equipment. These maintenance repairs will address both temporary flood and safety goals. The proposed project as described in the BA does not include any changes to operations of BSOG, nor does the BA identify any changes to operations as an effect of the project. USACE has confirmed it does not plan to change its Operations and

Maintenance Manual for BSOG. Accordingly, this opinion does not include operations and maintenance of BSOG as part of the proposed federal action.

We considered, under the ESA, whether or not the proposed action would not cause any other activities and determined that it would not.

The following sections describe the project location, project description, and proposed avoidance, minimization, and conservation measures (AMMs).

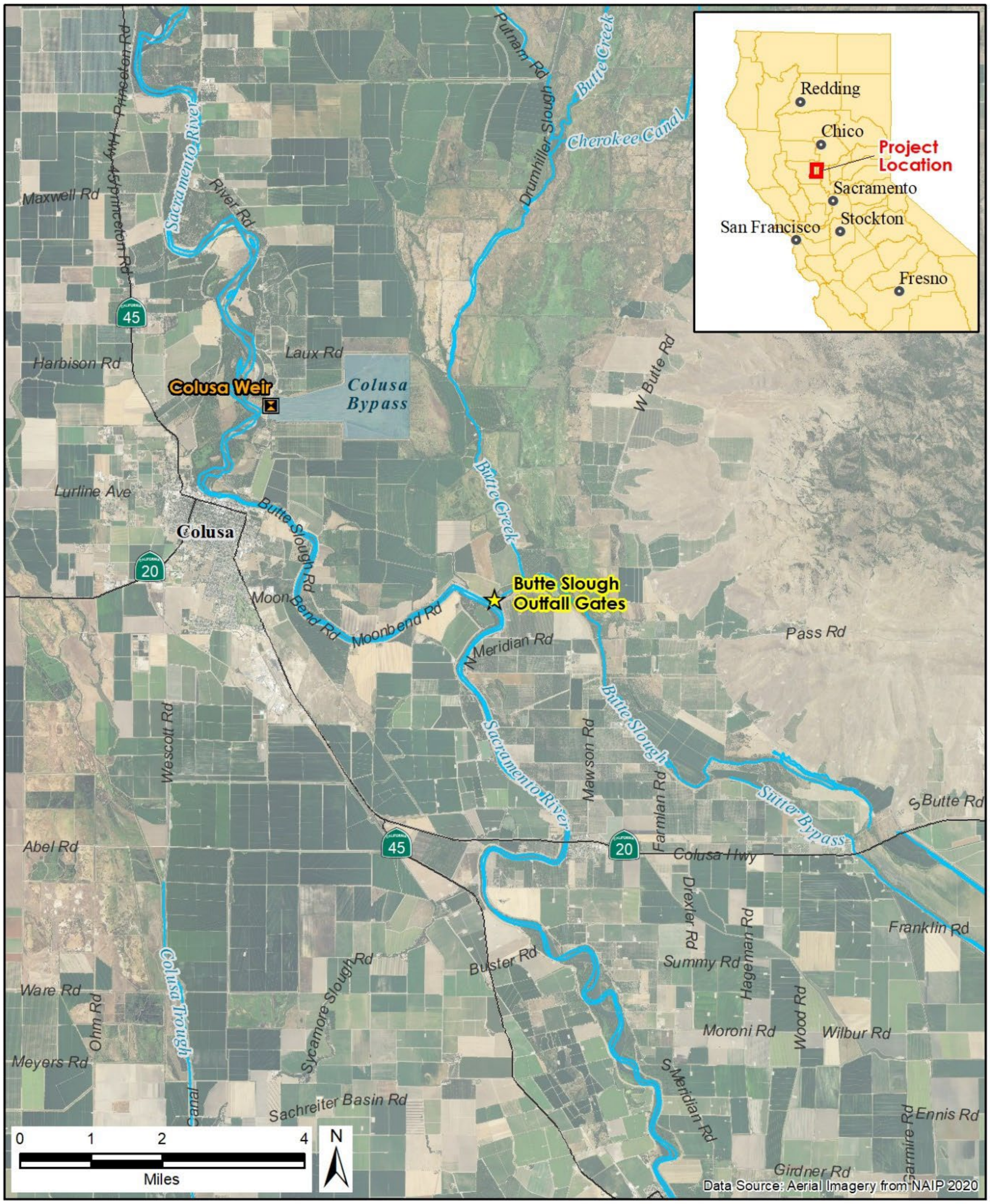
1.3.1. Project location

The proposed Project is located at approximately 39.194935, -121.936277, on Butte Slough adjacent to its confluence with the Sacramento River (Figure 1). The project site is located approximately 5 miles downstream from the town of Colusa in both Sutter and Colusa counties and is accessed by Marty Road on the Sutter County side and Butte Slough Road on the Colusa County side. The BSOG structure is located on both sides of the Sacramento River levee, within both Butte Slough and the Sacramento River. Rural agricultural areas within both Colusa and Sutter counties occur landside of the Sacramento River levee, and the BSOG is used to control a significant amount of the regional agricultural runoff within the basin.

1.3.2. Project description

1.3.2.1. Laydown area and staging activities

Figure 2 depicts the laydown and staging areas of the project. The applicant will clear/grub vegetation from construction areas prior to offloading/storing equipment at the project site. The applicant will remove one small sandbar willow from the southern bank of the outlet portion of the project area to accommodate equipment access to install a cofferdam.



Z:\Projects\1905950_DWR_FloodMgmtServices_TO_23_02_ButteSloughOutfallGates\
G002_1905950_TO2302_RegionalLocation_20240418
18Apr2024 RS

Figure 1. Project location (GEI Consultant 2024a).

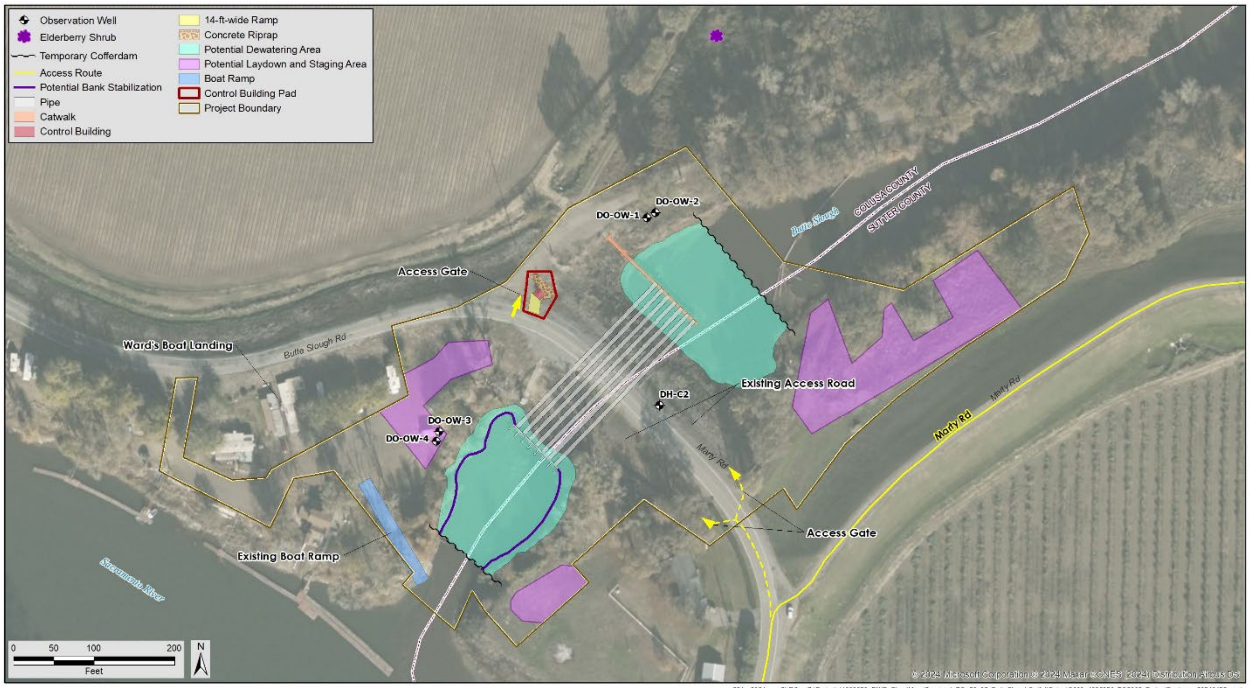


Figure 2. Project site and features (GEI Consultants 2024a)

Dewatering

The Project will require dewatering on both the inlet and outlet sides of BSOG to facilitate clearing and grubbing, removal of the existing features to be replaced/repaired, construction of new features, and the testing of installed components. Dewatering will occur during the proposed in-water work window from June 15–October 31.

The applicant will use cofferdam sheet piling, or a similarly effective method, to dewater the channel. Up to five dewatering (observation) wells, placed outside the cofferdam, will manage seepage in proximity to the sheet piling areas. These wells will extract water just below the ground, and sump pumps within sheet piling areas will dewater the project site within Butte Slough.

Dewatering of the project site will take place over approximately 4 to 6 days, depending on stage-volume relationships of Butte Slough within the project site. The dewatered area on the western side of the BSOG facility is estimated to cover an approximately 0.52-acre area and the dewatering area on the eastern side of the BSOG facility would cover an approximately 0.54-acre area. The dewatered area will be approximately 23 feet deep on both sides of the BSOG facility. The applicant will pump water out of the project site and back into the contributing surface waters – the Sacramento River or Butte Slough. Discharged water will be managed in compliance with permits issued by the Regional Water Quality Control Board (RWQCB) that regulates water discharges into waters of the United States.

Pile driving

The applicant proposes to use vibratory pile driving to install and remove the sheet piles and four H-piles required for the project. Based on the preliminary substrate analysis, vibratory piling driving should be sufficient for piling driving; however, depending on the site conditions, the applicant may need to use an impact pile driver if the vibratory pile driver meets a point of refusal.

The applicant will drive a minimum of eight sheet piles approximately 60 feet below the top layer of bottom substrate. Sheet piling will occur using equipment staged on the banks in areas with minimal riparian habitat; however, two temporary construction pads may need to be constructed adjacent to the bank in the Butte Slough or Sacramento River to facilitate installation of the sheet piles beyond the crane's reach. A shallow draft barge may also be used.

1.3.2.2. Maintenance repairs and new construction

The proposed action consists of implementing the following maintenance repairs and new development necessary to restore the safe operability and function of the BSOG.

Outlet headwalls

The present concrete outlet headwall rests atop the original 1935 timber piles. There is no restraint or anchoring of the headwalls to the piles, and the headwall position is maintained by gravity. The present risk of outfall structure failure is due to the ongoing scour and erosion at and around the outlet headwall that could precipitate a shifting of soil mass behind and above the headwall. A lateral shift or rotation of the headwall off the supporting timber piles could bind and/or torque the flap gates into a non-operable position or tear the flap gates off the pipe ends. Either outcome would result in a complete loss of positive flood control.

The applicant will undertake activities to stabilize the outlet headwall(s) to prevent them from rotating or settling. These improvements will enable the outlet headwall to resist both lateral and rotational movement from exterior loads thereby reinforcing the full functionality of the flap gates to provide complete closure as required. Stabilizing activities would consist of backfilling the scour area with a lightweight concrete slurry to protect exposed timber piles against future scour. The total volume of fill needed is approximately 34 cubic yards and was estimated by assuming a void or “fill space” of the entire length of the outlet headwall (77 feet) at 4 feet deep and 3 feet high. The construction contractor would perform this work over a 1- or 2-day period and the work would be contained within a dewatered work area.

Inlet catwalk

The applicant will replace the existing catwalk with a new catwalk that is supported by a system of foundation piles to ensure safe access to the inlet slide-gate-apparatus. Activities to improve the inlet catwalk include:

- Removing the existing catwalk and support framing, which is presently attached directly to the pipes at the inlet side to unload excess deflection or torsional forces on the pipe ends
- Installing four new support piles
- Erecting a new catwalk system to provide safe accessibility to operate the slide gates

Inlet slide gate

The applicant will replace the gate actuators and related gate infrastructure to restore the slide gate to its full operating ability. These repairs include:

- Replacement of the inlet slide gates, gate frames, and stems
- Attaching and aligning the slide frames to the new catwalk
- Replacing the old manual slide gate actuators with modern actuators to improve the operator's ability to fully open and close the gates and make fine adjustments to a partially opened gate to manage stage requirement.

Facility control building

The applicant will construct a new, climate-controlled equipment building on the Butte Slough side of the project site to maintain the controls necessary for facility operation. The building will draw power from a generator and an above ground propane tank. Fencing and concrete walls will protect the propane tank. Power for the controls will be routed through a trench from an existing Pacific Gas and Electric Company (PG&E) pole near the control building, and a PG&E meter will be mounted on the outside of the control building within the fenced area.

Resource monitoring capabilities

The applicant will install small-scale resource monitoring equipment (such as flap gate angle monitors and inclinometers) to improve the collection and monitoring of local water flow and fisheries conditions in the project area. The facility control building described above will support this equipment.

Other supporting infrastructure

Additional maintenance repairs may include security cameras, lights, and some bulk stabilization work at locations in dewatered areas on the Sacramento River side of the project footprint. Stabilization measures will include the use of riprap or other rock. The maximum expected amount of riprap placement is 0.05 acres on both the inlet and outlet side of the facility.

Project close out

Following completion of the maintenance and repair activities, the applicant will remove the cofferdams, hydro-seed disturbed soils with native seed mix, and plant native vegetation. Upon completion of construction, the applicant will cap and abandon the dewatering wells in compliance with applicable regulations and permit conditions, and will perform site clean-up. After project repairs and construction are completed, the applicant will continue its existing program of routine annual maintenance of the structure, levees, vegetation, and adjacent roads within the area.

1.3.2.3. Construction Schedule

The applicant will complete the project within a single construction season between April and November. Dewatering of the construction area will occur between June 15 and October 31. To maximize efficiency to stay within the in-water work window timeframe, as many project components as possible will be prefabricated and/or assembled prior to installation at the project site.

<u>*General work conditions*</u>

Construction activity will occur Monday–Friday between 7 a.m. and 7 p.m. during the construction phase of the proposed project. These work times may be extended at key points in the construction phase that must proceed continuously (*e.g.,* dewatering or large concrete placements) into Saturdays from 8 a.m. to 5 p.m. as needed. If construction needs to be conducted beyond these windows, it will be done in short durations.

Construction activities will include the daily arrival and departure of construction workers and trucks hauling equipment and materials. Construction trucks on local roadways will include dump trucks, concrete trucks, and other delivery trucks and trailers. Dump trucks will be used for earth moving and clearing, removing excavated material, and importing fill material and other structural and paving materials. Other trucks will deliver heavy construction equipment, job trailer items, concrete forming materials, piping materials, piles, new facility equipment, and other miscellaneous deliveries.

1.3.3. Avoidance and minimization measures

The applicant proposes to implement the following AMMs to minimize or offset the effects of the proposed action.

1.3.3.1. General environmental and water quality measures

The applicant will minimize fish habitat disturbance by implementing the following measures:

1. Before any work occurs within the project site, including equipment staging and vegetation removal, a qualified biologist will conduct a mandatory environmental awareness training. The training will be provided to all construction personnel (contractors and subcontractors), briefing them on the need to avoid and minimize effects on sensitive biological resources within the project site and the penalties for not complying with applicable federal and state laws and permit requirements. The biologist will inform all construction and maintenance personnel about the life history and habitat requirements of special-status species with potential for occurrence on-site, and the terms and conditions of the biological opinion or other authorizing documents.
2. The applicant will use existing staging sites, maintenance toe roads, and levee crown roads for staging and access to avoid affecting previously undisturbed areas. The applicant will also limit the number of access routes and the size of staging and work areas to the minimum necessary to conduct the activity.
3. The applicant will clearly mark work area limits, including access roads, staging and equipment storage areas, stockpile areas, equipment fueling areas, and other areas where construction activities will occur. Work will occur only within the marked limits.
4. The amount of revetment and similar materials used for bank protection and other maintenance activities will be limited to meet maintenance obligations and ensure proper flood-protection-system integrity and function.

5. The applicant will remove temporary fill and construction debris, and will dispose of these materials following completion of any maintenance activities.
6. The applicant will restore habitats to pre-project conditions, when feasible.
7. All in-water work will occur from June 15–October 31 to minimize the potential presence of anadromous special-status fish during construction.
8. In-water construction work will occur only in dry, dewatered areas behind sheet pile cofferdams within one construction season. All construction equipment used for in-water work will be cleaned and free of invasive species. The cofferdams will be constructed around both sides of the BSOG facility, prior to any in-water soil-disturbing activities. The Sacramento River cofferdam will be constructed high enough to avoid flooding during the construction period. Sutter Maintenance Yard staff will control the stage elevations downstream of the BSOG facility during the entirety of construction to avoid flooding the cofferdam on the Butte Slough side.
9. The applicant will use sealed bearings and watertight actuators to reduce the introduction of mechanical lubricants into the waterway.
10. The applicant will employ a qualified biologist who will be onsite or on call during in-water construction activities. If a special-status species is encountered during construction, activities will cease until the appropriate measures are taken to remove the species from harm.
11. A dewatering plan, prepared and submitted to NMFS for approval by the applicant before construction, will dictate dewatering activities. Pump intakes will be fitted with appropriately sized NMFS-approved fish screens in accordance with the NOAA Anadromous Salmonid Passage Design Manual (NMFS 2023).
12. The applicant will refrain from using erosion control fabrics that contain micro-plastic filaments or could trap wildlife (*e.g.,* Straw wattles, fiber rolls, or erosion control blankets).
13. The applicant will inspect all vehicles and equipment for the presence of wildlife before the start of each workday. Additionally, the applicant will look for wildlife in all pipes, culverts, and similar structures that have been stored on-site for one or more nights before being buried, capped, or moved.
14. The applicant will cover all excavated, steep-walled holes or trenches with appropriate covers at the end of each workday. These covers will ensure that trench edges are fully sealed. Alternatively, the applicant may furnish trenches with escape ramps made of earthen fill or wooden plants to provide escape ramps for wildlife.
15. The applicant will ensure that all project-related trash items, including wrappers, cans, bottles, and food scraps, are collected in closed containers, removed from maintenance sites each day, and disposed of at an appropriate off-site location to minimize attracting wildlife to work areas.
16. The applicant and the construction contractor will prepare and implement the following measures to minimize water quality degradation, including from accidental spills, turbidity, erosion, and sedimentation:
    a. The contractor will develop a Water Quality Control Plan (WQCP) prior to the start of construction and will implement the plan throughout construction. A copy of the plan will be available at all times at the construction site.
    b. The WQCP will include spill prevention and contingency measures, including measures to prevent or clean up spills of hazardous material used for equipment,

and emergency procedures for responding to spills. It will be updated as needed to reflect changes in on-site hazardous material. In addition, spill control materials will be available on-site and available for deployment during all phases of work.

c. The WQCP will identify best management practices (BMPs) for preventing or minimizing the discharge of sediment and other potential contaminants that could lead to a violation of water quality objectives. The plan will specify the use of an effective combination of appropriate temporary and/or between season erosion and sediment control BMPs for use on the project site, spill prevention and contingency measures, waste disposal, and emergency contacts and responsibilities. The erosion control will include measures for construction, long-term management, and stabilizing soils, if necessary, before the onset of winter. BMPs may include the careful use of grading management techniques, silt fences, silt or turbidity curtains, berms, sandbags, and revegetation.
d. The applicant will develop a dewatering plan that will include measures to minimize turbidity levels of discharge water and will detail the approach to season the channel before reestablishing flows so that flushing flows do not cause turbidity. In addition, any potential discharges to surface water will meet the water quality objectives of the Central Valley RWQCB.
e. The applicant will use BMPs for erosion control as set forth in the erosion control plan. The erosion control plan will identify specific measures for construction, long-term management, and stabilizing soils. Such BMPs may include the careful use of grading management techniques, silt fences, silt or turbidity curtains, berms, sandbags, and revegetation.
f. The WQCP will include inspection, monitoring, and reporting measures to ensure water quality objectives are met during construction and long-term management. The applicant or their contractor will evaluate BMP effectiveness during construction. If the quantity or quality of the BMPs needs to be addressed, the applicant or their contractor will implement improvements within 24 hours after the initial discovery or before the onset of an expected storm event.
g. Turbidity measurements will be taken daily up and downstream of the work areas, as well as at any other discharge points, during project activities with potential to degrade water quality, such as pile driving and discharge to surface waters. If measurements have a weekly average of 50 nephelometic turbidity units (NTUs) above baseline (upstream), the following steps will be taken:
    i. Keeping site safety precautions in mind, the applicant will immediately take steps to prevent further discharge, including stopping work if necessary.
    ii. The applicant will determine if dewatering and/or other controls for discharge are operating effectively and if they may be causing turbid conditions.
    iii. The applicant will make necessary adjustments, repairs, or replacements to dewatering or other discharging mechanisms to lower turbidity levels below the benchmark or to prevent/remove a visible turbidity plume or water sheen.

1.3.3.2. Measures for federally listed fish species

The applicant proposes to use the following measures to minimize or avoid impacts to federally listed fish species:

1. In-water construction activities, including cofferdam construction and dewatering, will be restricted to June 15 to October 31 when listed fish species are less likely to occur within or near the project site.
2. If project activities must occur during non-daylight hours, a biologist will establish monitoring measures based on fish species, individual behavior, and type of construction activities. When nighttime work cannot be avoided, nighttime lighting will be used only in the portion of the project area actively being worked on (limited to a minimum distance of 200 feet from habitat for listed fish species) and will be focused directly on the work area. To minimize impacts outside the work area, lights on work areas will be shielded and focused to minimize lighting of listed fish species habitat. If the work area is located near surface waters, the lighting will be shielded to avoid shining directly into the water.
3. To avoid or minimize the potential for injury or mortality of listed fish species from pile-driving noise, all pile driving for the cofferdams and inlet catwalk will be restricted to the in-water work period (June 15 to October 31). Due to the anticipated soft nature of the substrate, non-impact pile-driving methods (*e.g.,* vibratory) are planned, though an impact hammer may be required depending on site conditions. Acoustic monitoring will occur during pile driving.
4. A biologist will be present during cofferdam installation and removal to monitor construction activities and compliance with the terms and conditions of permits. If any salmonids or sturgeon are found dead or injured during pile-driving activities, NMFS will be notified immediately, and in-water pile driving will cease.
5. Designated Biologist(s): the applicant proposes to submit in writing to NMFS the name, qualifications, business address, and contact information of a biologist(s) (designated biologist) at least 30 days before starting cofferdam activities that occur in the water. The applicant will ensure that the designated biologist is knowledgeable and experienced in the biology and natural history of the listed species. The designated biologist will be responsible for monitoring in-water cofferdam activities to help minimize and fully mitigate or avoid the incidental take of individual listed species and to minimize disturbance of listed species' habitat. The applicant will obtain NMFS' approval of the designated biologist in writing in email prior to starting in-water cofferdam activities and will obtain approval in advance in writing if the designated biologist must be changed.
6. Biological Monitor(s): The designated biologist may authorize biological monitors to assist in ESA compliance with this Opinion, under the direct supervision of the designated biologist. The designated biologist is responsible for assuring that any biological monitors working under their supervision are knowledgeable and experienced in the biology and life history of the listed species, the Opinion, the definition of "take" in ESA, and in implementation of standard avoidance and minimization measures used on construction Projects. The applicant proposes to provide a description of the biological monitor duties, for NMFS approval, prior to the start of Project activities.
7. Vibratory and/or impact hammers will be used only during daylight hours and will only be used along the riverbank during the standard work window of June 15 to October 31.

8. The applicant will conduct water quality monitoring during in-water cofferdam installation and removal that occurs in the Sacramento River. Water quality of the previously dewatered areas should be monitored during sheet pile removal as well. Sheet pile removal may need to be phased to allow waters to equilibrate/settle in an effort to avoid sudden drops in water quality (*e.g.,* turbidity or dissolved oxygen).

1.3.3.3. Minimizing underwater sound pressure from pile driving

The applicant will use the following measures to minimize impacts on listed fish species from underwater sound pressure if an impact hammer is used to complete installation of sheet piles.

1. Noise levels will not exceed the following threshold levels:
    a. Peak pressure = 206 decibels (dB)
    b. Accumulated SEL = 187 dB
2. To comply with thresholds, the applicant will employ the following measures:
    a. Use of an impact hammer cushion block.
    b. The applicant will only use hammers during daylight hours.
    c. Hammers will start at reduced energy levels and impact frequency.
    d. Applied energy and frequency will be gradually increased until necessary full force and frequency are achieved.
3. If noise thresholds are not met using the above measures, the applicant will consult with NMFS and one or more of the following mitigation measures may be implemented:
    a. A bubble curtain may be implemented, surrounding the pile to be driven.
    b. Shortening the daily duration of pile-driving activities.
    c. A qualified biologist will be present to monitor pile driving and compliance with regulatory documents for the project. If any injury or mortality to fish is observed, NMFS will be immediately notified, and in-water pile driving will cease.

1.3.3.4. Fish relocation during construction-related dewatering

1. The applicant will develop a fish capture/relocation plan that is approved by NMFS prior to cofferdam installation. The plan will reference and implement adapted fish relocation measures defined in the CDFW California Salmonid Stream Habitat Restoration Manual (Flosi *et al.* 1998). Fish entrapped within the cofferdam will be captured and relocated by a qualified biologist before the cofferdam is drained completely.
2. Methods used for capturing fish could include seining and net fishing. These methods will precede electrofishing (if needed). Water will be pumped and discharged back into the Sacramento River or Butte Slough (depending on its sources) from the cofferdam areas as needed to facilitate fish collection activities. Pump intakes will be fitted with appropriately sized fish screens to prevent fish from becoming entrained, according to the NMFS West Coast Region Anadromous Salmonid Passage Design Manual (2023), which incorporates different specifications depending on the life stage expected at the project site during construction activities.

1.3.3.5. Fish Rescue and Relocation Plan

The applicant will incorporate the following into the Fish Rescue and Relocation Plan:

1. The applicant will conduct fish rescue and relocation efforts in accordance with all required state and federal permits.
2. A list of fish species that may be encountered.
3. Descriptions of the proposed methods and equipment used to prevent stranding.
4. Proposed timing of fish relocation activities.
5. Proposed location where captured fish will be released.
6. Fish relocation operations will occur at all in-water construction where dewatering and resulting isolation of fish may occur.
7. The qualifications of the approved fish biologist implementing the plan. The applicant will submit the Fish Rescue and Relocation Plan to NMFS no less than 10 days before planned dewatering for construction and maintenance activities.
8. Each team conducting fish rescue and relocation efforts will include at least one approved fish biologist.
9. To avoid and minimize the risk of injury to fish, attempts to seine and/or net fish will always precede the use of electrofishing equipment. Electrofishing will be conducted in accordance with NMFS and other appropriate fish and wildlife agency guidelines.
10. The applicant will include the results of all fish capture and relocation efforts in an End of Project Report, including, but not limited to, date, time, location, comments, method of capture, fish species, number of fish, life stage, condition, release location, and release time.
11. The designated biologist will report any mortalities spotted during the dewatering. Mortalities will be identified to species and life stage. The rate of dewatering will decrease or cease if any special status species are found. The applicant will work in good faith and consult with agencies, as necessary, to determine and remedy any known causes of mortality.

1.3.3.6. Mitigation and compensation for adverse effects

A Bank Enabling Instrument (BEI) is a legally binding agreement that establishes and regulates the operation of a mitigation bank. The BEI was established for Bullock Bend on June 30, 2016. DWR entered into a credit sale agreement with the Bullock Bend Mitigation Bank sponsor and pre-purchased bulk mitigation credits to apply to future projects as needed. The BEI defines “sale” as the sale of credits by the bank sponsor, and “transfer” as the use or application of credits to mitigate for a particular project’s impacts by a person or entity seeking the transfer.

DWR proposes to transfer pre-purchased credits to offset impacts of the proposed action at a 1:1 acre ratio for temporary impacts and 3:1 acre ratio for permanent impacts, pending NMFS approval. A total of 1.58 acres of temporary impacts will result from dewatering the site. A total of 0.13 acres of permanent impacts will result from backfilling the scour area, inlet catwalk pile driving, and potential bank stabilization.

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 Central Valley (CV) spring-run Chinook salmon, California Central Valley (CCV) steelhead distinct population segment (DPS), and southern DPS (sDPS) North American 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 range-wide 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. Range-Wide 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 designated critical habitat, evaluates the conservation value of the various watersheds and coastal and marine environments that make up the designated critical habitat, and discusses the function of the PBFs that are essential for the species' conservation.

2.2.1. Sacramento River winter-run Chinook salmon

NMFS listed the Sacramento River (SR) winter-run Chinook salmon ESU as a threatened species under emergency provisions of the Endangered Species Act (ESA) in August 1989 (54 FR 32085 (August 4, 1989)) and formally listed it as a threatened species in November 1990 (55 FR 46515 (November 5, 1990)). On January 4, 1994, it was reclassified as endangered (59 FR 440). On June 28, 2005, NMFS issued a final listing determination for the SR winter-run Chinook salmon ESU, which concluded that the SR winter-run Chinook salmon ESU is "in danger of extinction" due to risks to the diversity and spatial structure of the ESU and, therefore, continues to warrant listing as an endangered species under the ESA (70 FR 37160 (June 28, 2005)). Critical habitat for SR winter-run Chinook salmon was designated on June 16, 1993 (58 FR 33212).

On July 22, 2014 (79 FR 42504), NMFS completed the "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" (NMFS 2014). In the 2024 5-year review, it was recommended that the SR winter-run Chinook salmon remain listed as endangered (NMFS 2024). The federally listed ESU of SR winter-run Chinook salmon and designated critical habitat occur in the Action Area and are likely to be affected by the proposed action.

2.2.1.1. *Life History*

Adult SR winter-run Chinook salmon immigration and holding through the Delta and into the lower Sacramento River occurs from December through July, with a peak during the period extending from January through April. SR winter-run Chinook salmon are sexually immature when upstream migration begins, and they must hold for several months in a suitable habitat before spawning. SR winter-run Chinook salmon primarily spawn in the mainstem Sacramento River between Keswick Dam (River Mile [RM] 302) and the Red Bluff Diversion Dam (RBDD) (RM 243). Spawning occurs between mid-April and mid-August, peaking in June and July as reported by CDFW annual escapement surveys (2000-2006). SR winter-run Chinook salmon embryo incubation in the Sacramento River can extend into October.

Larval fish, known as 'alevins,' normally remain in the gravel for four to six weeks until their yolk sac has been absorbed. Upon emergence from the gravel, "fry" seek adequate rearing habitat. Juvenile SR winter-run Chinook salmon emigration past RBDD may begin after almost one year in the river. They begin to move downriver as early as mid-July, typically peaking in September, and can continue through March in dry years. From 1995 to 1999, all SR winter-run Chinook salmon out-migrating as fry passed RBDD by October, and all out-migrating pre-smolts and smolts passed RBDD by March.

Once juvenile fish have completed the physiological changes necessary to enter saltwater (called smoltification), they enter the Pacific Ocean and rear until adulthood for approximately three to four years. Once adult fish are three or four years old, they migrate back upstream to freshwater to start the life cycle again and create the next generation. All Chinook salmon are "semelparous" fish, meaning they reproduce once in their lifetime and then die shortly after spawning. Table 2-1 of the Recovery Plan for Central Valley Chinook Salmon and Steelhead outlines the temporal occurrence and relative abundance of adult and juvenile SR winter-run Chinook salmon in the Sacramento River and is incorporated here by reference.

2.2.1.2. *Viability status*

The biological status of the SR winter-run Chinook salmon population has declined since the 2016 5-year review, with the single spawning population on the mainstem Sacramento River at a high risk of extinction. New information indicates the population, which had experienced a declining trend in abundance through 2017, is beginning to rebuild such that the viability criteria would indicate a low risk of extinction for SR winter-run Chinook salmon; however, the population remains at an increased risk of extinction due to the influence of the hatchery broodstock (NMFS 2024).

The following recovery criteria must be met to delist the species:

- Three populations in the Basalt and Porous Lava Diversity Group at a low risk of extinction

The Basalt and Porous Lava diversity group does not currently meet the number of viable/independent populations at a low risk of extinction needed to meet recovery criteria (Johnson *et al.* 2023).

2.2.1.3. Abundance & trends

The abundance of SR winter-run Chinook salmon has declined during recent periods of unfavorable ocean conditions (2005–2006) and droughts (2007–2009, 2012–2016). Temperature conditions during egg development and fry emergence were suboptimal during SR winter-run Chinook salmon rearing in 2014 and 2015, reaching lethal levels in both years due to reduced cold-water releases from Shasta Reservoir for this life stage. Two consecutive years of poor returns worsened the vulnerability of the overall population. Yet, water year 2017, one of the wettest years on record, may have contributed to the high survival of SR winter-run Chinook salmon, especially SR winter-run Chinook salmon spawning in natural areas observed in the 2019 returns (Johnson *et al.* 2023).

In 2019, the total number of mainstem in-river spawners observed was 7,852. This number included 2,873 hatchery-origin fish and 4,979 natural-origin fish. Decreased effective population size places a species at risk of losing gene variants faster than can be replaced by mutation. Criteria for assessing extinction risk in Lindley *et al*. (2007) indicate that species with an effective population of greater than 500 are considered at low risk for genetic drift. However, the authors acknowledge that this value was developed under the assumption that all mutations were mildly deleterious, as was reported by Franklin (1980) and Soule (1980). Further research by Lande (1995) indicated that only 10% of mutations are mildly deleterious. As such, it was determined that mutations introduced genetic variation at only 10% of the assumed rate, and effective populations should be greater than 5000 to mitigate for the loss of diversity due to genetic drift. Despite this finding, Lindley *et al*. (2007) recommends maintaining effective populations above 500 to maintain genetic integrity given that salmonid populations are assumed to have low immigration rates, which can significantly curtail the effect of drift. Since 2010, an average of 173 fish have been taken annually for hatchery broodstock at the Livingston Stone National Fish Hatchery (LSNFH). Because of the sustainable LSNFH population and a naturally spawning population, the SR winter-run Chinook salmon ESU is likely at a lower extinction risk than it would be with just a single naturally spawning population, at least in the near term. Yet, reliance on production from LSNFH can result in introgression with natural-origin SR winter-run Chinook salmon at a level that results in a "high" extinction risk (NMFS 2024).

An emerging threat to SR winter-run Chinook salmon is thiamine deficiency. In 2020, staff at several fish hatcheries noticed abnormal behaviors in recently hatched fry. At that time, there were also reports of high mortality among naturally produced juvenile Chinook salmon in some Central Valley rivers. Fish pathologists determined that the abnormal behavior and mortality were associated with thiamine deficiency due to shifting Chinook prey populations. While efforts are underway to respond to this new threat, the full extent of the impact is not fully known since many monitoring efforts target later life stages (rather than recently emerged fry) and, therefore, are unlikely to detect early life stage mortality associated with thiamine deficiency. Impacts may become more apparent as affected salmon cohorts return to rivers and hatcheries (NMFS 2024).

2.2.1.4. Spatial Structure & Diversity

SR winter-run Chinook salmon spawning is currently limited to the mainstem of the Sacramento River between the Keswick Dam (RM 302) and the RBDD (RM 243). Species with a restricted spatial distribution and few spawning areas are at a higher risk of extinction from catastrophic environmental events (*e.g.,* a single landslide) than are species with more widespread and complex spatial structure (NMFS 2014).

The spatial structure and diversity of the SR winter-run Chinook salmon ESU will improve by re-establishing winter-run Chinook salmon in their historical spawning and rearing habitat. Projects to reintroduce SR winter-run Chinook salmon into Battle Creek are ongoing while reintroductions to historical habitats upstream of Shasta Reservoir are in the planning and early implementation phases. In the summer of 2020, juvenile salmon were observed in Battle Creek indicating the first successful spawning of SR winter-run Chinook salmon in Battle Creek in over 100 years (Johnson *et al.* 2023).

2.2.1.5. SR winter-run Chinook salmon critical habitat

Critical habitat was designated for the SR winter-run Chinook salmon on June 16, 1993 (58 FR 33212). The geographic range of the species includes the Sacramento River from Keswick Dam to Chipps Island at the westward margin of the delta, all waters from Chipps Island westward to Carquinez Bridge, including Honker Bay, Grizzly Bay, Suisun Bay, and Carquinez Straight, all waters of San Pablo Bay westward of the Carquinez Bridge, and those waters north of San Francisco-Oakland Bay Bridge (58 FR 33212).

The construction of major dams has confined SR winter-run Chinook salmon to the lower Sacramento River mainstem that historically was only used for migration. This reduced spawning and rearing habitat resulting in declines in population abundance. Additionally, the remaining habitat is of lower quality because of higher water temperatures in late summer and fall, reduced gravel recruitment, and lack of instream, large woody material.

The PBFs that are essential for SR winter-run Chinook salmon include:

1. Volitional passage from the Pacific Ocean to appropriate spawning areas in the upper Sacramento river,
2. The availability of clean gravel for spawning substrate,
3. Adequate river flows for successful spawning, incubation of eggs, fry development and emergence, and downstream transport of juveniles,
4. Water temperatures between 42.5 and 57.5ºF for successful spawning, egg incubation, and fry development,
5. Habitat and adequate prey free of contaminants,
6. Riparian habitat that provides for successful juvenile development and survival, and
7. Volitional passage of juveniles downstream from the spawning grounds to San Francisco Bay and the Pacific Ocean.

The current condition of SR winter-run Chinook salmon critical habitat PBFs has been degraded from the historic condition, and critical habitat in the ESU faces challenges with maintaining essential features due to ongoing human activities. Large dams stop the recruitment of spawning gravels, which affect both habitat type (spawning areas) and essential features of spawning areas (substrate). Water utilization in many regions throughout the ESU reduces summer base flows, which limits the establishment of several essential features, such as water quality and water quantity. In the Sacramento River, bank armoring has significantly reduced the quantity of floodplain-rearing habitat for juvenile salmonids and has altered the natural geomorphology of the river (NMFS 2014).

Levee construction involves the removal of riparian vegetation, resulting in reduced habitat complexity and shading, making juveniles more susceptible to predation. Additionally, loss of riparian vegetation reduces aquatic macroinvertebrate recruitment resulting in decreased food availability for rearing juveniles (Anderson and Sedell 1979; Pusey and Arthington 2003). Although the current conditions of SR winter-run Chinook salmon critical habitat are significantly degraded, the remaining spawning habitat, migratory corridors, and rearing habitat are considered to have high intrinsic value for the conservation of the species.

2.2.1.6. Summary of the SR winter-run Chinook salmon ESU Viability

To conclude, the viability of the SR winter-run Chinook salmon has deteriorated since it was listed under the ESA (NMFS 2014; Johnson *et al.* 2023). The largest impacts are likely due to unfavorable ocean conditions and droughts, as well as new emerging threats, including thiamine deficiency. SR winter-run Chinook salmon continue to face significant threats likely exacerbated by environmental variation. Based on the most recent 5-year review, the remaining population remains at an increased risk of extinction and does not meet the criteria for delisting (NMFS 2024). Increased efforts to increase spatial structure and diversity hold the greatest potential to improve the status of the species.

2.2.2. Central Valley spring-run Chinook salmon

In 1999 (64 FR 50394), NMFS listed CV spring-run Chinook salmon under the ESA and classified it as a threatened species. This initial classification was reaffirmed in 2005 when the Feather River Fish Hatchery (FRFH) population was added to the Evolutionarily Significant Unit (ESU) (70 FR 37159). Critical habitat for CV spring-run Chinook salmon was later designated in 2005 (70 FR 52488).

On July 22, 2014 (79 FR 42504), NMFS completed the "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" (NMFS 2014). In the previous 5-year review, it was recommended that the CV spring-run Chinook remain listed as threatened (NMFS 2016a; 81 FR 33468). The federally listed ESU of CV spring-run Chinook salmon and designated critical habitat occur in the Action Area and may be affected by the proposed action.

2.2.2.1. Life History

Generally, adult CV spring-run Chinook salmon fish migrate from the Pacific Ocean in a reproductively immature state and swim upstream into fresh water in the spring months (approximately February through September) using olfactory senses to locate their birth waters. The adult fish then hold (approximately March through October) and spawn in cold, fresh water in the early fall (approximately September through November). Alevins hatch from eggs and emerge from their gravel nests throughout fall and early winter (approximately October through December). Juvenile fish then rear and feed in freshwater from late fall through spring (approximately October through June) or rear for a year (*e.g.,* October to subsequent October to December) and become 'yearling' juveniles when conditions are suitable.

As juvenile fish rear, they migrate downstream and eventually reach the Sacramento-San Joaquin River Delta and the San Francisco Bay estuary. Once juvenile fish have completed smoltification, they enter the Pacific Ocean and rear until adulthood for approximately three to four years, typical for Chinook salmon. Once adult fish are three or four years old, they migrate back upstream to freshwater to start the life cycle again and create the next generation. Table 2-3 of the Recovery Plan for Central Valley Chinook Salmon and Steelhead outlines the temporal occurrence and relative abundance of adult and juvenile CV spring-run Chinook salmon in the Sacramento River and tributaries and is incorporated here by reference.

In general, wetter water years result in higher survival of juveniles out-migrating during the spring of the same year they emerged. In three to four years, the juvenile cohort that experienced wetter out-migration conditions are more likely to result in a higher abundance of adults returning to freshwater to spawn. Drier water years generally result in low survival rates during spring out-migration, and encourage a subset (roughly 10%) of juveniles to express the yearling life history strategy (Cordoleani *et al.* 2020). This results in fewer large juveniles out-migrating to the ocean much later in the year. When the dry condition cohort returns as adults, there are fewer adults because there was less survival during the spring outmigration. Therefore, the number of adult spawners is likely lower than a juvenile cohort that experienced drought conditions in freshwater during their out-migration, in contrast to a juvenile cohort that experienced high river flows during a wet-water year while out-migrating.

2.2.2.2. Viability status

The viability of CV spring-run Chinook salmon has deteriorated since the NMFS 2016a status review, with the weakening of all independent CV spring-run Chinook salmon populations (Johnson *et al.* 2023). The estimated abundance of adult CV spring-run Chinook salmon for the Sacramento River watershed in 2019 was 26,553, approximately half of the population in 2014 (N=56,023). In addition, population sizes have hit decadal lows, of ~14,000 individuals recently (Johnson *et al.* 2023). The 2023 CDFW escapement estimates counted just 95 salmon in Butte Creek (Azat and Killam 2024). In 2024, the estimated escapement for adult Butte Creek spring-run Chinook salmon was 51 salmon with only 28 successfully spawning (Azat and Killam 2025)

The CV spring-run Chinook salmon ESU includes all naturally spawned CV spring-run Chinook salmon originating from the Sacramento River and its tributaries (70 FR 37159, June 28, 2005). In 2014, FRFH broodstock was used to reintroduce CV spring-run Chinook salmon into the mainstem San Joaquin River as an ESA 10(j) experimental population (78 FR 79622). Since 2019, adults have been observed returning to the San Joaquin River and successfully spawning within the San Joaquin River Restoration Program Restoration Area. There have also been observations of CV spring-run Chinook salmon returning to the San Joaquin River tributaries (Gutierrez *et al.* 2024). This ESU does not include designated Chinook salmon as part of the San Joaquin River experimental population (Johnson *et al.* 2023).

To meet the recovery criteria for this ESU and thereby delist the species, there must be at least nine populations at low risk of extinction (Core 1) distributed throughout the Central Valley, as well as additional Core 2 populations.

- One population in the Northwestern California Diversity Group at low risk of extinction
- Two populations in the Basalt and Porous Lava Diversity Group at low risk of extinction
- Four populations in the Northern Sierra Nevada Diversity Group at low risk of extinction
- Two populations in the Southern Sierra Nevada Diversity Group at low risk of extinction

None of the four diversity groups currently meet the number of viable/independent populations at a low risk of extinction needed to meet recovery criteria (Johnson *et al.* 2023).

Butte Creek is the most productive spring-run Chinook salmon stream in the Sacramento Valley (DWR 2005); therefore, the viability of the CV spring-run Chinook salmon ESU is reliant upon sustaining the Butte Creek spring-run Chinook salmon population (NMFS 2014). Butte Creek spring-run Chinook salmon regularly survive temperatures above the incipient lethal limit reported for Chinook salmon, suggesting that they may be adapted to warmer temperatures than most Chinook stocks (Lindley *et al.* 2004). This adaptation may contribute to an increased resilience to environmental variation and further emphasizes the importance of maintaining the genetic integrity of the Butte Creek population for the species. Key stressors to the Butte Creek population include passage impediments/barriers that affect migration and holding (NMFS 2014).

Adults migrating to Butte Creek from the Sacramento River can enter the watershed through BSOG or via the Sutter Bypass through the Sacramento Slough (CDFW 2013). Adult migrants can also enter the Sutter Bypass when the Sacramento River overtops the Tisdale Weir, or Butte Creek when the Sacramento River overtops the Moulton and Colusa Weirs during high-flow events. The Sutter Bypass has numerous passage barriers and water quality issues. Overgrowth of vegetation (invasive yellow primrose and water hyacinth) during drought conditions can inhibit stream passage for adult Chinook salmon, and salmon passage depends on efforts carried out by DWR to remove the vegetation overgrowth (DWR 2022a). Temporal passage barriers at Weir 1 and the East-West Weir are documented in the CDFW passage assessment database, and CV spring-run Chinook salmon mortality events have been reported at Weir 1 due to stranding and low flow in 2012, 2013, and 2021 (CDFW 2022). Updates at Weir 1 to reduce species mortality are in the planning and early implementation phase. Additionally, at least 50 unscreened diversions used for agricultural irrigation limit migration through the Sutter Bypass, which can create passage impediments during low flows, and can route fish into areas disconnected from the creek (CDFW 2024a).

2.2.2.3. Abundance & trends

In 2015, CV spring-run Chinook salmon showed strong signs of repopulating Battle Creek, home to a historic independent population in the Basalt and Porous Lava diversity group that had been extirpated for many decades (NMFS 2016a). Current viability metrics show a significant declining trend (23% decline per year) and low population size (90% decline) with the main independent populations of CV spring-run Chinook salmon reaching all-time declines over one generation (Battle Creek = 77%, Butte Creek = 76%, Deer Creek = 84%, and Mill Creek = 68%) (Johnson *et al.* 2023).

The rate of decline over the past decade, coupled with low abundances, place the Battle, Deer, and Mill Creek populations at a high risk of extinction. The Butte Creek population remains at a low risk of extinction, yet all viability metrics are trending downward relative to the 2015 Viability Assessment. In 2021, nearly 20,000 adult Butte Creek spring-run Chinook salmon perished before spawning, which was 96% of the returning fish that year (CDFW 2022). The 2021 Butte Creek spring-run pre-spawn mortality event led to catastrophic population loss due to warm waters and disease outbreak, because population demands outpaced the availability of cold water and sufficient flows (Bacher 2022; CDFW 2022). Further, the erosion event from the Butte Canal failure (August 9, 2023), subsequent sediment deposition, and high turbidity in Butte Creek impacted multiple life history stages of CV spring-run Chinook salmon (Manes 2024) resulting in a 59% loss of the 2023 spawning class and probable reduced juvenile survival (FERC 2024). In 2023, less than 100 Butte Creek spring-run Chinook salmon returned to spawn (Azat and Killman 2024). In 2024, the estimated number of holding adult Butte Creek spring-run Chinook salmon was 51 salmon (Henley 2024).

Counteracting recent declines in the abundance of adults from dependent populations, CV spring-run Chinook salmon have continued to repopulate areas where they were once extirpated, including Battle and Clear Creeks, and more recently the San Joaquin River. Each of these watersheds has the potential to support independent and viable CV spring-run Chinook salmon populations (Gutierrez *et al.* 2024; NMFS 2014; Lindley *et al.* 2004). CV spring-run Chinook salmon ESU populations have experienced a series of droughts over the past decade. From 2007–2009 and 2012–2016, the Central Valley experienced drought conditions and low river and stream discharges, strongly associated with lower survival of Chinook salmon (Michel *et al.* 2015).

An emerging threat to the CV spring-run Chinook salmon populations includes thiamine deficiency, which was responsible for early life stage mortality of FRFH spring-run Chinook salmon in the hatchery in recent years, initially being diagnosed in 2019 (Mantua *et al.* 2021). Starting in 2019, significant numbers of juvenile mortalities were observed in the Feather River rotary screw trap, early in the juvenile out-migration season, consistent with the thiamine deficiency complex observed in the hatchery. Significantly fewer juveniles were observed in 2019 (N=1149) compared to 2018 (N=30,334), and 45% of juveniles in 2019 were found dead compared to 1% observed in 2018 (Johnson *et al.* 2023). It is unclear the extent to which this was a basin-wide nutritional deficiency for all CV spring-run Chinook salmon spawning in 2019.

2.2.2.4. Spatial Structure & Diversity

At the ESU level, the spatial diversity is increasing and CV spring-run Chinook salmon are present (albeit at low numbers in some cases) in all diversity groups. The continued returns of CV spring-run Chinook salmon to Battle Creek and Clear Creek are benefiting the viability of CV spring-run Chinook salmon. Similarly, the reappearance of early migrating Chinook salmon to the San Joaquin River tributaries may be the beginning of natural dispersal processes into rivers where they were once extirpated. While expanding spatial diversity is a positive indicator for the ESU, populations have still declined sharply in recent years to in most cases worryingly low levels of abundance.

2.2.2.5. *CV spring-run Chinook salmon critical habitat*

Critical habitat was designated for the CV spring-run Chinook salmon on September 2, 2005 (70 FR 52488). The geographic range of the species includes stream reaches of the Feather, Yuba, and American rivers; Big Chico, Butte, Deer, Mill, Battle, Antelope, and Clear creeks; and the Sacramento River downstream to the Delta, as well as portions of the northern Delta (70 FR 52488).

Because of human-made migration barriers, especially the construction of major dams, CV spring-run Chinook salmon have been confined to lower-elevation river mainstems that historically were only used for migration. The greatly reduced spawning and rearing habitat has resulted in declines in population abundances in these streams. Additionally, the remaining habitat is of lower quality, in particular, because of higher water temperatures in late summer and fall, reduced gravel recruitment, and lack of instream large woody material.

The critical habitat designation for CV spring-run Chinook salmon lists the PBFs essential to the conservation of the species ((70 FR 52488); September 2, 2005), which include:

1. Freshwater spawning sites with water quantity and quality conditions and substrate supporting spawning, incubation and larval development,
2. Freshwater rearing sites with: (i) water quantity and floodplain connectivity to form and maintain physical habitat conditions and support juvenile growth and mobility; (ii) water quality and forage supporting juvenile development; and (iii) natural cover, such as shade, submerged and overhanging large wood, log jams and beaver dams, aquatic vegetation, large rocks and boulders, side channels, and undercut banks,
3. Freshwater migration corridors free of obstruction and excessive predation with water quantity and quality conditions and natural cover, such as submerged and overhanging large wood, aquatic vegetation, large rocks and boulders, side channels, and undercut banks supporting juvenile and adult mobility and survival, and
4. Estuarine areas free of obstruction and excessive predation with: (i) water quality, water quantity, and salinity conditions supporting juvenile and adult physiological transitions between fresh- and saltwater; (ii) natural cover, such as submerged and overhanging large wood, aquatic vegetation, large rocks and boulders, side channels; and (iii) juvenile and adult forage, including aquatic invertebrates and fishes, supporting growth and maturation.

The current condition of spring-run Chinook salmon critical habitat PBFs have been degraded from their historic condition. Although there are exceptions, many streams and rivers in the ESU have impaired habitat. Additionally, critical habitat in the ESU often lacks the ability to establish or maintain essential features due to ongoing human activities.

Large dams stop the recruitment of spawning gravels, which impacts both an essential habitat type (spawning areas) and the essential feature of spawning areas (substrate). Water utilization in many regions throughout the ESU reduces summer base flows, which limits the establishment of several essential features, such as water quality and quantity. In the Sacramento River and adjacent tributaries, bank armoring has significantly reduced the quantity of floodplain-rearing habitat for juvenile salmonids and has altered the natural geomorphology of the river (NMFS 2014).

CV spring-run Chinook salmon are only able to access large floodplain areas, such as the Yolo Bypass, under certain hydrologic conditions that do not occur in drier years. Levee construction involves the removal of riparian vegetation, resulting in reduced habitat complexity and shading, making juveniles more susceptible to predation. Additionally, loss of riparian vegetation reduces aquatic macroinvertebrate recruitment resulting in decreased food availability for rearing juveniles (Anderson and Sedell 1979; Pusey and Arthington 2003). Although the current conditions of CV spring-run Chinook salmon critical habitat are significantly degraded, the spawning habitat, migratory corridors, and rearing habitat that remain are considered to have high intrinsic value for the conservation of the species.

2.2.2.6. Summary of the CV spring-run Chinook salmon ESU Viability

To conclude, the viability of the CV spring-run Chinook salmon has deteriorated since it was listed under the ESA (NMFS 2016a, Johnson *et al.* 2023). The largest impacts are likely due to the 2012-2015 and 2020-2022 freshwater drought conditions and unusually warm ocean conditions experienced by these cohorts. This ESU continues to face significant, unyielding threats likely to be exacerbated by the impacts of future environmental variation. Based on the previous 5-year review and recent data, there has been a decrease in species viability and the ESU remains at a moderate to high risk of extinction, and threats to the species are not declining (Johnson *et al.* 2023).

2.2.3. California Central Valley steelhead

The CCV steelhead includes fish that spawn naturally in the Sacramento and San Joaquin Rivers and their tributaries, as well as steelhead that are part of the hatchery program at the Coleman National Fish Hatchery (CNFH) and FRFH (70 FR 37204).

In 1998, NMFS listed CCV steelhead under the ESA and classified it as a threatened species. In 2006, following the development of NMFS' Hatchery Listing Policy (70 FR 37204, June 28, 2005), NMFS re-evaluated the status of this DPS and determined that the DPS continued to warrant listing as a threatened species. Furthermore, NMFS determined that the CNFH and FRFH stocks of CCV steelhead should be part of the DPS.

On July 22, 2014 (79 FR 42504), NMFS completed the "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" (NMFS 2014). In the following (2016) 5-year review, it was recommended that CCV steelhead should remain listed as threatened (NMFS 2016b; 81 FR 33468). The 2023 Southwest Fisheries Science Center assessment indicates that the viability of CCV steelhead appears unchanged since the 2016 review (Johnson *et al.* 2023).

CCV steelhead historically occurred naturally throughout the Sacramento and San Joaquin River basins, although stocks have been extirpated from large areas in both basins. In 1988, the California Advisory Committee on Salmon and Steelhead reported a reduction in freshwater CCV steelhead habitat from 6,000 linear miles to 300 linear miles of stream habitat.

2.2.3.1. *Life History*

Steelhead exhibits perhaps the most complex suite of life-history traits of any species of Pacific salmonid. Members of this species can be anadromous or freshwater residents and, under some circumstances, members of one form can yield offspring of another.

Adult migration from the ocean to spawning grounds occurs much of the year, with peak migration occurring in the fall or early winter. Steelhead generally begins spawning in December and continues through March/April.

CCV steelhead spawn downstream of dams on every major tributary within the Sacramento and San Joaquin River systems. Due to water development projects, most spawning is now confined to lower stream reaches below dams. In a few streams, such as Mill and Deer creeks, steelhead still have access to historical spawning areas (NMFS 2014).

Spawning occurs mainly in gravel substrates (particle size range of about 0.2–4.0 inches). Adults tend to spawn in shallow areas (6–24 inches deep) with moderate water velocities (about 1 to 3.6 feet per second) (Hannon and Deason 2008). Unlike Chinook salmon, CCV steelhead may not die after spawning (McEwan *et al.* 1996). Some may return to the ocean and repeat the spawning cycle for two or three years. The percentage of CCV steelhead that survive spawning is presumed low, but varies annually between stocks. Acoustic tagging of CCV steelhead kelts from the CNFH indicates survival rates can be high, especially for CCV steelhead reconditioned by holding and feeding at the hatchery before release. Some return immediately to the ocean and some remain and rear in the Sacramento River (NMFS 2014). Recent data have shown that kelts may remain in freshwater for a year after spawning (Teo *et al.*2013), but most return to the ocean.

CCV adult steelhead eggs incubate within the gravel and hatch from approximately 19 to 80 days at water temperatures ranging from 60°F to 40°F, respectively (NMFS 2014). Steelhead embryo incubation generally occurs from December through June in the Central Valley. Steelhead eggs reportedly have the highest survival rates at water temperature ranges of 44.6°F to 50.0°F (Myrick and Cech 2004).

After hatching, alevins remain in the gravel while absorbing their yolk sacs, and emerge as young juvenile fry that immediately begin feeding (NMFS 2014). Productive juvenile-rearing habitat is characterized by complexity, primarily in the form of cover, which can be deep pools, woody debris, aquatic vegetation, or boulders. Cover is an important habitat component for juvenile steelhead, both as velocity refugia and as a means of avoiding predation (Bugert *et al.* 1991). Older juveniles use riffles and larger juveniles may also use pools and deeper runs (McEwan 2001). An upper water temperature limit of 65°F is preferred for the growth and development of the Sacramento River and American River juvenile steelhead (NMFS 2014).

In the Sacramento River, juvenile steelhead generally migrate to the ocean in spring and early summer at 1 to 3 years of age, with peak migration through the Delta in March and April (NMFS 2014). Steelhead successfully smolt at water temperatures in the 43.7°F to 52.3°F range (Myrick and Cech 2001). Table 2-4 of the Recovery Plan for Central Valley Chinook Salmon and

Steelhead outlines the temporal occurrence and relative abundance of adult and juvenile CCV steelhead in the Sacramento River and tributaries and is incorporated here by reference.

2.2.3.2. Viability status

Good *et al.* (2005) found that the CCV steelhead DPS was in danger of extinction, with a minority of the Biological Review Team (BRT) viewing the DPS as likely to become endangered. The BRT's major concerns were the low abundance of natural-origin anadromous *O. mykiss*, the lack of population-level abundance data, and the lack of any information to suggest that the decline in steelhead abundance evident from 1967–1993 dam counts had stopped.

Using data through 2005, Lindley *et al.* (2007) found that data were insufficient to determine the viability of any of the naturally-spawning populations of CCV steelhead, except for those spawning in rivers adjacent to hatcheries, which were likely to be at high risk of extinction due to extensive spawning of hatchery-origin fish in natural areas.

The Central Valley Salmon and Steelhead Recovery Plan (NMFS 2014) includes biological recovery criteria based on the viable salmonid population concept. The "Central Valley Salmon and Steelhead Recovery Plan" includes the following recovery criteria:

- One population in the Northwestern California Diversity Group at low risk of extinction
- Two populations in the Basalt and Porous Lava Diversity Group at low risk of extinction
- Four populations in the Northern Sierra Diversity Group at low risk of extinction
- Two populations in the Southern Sierra Diversity Group at low risk of extinction
- Maintain multiple populations at moderate risk of extinction

To meet the recovery criteria to delist the species, there must be at least nine populations at a low risk of extinction distributed throughout the Central Valley, as well as additional populations at a moderate risk of extinction (NMFS 2014). Currently, no CCV steelhead populations satisfy the low extinction risk criteria. Of the 16 populations evaluated, 11 are at high extinction risk and six are at moderate extinction risk (Johnson *et al.* 2023).

2.2.3.3. Abundance & trends

Population trend data remain extremely limited for the CCV steelhead DPS. The total hatchery populations from CNFH, FRFH, and Mokelumne River Hatchery (MRH) have significantly increased since the 2010 and 2015 viability assessments. CNFH returns have steadily increased by 15% per year over the last decade. The American River steelhead population has experienced a precipitous decline since 2003, resulting in a moderate risk of extinction.

Looking broader than the individual population level, Chipps Island midwater trawl data provide information on the trend in abundance for the CCV steelhead DPS as a whole. Updated through 2019, the trawl data indicate that the production of natural-origin steelhead remains very low relative to hatchery production. The catch-per-unit effort has fluctuated and generally increased over the past decade, but the proportion of the catch that is adipose fin-clipped has increased steadily, exceeding 90% in recent years and reaching 96% during the drought in 2015 (100% of hatchery steelhead production have been adipose fin-clipped starting in 1998). This suggests that the majority of CCV steelhead out-migrating from the Sacramento-San Joaquin Delta (Delta) are of hatchery origin (Johnson *et al.* 2023).

The proportion of hatchery-origin fish in the Battle Creek returns averaged 29% over the 2002–2010 period, elevating the level of hatchery influence to a moderate risk of extinction. The Chipps Island midwater trawl dataset of the U.S. Fish and Wildlife Service (USFWS) indicated that the decline in natural production of steelhead had continued unabated through 2010, with the proportion of adipose fin-clipped steelhead reaching 95% (Johnson *et al.* 2023). In 2015, population trend data showed significant increases in the abundance of CNFH and FRFH populations, but data are still lacking to estimate trends in natural populations (Johnson *et al.* 2023).

2.2.3.4. *Spatial Structure & Diversity*

This DPS includes steelhead populations spawning in the Sacramento and San Joaquin rivers and their tributaries. Populations upstream of migration barriers remain excluded from this DPS. Hatchery stocks within the DPS include CNFH, FRFH, and MRH. Genetic analysis showed that the steelhead stock propagated in the MRH was genetically similar to the steelhead broodstock in the FRFH (Pearse and Garza 2015), consistent with documentation on the recent transfers of eggs from the FRFH for broodstock at the MRH. The Nimbus Hatchery (NH) steelhead remains genetically divergent from the Central Valley DPS lineages, consistent with their founding from coastal steelhead stocks, and excluded from the DPS (Pearse and Garza 2015). As overall data remain extremely limited for the CCV steelhead DPS, it is difficult to ascertain if their spatial distribution has changed. Recent monitoring data suggest steelhead are not noted to have had any substantial changes in spatial distribution or diversity. Hatchery influence continues to be a high threat to the diversity of the DPS, and the out-of-basin stock at NH poses a significant genetic threat to CCV steelhead (Johnson *et al.* 2022).

2.2.3.5. *California Central Valley steelhead critical habitat*

On February 16, 2000, (65 FR 7764), NMFS published a final rule designating critical habitat for CCV steelhead. This critical habitat includes all river reaches accessible to listed steelhead in the Sacramento and San Joaquin rivers and their tributaries in California, including the lower Yuba River upstream to Englebright Dam. NMFS proposed a new critical habitat for CCV steelhead on December 10, 2004, (69 FR 71880) and published a final rule designating critical habitat for these species on September 2, 2005.

Critical habitat for CCV steelhead includes stream reaches, such as those of the Sacramento, Feather, and Yuba Rivers; Deer, Mill, Battle, and Antelope creeks in the Sacramento River basin; the San Joaquin River, including its tributaries; and the waterways of the Delta. Currently, the CCV steelhead DPS and critical habitat extend up the San Joaquin River up to the confluence with the Merced River. Critical habitat includes the stream channels in the designated stream reaches and the lateral extent as defined by the ordinary high-water line.

The critical habitat for CCV steelhead lists the essential PBFs ((70 FR 52488); September 2, 2005), which include:

1. Freshwater spawning sites with water quantity and quality conditions and substrate supporting spawning, incubation and larval development,
2. Freshwater rearing sites with: (i) water quantity and floodplain connectivity to form and maintain physical habitat conditions and support juvenile growth and mobility; (ii) water quality and forage supporting juvenile development; and (iii) natural cover, such as shade, submerged and overhanging large wood, log jams and beaver dams, aquatic vegetation , large rocks and boulders, side channels, and undercut banks,
3. Freshwater migration corridors free of obstruction and excessive predation with water quantity and quality conditions and natural cover, such as submerged and overhanging large wood, aquatic vegetation, large rocks and boulders, side channels, and undercut banks supporting juvenile and adult mobility and survival, and
4. Estuarine areas free of obstruction and excessive predation with: (i) water quality, water quantity, and salinity conditions supporting juvenile and adult physiological transitions between fresh- and saltwater; (ii) natural cover, such as submerged and overhanging large wood, aquatic vegetation, large rocks and boulders, side channels; and (iii) juvenile and adult forage, including aquatic invertebrates and fishes, supporting growth and maturation.

Historically, CCV steelhead spawned in many headwaters and upstream portions of the Sacramento River and San Joaquin River basins. Passage impediments have contributed to substantial reductions in the populations of these species by isolating them from much of their historical spawning habitat. The current condition of CCV steelhead critical habitat PBFs have been degraded from their historic condition within the Action Area. The majority of streams and rivers in the DPS have impaired habitat. Additionally, critical habitat cannot often re-establish essential features due to ongoing human activities. Large dams stop the recruitment of spawning gravels, which impacts both an essential habitat type (spawning areas), as well as an essential feature of spawning areas (substrate). Water utilization in many regions throughout the DPS reduces summer base flows, which limits the establishment of several essential features, such as water quality and quantity.

Freshwater rearing and migration PBFs have been degraded from their historic condition within the Action Area. In the Sacramento and San Joaquin rivers, bank armoring has significantly reduced the quantity of floodplain-rearing habitat for juvenile salmonids and has altered the natural geomorphology of the river (NMFS 2014). Like winter-run Chinook salmon, CCV steelhead can only access large floodplain areas, such as the Yolo Bypass, under certain hydrologic conditions that do not occur in drier years. Levee construction involves the removal of riparian vegetation, resulting in reduced habitat complexity and shading, making juveniles more susceptible to predation. Additionally, loss of riparian vegetation reduces aquatic macroinvertebrate recruitment resulting in decreased food availability for rearing juveniles (Anderson and Sedell 1979; Pusey and Arthington 2003).

Recent conservation actions have improved critical habitat conditions for Butte Creek steelhead. Completion of the Willow Slough Weir Project (new culverts and a new fish ladder) in 2010 improved fish passage through the Sutter Bypass. In addition, since 2000, real-time coordinated operations of the DeSabla Centerville Federal Energy Regulatory Commission (FERC) Project No. 803 have been implemented to reduce the water temperature-related effects of the project on spring-run Chinook salmon adults during the summer, which also benefit steelhead (NMFS 2016b); however, punctual cold-water releases are not always feasible (Bacher 2022).

Although the current conditions of CCV steelhead critical habitat are significantly degraded, the spawning habitat, migratory corridors, and rearing habitat that remain in the Sacramento-San Joaquin River watershed and the Delta are considered to have high intrinsic value for the conservation of the species, as they are critical to ongoing recovery efforts.

2.2.3.6. Summary of the California Central Valley steelhead viability

Based on the limited information available, the overall viability of the CV steelhead DPS appears to be unchanged since the NMFS 5-year review (NMFS 2016b). However, most (11 of 16) of the populations for which data exists are at a high risk of extinction based on abundance and/or hatchery influence. No population is currently considered to be at a low risk of extinction. The lack of improved natural production estimates, and low abundances coupled with large hatchery influence are causes for continued concern (Johnson *et al.* 2023).

2.2.4. sDPS North American green sturgeon

The California Central Valley green sturgeon includes the genetically isolated sDPS that naturally spawn within the Sacramento River and its tributaries (71 FR 17757). On April 7, 2006 (71 FR 17757), NMFS listed the sDPS North American green sturgeon (sDPS green sturgeon) under the ESA and classified it as a threatened species. This was followed by NMFS' designation of critical habitat for the sDPS green sturgeon on October 9, 2009 (74 FR 52300), as well as an updated ESA 4(d) ruling publishing final ESA protective regulations on June 2, 2010 (75 FR 30714).

On August 8, 2018, NMFS published the recovery plan for the sDPS green sturgeon (NMFS 2018). The following 5-year review published on October 26, 2021, determined no change to the species status (NMFS 2021). The federally listed sDPS of North American green sturgeon and its designated critical habitat occur in the Action Area and may be affected by the proposed action.

2.2.4.1. Life history

The green sturgeon in the sDPS are genetically unique from the northern population due to their isolated breeding behavior endemic solely to the Sacramento River Basin. The sDPS green sturgeon enter the San Francisco Bay-Delta Estuary in late winter/early spring and migrate upstream to their spawning grounds in the Sacramento, Feather, and Yuba rivers. Since sDPS green sturgeon spawn during the summer months (April through July, peaking in May), mature adults must reach upper areas of the Sacramento River Basin where cooler temperatures persist during the hottest months (Moser and Lindley 2007). sDPS green sturgeon predominantly spawn between the Glenn-Colusa Irrigation Dam (GCID) area (RM 206) to Cow Creek (RM 280) on the Sacramento River, from the fish barrier dam (RM 67) to the Thermalito Afterbay Outlet (RM 67) on the Feather River, and at the base of the Daguerre Point Dam (RM 11) on the Yuba River (NMFS 2018).

The eggs require water temperatures around 15°C to hatch successfully and within 10 days will hatch and rapidly move downstream. It is unknown how long juveniles remain in upriver-rearing habitats after metamorphosis. Based on length distribution data from salvage and recent upstream surveys, juveniles typically enter the Delta as sub-yearlings or yearlings to rear before ocean entry (NMFS 2018). After reaching subadult sizes (approx. 91cm), sDPS green sturgeon will migrate into the ocean, traveling along the North American west coast for up to 15 years or until they reach sexual maturity (Lindley *et al.* 2011). Adult sDPS green sturgeon will spawn every 2-6 years on average, with higher returns upriver during high precipitation years (Heublein *et al.* 2009, NMFS 2018).

2.2.4.2. Viability status

The viability of sDPS green sturgeon is limited by small population size, lack of multiple populations, and the concentration of spawning sites to a few locations; their risk of extinction is considered moderate (NMFS 2018). NMFS' goal is to reduce their risk of extinction to an acceptably low level; however, NMFS does not have the biological basis to define this level quantitatively. Viability modeling requires demographic information, which is currently limited. In the interim, NMFS developed both demographic and threat-based recovery criteria using general principles of conservation biology to describe a population at low risk of extinction (the Recovery Plan for the Southern Distinct Population Segment of North American Green Sturgeon is incorporated here by reference).

2.2.4.3. Abundance & trends

Trends in abundance of sDPS green sturgeon have historically been estimated from two long-term data sources: (1) salvage numbers at the State and Federal pumping facilities, and (2) incidental catch of green sturgeon by the CDFW's white sturgeon sampling/tagging program. Historical estimates from these sources are expected to be unreliable, as sDPS green sturgeon were likely not considered in incidental catch data, and salvage does not capture range-wide abundance in all water year types.

The sDPS of green sturgeon consists of a single, independent population that spawns in the mainstem Sacramento River, though spawning has been documented in both the Feather and Yuba Rivers (NMFS 2018).

Recovery criteria for abundance require the adult sDPS green sturgeon census population to remain at or above 3,000 for 3 generations, (this equates to a yearly running average of at least 813 spawners for approximately 66 years). In addition, the effective population size must be at least 500 individuals in any given year and each annual spawning run must comprise a combined total, from all spawning locations, of at least 500 adult fish in any given year. The NMFS 2021 5-year status review concluded that the stated criteria have not yet been met (NMFS 2021b). The estimated total population of southern DPS green sturgeon is 17,548 individuals, with an estimated 2,106 adults (Mora *et al.* 2018). Therefore, the adult population does not meet the criteria of a yearly average of 3,000 adults. Reported annual spawners have been less than 500 in the Sacramento River (NMFS 2021b). Currently, there are no reliable estimates for spawner counts for the Feather and Yuba Rivers.

The parameters of green sturgeon population growth rate and carrying capacity in the Sacramento Basin are poorly understood. Larval count data from incidental bycatch in rotary screw traps collected since the mid-90s at Red Bluff Diversion Dam and near the Glenn Colusa Irrigation District diversion show enormous variability between years. In general, sDPS green sturgeon year class strength appears highly variable with overall abundance dependent upon a few successful spawning events (NMFS 2010). Other indicators of productivity, such as data for cohort replacement ratios and spawner abundance trends, are not currently available for sDPS green sturgeon, and more research is needed to establish sDPS green sturgeon productivity.

2.2.4.4. Spatial Structure & Diversity

The Sacramento River watershed is the only confirmed historical and present spawning area for the sDPS; whether sDPS green sturgeon historically spawned above Keswick and Shasta dams has been debated. Adult green sturgeon have been observed in other rivers, such as the lower Yuba River downstream of Daguerre Point Dam, and spawning was documented in the lower Yuba River by CDFW in 2018 and 2019 (NMFS 2021b). The reduction of green sturgeon spawning habitat into one reach on the Sacramento River, between Keswick Dam and Hamilton City, has increased the vulnerability of this spawning population to catastrophic events.

Successful spawning of green sturgeon in other accessible habitats in the Central Valley (*e.g.,* the Feather and Yuba rivers) is limited, in part, by late spring and summer water temperatures and water flow. Like salmonids in the Central Valley, green sturgeon spawning in the major lower river tributaries to the Sacramento River are likely further limited if water temperatures increase. Dams and other barriers causing fragmentation and blocking access to suitable spawning grounds for migrating sturgeon are the leading threat in the decline of many sturgeon populations (Auer 1996).

Within the sDPS green sturgeon, diversity is not yet well documented. Little is known about current levels of diversity (*e.g.,* genetics, life history) compared with historical levels. Further inquiry is needed to determine what, if any, genetic separation exists between those fish spawning within the Sacramento River, and those spawning elsewhere. NMFS (2021b) concluded that there has been no net loss of sDPS green sturgeon diversity from previous levels, as the spawning habitat available to sDPS has not increased.

2.2.4.5. sDPS green sturgeon critical habitat

Critical habitat for sDPS green sturgeon was designated on October 9, 2009 (74 FR 52300). The critical habitat includes: (1) the Sacramento River from the I-Street Bridge to Keswick Dam, including the Sutter and Yolo Bypasses and the American River to the Highway 160 Bridge (2) the Feather River up to the Fish Barrier Dam, (3) the Yuba River up to Daguerre Point Dam, (4) the Sacramento-San Joaquin Delta (as defined by California Water Code section 12220), but with many exclusions, (5) San Francisco Bay, San Pablo Bay, and Suisun Bay, but with many exclusions, and (6) coastal marine areas to the 60-fathom depth bathymetry line, from Monterey Bay, California to the Strait of Juan de Fuca, Washington.

The designated critical habitat for sDPS green sturgeon lists the essential PBFs ((74 FR 52300); October 9, 2009), which include the following for freshwater riverine and estuarine habitats:

Freshwater Riverine Habitats:

1. Food resources: Abundant prey items for larval, juvenile, subadult, and adult life stages.
2. Substrate type or size: Substrates suitable for egg deposition and development (*e.g.,* bedrock sills and shelves, cobble and gravel, or hard clean sand, with interstices or irregular surfaces to "collect" eggs and provide protection from predators, and free of excessive silt and debris that could smother eggs during incubation), larval development (*e.g.,* substrates with interstices or voids providing refuge from predators and from high water flow), and feeding of juveniles, subadults, and adults (*e.g.,* sand/mud substrates).
3. Water flow: A flow regime (*e.g.,* the magnitude, frequency, duration, seasonality, and rate-of-change of fresh water discharge over time) necessary for normal behavior, growth, and survival of all life stages.
4. Water quality: Water quality, including temperature, salinity, oxygen content, and other chemical characteristics, necessary for normal behavior, growth, and viability of all life stages.
5. Migratory corridor: A migratory pathway necessary for the safe and timely passage of all life stages within riverine habitats and between riverine and estuarine habitats (*e.g.,* an unobstructed river or dammed river that still allows for safe and timely passage).
6. Depth: Deep (greater than or equal to five meters) holding pools for both upstream and downstream holding of adult or subadult fish, with adequate water quality and flow to maintain the physiological needs of the holding adult or subadult fish.
7. Sediment quality: Sediment quality (*e.g.,* chemical characteristics) necessary for normal behavior, growth, and viability of all life stages.

Estuarine Habitats:

1. Food resources: Abundant prey items within estuarine habitats and substrates for juvenile, subadult, and adult life stages.
2. Water flow: Within bays and estuaries adjacent to the Sacramento River (*e.g.,* the Sacramento-San Joaquin Delta and the Suisun, San Pablo, and San Francisco bays), sufficient flow into the bay and estuary to allow adults to successfully orient to the incoming flow and migrate upstream to spawning grounds.
3. Water quality: Water quality, including temperature, salinity, oxygen content, and other chemical characteristics, necessary for normal behavior, growth, and viability of all life stages.
4. Migratory corridor: A migratory pathway necessary for the safe and timely passage of all life stages within estuarine habitats and between estuarine and riverine or marine habitats.
5. Depth: A diversity of depths necessary for shelter, foraging, and migration of juvenile, subadult, and adult life stages.
6. Sediment quality: Sediment quality (*e.g.,* chemical characteristics) necessary for normal behavior, growth, and viability of all life stages.

PBFs for sDPS green sturgeon have been significantly altered from their historic condition. Factors that lessen the quality of migratory corridors for juveniles include unscreened or inadequately screened diversions, altered flows in the Delta, mainstem Sacramento River, and tributaries, bank protection altering sediment types and depths, and contaminants in sediment.

Although the current conditions of green sturgeon critical habitat are significantly degraded, the spawning habitat, migratory corridors, and rearing habitat that remain in both the Sacramento River watershed, the Delta, and nearshore coastal areas are considered to have high intrinsic value for the conservation of the species.

2.2.4.6. Summary of the sDPS green sturgeon Viability

The southern DPS of green sturgeon is at substantial risk of future population declines (NMFS 2021b). The principal threat to sDPS green sturgeon is the reduction in available spawning habitat due to the construction of barriers on Central Valley Rivers. The potential threats faced by the green sturgeon include enhanced vulnerability due to the reduction of spawning habitat into one concentrated area on the Sacramento River, lack of good empirical population data, vulnerability of long-term cold water supply for egg incubation and larval survival, loss of juvenile green sturgeon due to entrainment at the project fish collection facilities in the South Delta and agricultural diversions within the Sacramento River and the Delta, alterations of food resources due to changes in the Sacramento River and Delta habitats, and exposure to various sources of contaminants throughout the basin to juvenile, sub-adult, and adult life stages.

Evaluation of new information during the most recent 5-year status review did not suggest a significant change in the status of sDPS green sturgeon; therefore, NMFS concluded that the sDPS of green sturgeon remains at a moderate to high risk of extinction (NMFS 2021b).

2.2.5. Current Limiting Factors

The following are current limiting factors for the listed species' population numbers included in this consultation:

- Dams block access to historical spawning and summer holding areas along with altering river flow regimes and temperatures (up to 90 percent for SR winter-run and CV spring-run Chinook salmon).
- Water management/diversions/barriers
- Loss of floodplain rearing habitat (levees/bank protection)
- Urbanization and rural development
- Logging
- Grazing
- Agriculture
- Mining – historic hydraulic mining from the California Gold Rush era
- Estuarine modified and degraded, thus reducing developmental opportunities for juvenile salmonids
- Predation
- Dredging and sediment disposal
- Contaminants
- Altering prey base for fish, especially for sDPS green sturgeon
- Fisheries
- Hatcheries
- "Natural" factors (*e.g.,* ocean conditions)
- Environmental variation exacerbating flow and water temperature related impacts (see below for more detail)

2.2.6. Global Environmental Variation

One major factor affecting the range-wide status of the threatened and endangered anadromous fish in the Central Valley and aquatic habitat at large is environmental variation. Warmer temperatures associated with environmental variation reduce snowpack and alter the seasonality and volume of seasonal hydrograph patterns (Cohen *et al.* 2000). Central California has shown trends toward warmer winters since the 1940s (Dettinger and Cayan 1995). Projected warming will likely affect Central Valley Chinook salmon, steelhead, and green sturgeon. Because the runs are restricted to low elevations due to impassable rim dams, if climate warms by 5°C (9°F), it is questionable whether any Central Valley Chinook salmon populations can persist (Williams 2006).

Factors modeled by VanRheenen *et al.* (2004) show that snowmelt earlier in the year leads to a large percent reduction of spring snow-water-equivalent (SWE) (up to 100 percent 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.

For SR winter-run Chinook salmon, the embryonic and larval life stages, which 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 that buffers the effects of warm temperatures in most years. The exception occurs during drought years, which are predicted to happen more often with environmental variation (Yates *et al.*2008). Additionally, air temperature appears to be increasing faster than previously analyzed (Beechie *et al.* 2012, Dimacali 2013). These factors will compromise the quantity and/or quality of SR winter-run Chinook salmon habitat available downstream of Keswick Dam.

CV spring-run Chinook salmon adults are vulnerable to environmental variation because they over-summer in freshwater streams before spawning in autumn (Thompson *et al.* 2012). CV spring-run Chinook salmon spawn primarily in the tributaries to the Sacramento River, and those tributaries without cold-water refugia (usually input from springs) will be more susceptible to the impacts of environmental variation.

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

Adult sDPS green sturgeon have been observed as far upstream as the Anderson-Cottonwood Irrigation District (ACID) Dam, which is considered the upriver extent of sDPS green sturgeon passage in the Sacramento River (Heublein *et al.* 2009). However, sDPS green sturgeon spawning occurs approximately 30 kilometers (18.6 miles) downriver of the ACID Dam where the water temperature is warmer than at the ACID Dam during late spring and summer. If water temperatures increase with environmental variation, temperatures at spawning locations below the ACID Dam may be above tolerable levels for the embryonic and larval life stages of sDPS green sturgeon.

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

2.2.7. Recovery plans

In July 2014, NMFS released a final recovery Plan for SR winter-run Chinook salmon, CV spring-run Chinook salmon, and CCV steelhead (NMFS 2014). The salmonid 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.

2.2.8. Recovery based on viability criteria

We cannot achieve salmonid or green sturgeon recovery without providing sufficient habitat (NMFS 2014; 2018). Delisting criteria for salmonids and sDPS green sturgeon are addressed in Table 1. Delisting salmonids will require the reestablishment of historical diversity groups. Diversity Groups (population groups) are salmonid ecoregions based on climatological, hydrological, and geological characteristics (NMFS 2014). Delisting the sDPS green sturgeon will require an increase in spawning success and population growth. The proposed action may affect salmonid species in the Northern Sierra Nevada Diversity Group and may affect sDPS green sturgeon present in the Action Area within the Sacramento River.

Table 1. Diversity Group recovery criteria (NMFS 2014) and sDPS green sturgeon delisting criteria (NMFS 2018).

SR winter-run Chinook salmon	CV spring-run Chinook salmon	CCV steelhead	sDPS green sturgeon
Three populations in the Basalt and Porous Lava Diversity Group at low risk of extinction	One population in the Northwestern California Diversity Group at low risk of extinction Two populations in the Basalt and Porous Lava Diversity Group at low risk of extinction Four populations in the Northern Sierra Diversity Group at low risk of extinction Two populations in the Southern Sierra Diversity Group at low risk of extinction Maintain multiple populations at moderate risk of extinction	One population in the Northwestern California Diversity Group at low risk of extinction Two populations in the Basalt and Porous Lava Flow Diversity Group at low risk of extinction Four populations in the Northern Sierra Diversity Group at low risk of extinction Two populations in the Southern Sierra Diversity Group at low risk of extinction Maintain multiple populations at moderate risk of extinction	Population remains at or above 3,000 for three generations Population size must be at least 500 individuals in any given year Successful spawning in at least two rivers within historic range Net positive trend in juvenile and sub-adult abundance is observed over the course of 20 years The population is characterized by a broad distribution of size classes representing multiple cohorts for over 20 years

2.2.8.1. Listing Factors

All threats to a species can be categorized into one of the following ESA listing factors:

1. The present or threatened destruction, modification, or curtailment of its habitat or range;
2. Overutilization for commercial, recreational, scientific, or educational purposes;
3. Disease or predation;
4. The inadequacy of existing regulatory mechanisms;
5. Other natural or manmade factors affecting its continued existence.

2.2.8.2. Threat Abatement

The following threat abatement criteria must be met in order to demonstrate that specific threats have been alleviated. The following threat abatement criteria have been established to ensure that each of the five ESA listing factors are addressed before a species can be delisted:

1. Populations should have unobstructed access to Core 1, 2, and 3 watersheds and assisted access to primary watersheds for reintroduction that are obstructed. Man-made structures affecting these watersheds and in migratory habitat must meet NMFS' salmonid passage guidelines for stream crossings and screening criteria for anadromous salmonids (Listing Factors 1, 4, and 5);

2. Utilization for commercial, recreational, scientific, and educational purposes is managed, such that all Core 1 populations meet the low extinction risk category for abundance (Listing Factor 2);
3. Hatchery programs are operated so that all Core 1 populations meet the low extinction risk criteria for hatchery influence (Listing Factors 3 and 5);
4. Migration and rearing corridors meet the life-history, water quality and habitat requirements of the listed species, such that the corridor supports multiple viable populations (Listing Factors 1, 3, 4, and 5)

2.3. Action Area

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

The Action Area of the project consists of both terrestrial and aquatic components.

- Terrestrial components
  - Areas cleared and grubbed for equipment access
  - Areas for staging
  - Areas where observation wells will be installed
  - Areas where the inlet catwalk will be repaired
  - Areas where the applicant will construct a new facility control building and additional supporting infrastructure
- Aquatic Components
  - Areas that are dewatered for construction purposes
  - Areas where sheet pile cofferdams will be installed
  - Areas where outlet headwalls will be repaired
  - Areas where the inlet slide gate will be repaired
  - Areas where water will be discharged into an adjacent waterway

Aquatic construction activity will generate disturbance, and pile driving sheet piles is expected to modify fish behavior up to ~961 feet away from the work area (GEI Consultants 2024). Taking into consideration the reach of the terrestrial and aquatic components of the project, the action area includes all areas on land where construction activity will occur, all aquatic areas included in the project area, and areas extending 961 feet away from where pile driving will occur. Project-related increased turbidity is not expected to extend beyond 961 feet. 961 feet upstream and downstream of where pile driving will occur includes sections of both the Sacramento River and the Butte Slough, which are connected at BSOG.

In addition, the proposed action includes the transfer of purchased conservation bank credits to offset temporary and permanent streambed and riparian impacts to listed species critical habitat. As a result, the following conservation bank is also included in the action area:

- Bullock Bend Conservation Bank: a 116-acre site along the Sacramento River. The site supports the objectives of the Recovery Plan for Sacramento River winter-run Chinook salmon, Central Valley spring-run Chinook salmon, and Central Valley steelhead, with a service area that includes the action area of the proposed project.

2.4. Environmental Baseline

The "environmental baseline" refers to the condition of the listed species or its designated critical habitat in the Action Area, without the consequences to the listed species or designated critical habitat caused by the proposed action. The environmental baseline includes the past and present impacts of all federal, state, or private actions and other human activities in the Action Area, the anticipated impacts of all proposed federal projects in the Action Area that have already undergone formal or early section 7 consultations, and the impact of State or private actions which are contemporaneous with the consultation in process. The impacts to listed species or designated critical habitat from federal agency activities or existing federal agency facilities that are not within the agency's discretion to modify are part of the environmental baseline (50 CFR 402.02).

The existence of a structure such as BSOG is generally considered part of the environmental baseline. Where a proposed action is to maintain or repair an existing structure, NMFS may consider whether the consequences of extending the useful life of the structure are effects of the action. However, pursuant to the 2022 Structures MOU, "[w]hen the Corps lacks the discretion to modify (or cease to operate and maintain) a previously authorized structure, the effects stemming from the existence of that structure into the future would be considered part of the environmental baseline," and NMFS will "defer to the Corps' case-specific and supported interpretation of any limits to its discretion on a project-by-project basis."

The Corps has provided information showing that BSOG is part of the congressionally authorized Sacramento River Flood Control Project (SRFCP), authorized in Section 2 of the Flood Control Act of 1917 (Section 2) (Pub. Law 64-367) for the purpose of "controlling the floods, removing the debris, and continuing the improvement of the Sacramento River, California" in accordance with a report prepared by the California Debris Commission (Commission) in 1910 and approved by the Chief of Engineers (H. R. Doc. 62-81 (1911) and a report submitted by the Board of Engineers for Rivers and Harbors in 1913 (H. Committee on Rivers and Harbors Doc. No. 63-5 (1913)). Section 2 was later modified by Section 13 of the Flood Control Act of 1928 (Section 13) (Pub. Law 70-391) in accordance with a subsequent Commission report approved by the Chief of Engineers and submitted to Congress in 1925. The 1925 Commission report recommended that the SRFCP be modified to add outfall gates at the confluence of Butte Slough and the Sacramento River (S. Doc. No. 69-23, at 30 (1925)).

The State of California is responsible for maintenance of various features of the SRFCP (S. Doc. No. 69-23, at 41 (1925); H. R. Doc. 62-81 at 3 (1911); H. Committee on Rivers and Harbors Doc. No. 63-5 at 3 (1913); Supplement to Standard Operation and Maintenance Manual Sacramento River Flood Control Project, Unit No. 161 Butte Slough Outfall Gates). Because of its status as a Congressionally-authorized flood control works, USACE asserts that it lacks discretion to relieve the State of California of its operation and maintenance responsibilities to ensure the continued existence and operation of BSOG. Accordingly, NMFS will treat the existence of the structure as part of the environmental baseline. *See also* Proposed Rule, Revision of Regulations for Interagency Cooperation, 88 FR 40753, 40756 (June 22, 2023) and Final Rule, Regulations for Interagency Cooperation, 89 FR 24268, 24276 (April 5, 2024) (discussing how NMFS will work with action agencies in establishing the scope of agency discretion and identification of non-discretionary facilities in the "environmental baseline").

2.4.1. Baseline conditions

2.4.1.1. Topography, climate, and geology

The Action Area is located within the California Central Valley and is ~70 feet above sea level (USGS 1954). The region follows a Mediterranean climate pattern experiencing cool, wet winters, and hot, dry summers. Average air temperatures between winter and summer typically range between ~55°F and ~98°F, although extended periods of air temperatures exceeding 100°F during the day are not uncommon. Precipitation generally falls from November through April; however, precipitation can vary annually, and an individual storm cell can deliver a large amount of rainfall in a relatively short period, even during drought conditions (NMFS 2014). The geologic makeup of the Action Area consists of quaternary sediments, including gravel, sand, silt, and minor amounts of clay deposited along channels (USGS 1986).

2.4.1.2. Water quality

Water quality measures include, but are not limited to, temperature, turbidity, and dissolved oxygen (NMFS 2018), and water quality can be influenced by many factors including agricultural and urban runoff, heavy metal from mine waste, and weather and climate. The most recent DWR water quality measurements near the Action Area were collected in 2022 at station A0297200 (BUTTE SLU NR MERIDIAN) and A0242000 (SACRAMENTO R A COLUSA). Both were measured on 05/11/2022 and showed no deleterious effects on water quality (DWR 2024). However, the 2018 California Water Boards 303(d) Integrated Report on Water Quality did not delist mercury or pH as pollutants in the Butte Creek watershed, or dieldrin, mercury, dichlorodiphenyltrichloroethane, and polychlorinated biphenyls as pollutants from the Sacramento River (SWRCB 2018). As such, it is possible that water quality in the Action Area is altered by pollutants. Summer water temperatures in the lower Sacramento River can exceed 72ºF (22.2ºC) and temperatures in Butte Slough can exceed 70ºF (21.1ºC), providing less than optimal habitat conditions for all life stages of salmonids and green sturgeon.

2.4.1.3. Vegetation and land use

According to the US Fish and Wildlife Service National Wetlands Inventory Mapper, the Action Area is vegetated with freshwater forested/shrub wetland vegetation (USFWS 2024). The applicant will remove one small sandbar willow (*Salix exigua*) on the southern bar of the Sacramento River side of the Action Area. The applicant will trim and top another weeping willow *(Salix babylonica*) on the Northern side of the same channel. While tree canopy in the Action Area provides shade to a portion of the Action Area, it is not considered shaded riverine aquatic habitat (SRA) because it does not meet the criteria of the definition defined by the USFWS (USFWS 1992). Adjacent land use is dominated by agricultural practices. Surrounding BSOG are grain, sunflower, safflower, and almond farming operations (DWR 2022b).

2.4.1.4. Hydrology and water diversion

The Action Area includes a portion of Butte Slough, a part of the Butte Creek watershed. The outfall gate in Butte Slough allows floodwater from Butte Creek to drain into the Sacramento River when the water level of Butte Creek is higher than the River. Water diverted from Butte Creek, upstream of the outfall gates, is used to irrigate land in the Sutter Bypass. BSOG can either release water from Butte Creek into the Sacramento River, or while in the closed position, allow for water flow into the Sutter Bypass that discharges at the Sacramento Slough (Wood Rodgers 2005).

2.4.1.5. Past and present operations and maintenance of BSOG

NMFS analyzed publicly available data between the years 2013–2020 to assess possible effects the structure presents to upstream migrating CV spring-run Chinook salmon. NMFS' analysis included data from two stations, the Sacramento River at Butte Slough Outfall Gates (station number A02400), and the Butte Slough at Outfall Gates near Colusa (station number A02967) (DWR 2025a). Daily average stage elevation was analyzed from both stations. The following assumptions were applied to NMFS' analysis based on information provided by DWR:

- The Butte Slough is maintained at the approximate North American Vertical Datum 1988 (NAVD 88) of 42 feet; when the stage elevation falls below 42 feet, the Butte Slough slide gates are closed
- If the manually operated gates are in the open position, but the Sacramento River stage is greater than the Butte Slough stage, the flap gates will remain closed because of hydrostatic pressure
- On the Sacramento River side, flap gates open and close based on stage differential, and the flap gates will open if the stage differential is 1 foot or more greater on the Butte Slough side than the Sacramento side

Using this information, NMFS determined that during the CV spring-run Chinook salmon upstream adult migration (February 1–July 15), there are limited times during which fish may pass through the facility (Table 2). Whether passage through the facility was possible during this limited time was dependent on the flow velocity through the structure. Because the needed stage differential to open the flap gates creates flow velocities inside the seven pipes that exceed 4 ft/s, which is greater than the reasonable velocity that is expected to allow fish to safely pass, the opportunity of successful passage is likely even less than the percentages presented in Table 2. Analysis was not performed for CCV steelhead, given that they have no distinct migration period for Butte Creek and that their Butte Creek population is limited in numbers (CDFW 2024d, 2024e).

Table 2. Percentage of times during the migration period of adult CV-spring-run Chinook salmon when both flap gates and slide gates were open, and water year conditions.

Year	2013	2014	2015	2016	2017	2018	2019	2020
Percent	38%	29%	16%	30%	1%	37%	14%	12%
Wtr Yr*	Dry	Critical	Critical	BN	Wet	BN	Wet	Dry

*Water Year is based on Sacramento Valley Water Year Hydrologic Classification, water year index (in Million acre-feet): Wet ≥ 9.2; BN (below normal) > 6.5, and ≤ 7.8; Dry > 5.4, and ≤ 6.5; Critical dry ≤ 5.4 (DWR 2025b)

Passage opportunities through the facility are not uniform. For example, from June 15 to July 15 (the period during adult upstream migration that proposed actions will occur), the facility was a complete barrier to fish passage on average 96.5% of the time during the years analyzed. Conversely, during the month of February, the facility was a complete barrier to fish passage on average only 51.75% of the time. Passage opportunities occur more frequently earlier in the migration season, but adult migrating Butte Creek spring-run Chinook salmon have a more protracted migration than other spring-run (Lindley *et al.* 2004). For juveniles, from October 1 to

October 31 (the period during juvenile downstream migration that proposed actions will occur), the facility was a complete barrier to fish passage 96.1% of the time during the years analyzed. More information is needed to determine the temporal relationship between migration success and BSOG operations and maintenance.

Bernard *et al.* (1996) indicated that CV spring-run Chinook salmon are more likely to enter the Sutter Bypass when flows are high (wet water years), and more likely to miss the Sutter Bypass during normal or low flow years. NMFS' analysis found that proportionally less flow from Butte Creek is diverted through BSOG during wet years, and more during dry years. Whether the findings of Bernard *et al.* (1996) are related to this observation is unknown. When flows through BSOG are higher, fish are drawn by attraction flow to the facility.

While the Sutter Bypass appears to have become an acknowledged fish entry point to Butte Creek, it is not considered an ideal migratory pathway. Bernard *et al.* (1996) referred to the passage of migrants through the Sutter Bypass as "catastrophic straying," indicating that the conditions in the bypass are greatly unsuitable for fish. While many changes in the bypass may have occurred since 1996, overgrowth of vegetation physically inhibits stream passage and significantly reduces water quality for adult Chinook salmon, and salmon passage depends on efforts carried out by DWR to remove the overgrowth (DWR 2022a). Temporal passage barriers at Weir 1 and the East-West Weir are documented in the CDFW passage assessment database, and CV spring-run Chinook salmon mortality events have been reported at Weir 1 due to stranding and low flow in 2012, 2013, and 2021 (CDFW 2022). Additionally, at least 50 unscreened diversions used for agricultural irrigation limit adult and juvenile migration through the Sutter Bypass, which can create passage impediments during low flows, and can route fish into areas disconnected from the creek (CDFW 2024a).

BSOG presents a complete barrier to Butte Creek salmonids when the slide gates are closed, and a partial barrier when the slide/flap gates are open due to the water velocities. Because of the structure, access to PBFs, including spawning habitat and upstream and downstream freshwater migration corridors, is reduced, thus negatively affecting the quantity of available critical habitat.

2.4.2. Status of the federally listed species and critical habitat in the Action Area and species recovery potential in the Action Area

Critical habitat consists of features that are essential to the conservation of the species including space for normal behavior and individual population growth, cover, sites for reproduction and rearing, and habitat protected from disturbance or habitat representative of historic geographical and ecological distribution of the species (NMFS 2014). Thus, critical habitat is essential for species recovery. Table 3 outlines how federally listed species use critical habitat in the Action Area, whether for spawning, rearing, or migration.

Critical habitat PBFs essential to the conservation of SR winter-run Chinook salmon include:

1. Access from the Pacific Ocean to appropriate spawning areas
2. Availability of clean gravel for spawning substrate
3. Adequate river flows
4. Water-temperatures for successful spawning, egg incubation, and fry development

5. Habitat areas and adequate prey that are not contaminated
6. Riparian habitat that provides for successful juvenile development and survival
7. Access downstream so that juveniles can migrate

Critical habitat PBFs essential to the conservation of CV spring-run Chinook salmon and CCV steelhead include:

1. Freshwater spawning sites
2. Freshwater migratory corridors
3. Freshwater rearing sites
4. Estuarine habitat
5. Near-shore area
6. Offshore marine areas

Critical habitat PBFs essential to the conservation of sDPS green sturgeon include:

1. Food resources
2. Substrate type
3. Water flow
4. Water quality
5. Migratory corridors
6. Water depth
7. Sediment quality

Table 3. How federally listed species use critical habitat in the Action Area.

Federally listed species	Action area within the Sacramento River	Action area within the Butte Slough
SR winter-run Chinook salmon	Rearing and migration	Not present
CV spring-run Chinook salmon	Rearing and migration	Rearing and migration
CCV steelhead	Rearing and migration	Rearing and migration
sDPS North American Green Sturgeon	Possible spawning, rearing, and migration	Not present

2.4.2.1. SR winter-run Chinook salmon and critical habitat in the Action Area

The Action Area in the Sacramento River contains PBFs of critical habitat for adult and juvenile SR winter-run Chinook salmon including access to appropriate spawning areas, adequate river flows, riparian habitat for successful juvenile development and survival, and access downstream so that juveniles can migrate. The water quality in the action area is likely limited by pollutants and warm water in the summer months. Sparse vegetation does not provide ideal shade or habitat to rearing juveniles; however, nearby rearing habitat is present upstream and downstream of the Action Area. Past and present operations of BSOG may affect SR winter-run Chinook salmon. Adult migrants are not likely to be attracted to the facility as there is no upstream attraction flow to draw them near; however, rearing juveniles could theoretically become trapped in the facility though there are no documented incidents of this occurring. While degraded from historic conditions, the remaining habitat is important for the recovery of the species.

2.4.2.2. CV spring-run Chinook salmon and critical habitat in the Action Area

The NMFS Recovery Plan strategy (NMFS 2014) for CV spring-run Chinook salmon, describes Butte Creek as a "core 1" population, meaning it possesses the known ability or potential to support a viable population. Butte Creek provides critical habitat for one of only three remaining independent spawning populations of spring-run Chinook salmon (Butte, Deer, and Mill), and the Butte Slough within the Action Area contains one of two locations through which the Butte Creek watershed connects with the Sacramento River (CDFW 2024b; Cordoleani *et al.* 2017). The Action Area in the Sacramento River and Butte Slough contain rearing and migratory habitat for adult and juvenile CV spring-run Chinook salmon. Recent documentation from CDFW indicates that adult Butte Creek CV spring-run Chinook salmon upstream migration may peak at BSOG in March, though there have been no formal studies to determine precisely when fish arrive at the facility (Garman 2018; McReynolds 2021). Juvenile CV spring-run Chinook salmon may enter the Sacramento River watershed through BSOG during their outmigration (CDFG 1999; CDFG 2001; Notch *et al.* 2022). While there is uncertainty regarding the number of Butte Creek juveniles that enter the Sacramento River through BSOG, Notch *et al.* (2022) reported that 3 of 42 acoustically monitored fish were documented as passing through BSOG that year.

Past and present operations and maintenance of BSOG have resulted in limited passage (due to impediments) for adult and juvenile CV spring-run Chinook salmon. Adult migrating fish are drawn by attraction flow to BSOG, but have few opportunities to migrate through the facility. Passage impediments that delay fish from migrating to their preferred spawning grounds can cause delayed spawning, straying into other watersheds, decreased fecundity, and pre-spawn mortality due to the expenditure of limited energy while trying to bypass impediments. Fish that queue outside of BSOG also face a greater risk of poaching (McReynolds 2021; CDFW 2022).

CDFW has documented some of the passage challenges presented by BSOG to adult CV spring-run Chinook salmon, which have resulted in large numbers of fish queuing at BSOG to pass through the facility. In 2021, CDFW reported large schools of adult CV spring-run Chinook salmon (greater than 100) trying to enter Butte Creek at BSOG between March 3 and April 21, 2021 (McReynolds 2021). Coordination with DWR allowed one slide gate to remain open, allowing fish passage through BSOG. In addition, during a couple of migration seasons, DWR staff manually propped open the associated flap gate on the Sacramento River side so that fish could escape the culvert when the Butte Slough gates were closed; thus preventing a repeat of a 2018 fish kill incident that occurred at BSOG (Garman 2018; McReynolds 2021; Bosworth 2022).

The Butte Creek spring-run Chinook salmon is close to extirpation given that it is supported by a single spawning area (Lindley *et al.* 2004), and has lower levels of allelic diversity than other runs in the Central Valley (indicating that the population has gone through a genetic bottleneck (Hedgecock *et al.* 2001)). The most recent escapement estimates reported by CDFW demonstrate that the Butte Creek spring-run Chinook salmon population has declined precipitously since 2019. The most recent NMFS Viability Assessment (Johnson *et al.* 2023) estimated that the 2019 Butte Creek spring-run Chinook salmon population size was 17,740. In 2021, the cohort was

~21,580, of which ~19,773 perished before spawning. The historic pre-spawn mortality event was attributed to warm water and a disease outbreak (CDFW 2022). Another pre-spawn mortality event occurred in August 2023, when the Butte Creek Canal failure resulted in increased turbidity that affected all life stages of Butte Creek Chinook salmon (Manes 2024). The preliminary 2023 CDFW escapement estimates counted just 95 salmon in Butte Creek; estimates for successful spawning have not yet been reported (Azat and Killam 2024). In 2024, the estimated number of holding adult Butte Creek spring-run Chinook salmon was 51-55 salmon (FERC 2024; Henley 2024).

Escapement data indicate that the Butte Creek spring-run Chinook salmon are supported by a greatly reduced population size, and adult Butte Creek spring-run Chinook salmon that stray (emigrate) to other spawning grounds worsen the genetic drift within the existing population. Genetic drift (in this case, a reduction in gene variants (alleles) in a population) results in decreased genetic variation and reduced heterozygosity across the genome. This can result in harmful recessive genotypes becoming more common within the remaining population. This low genetic diversity results in low phenotypic diversity, resulting in populations that are more susceptible to disaster or predation (Robinson *et al.* 2023). Butte Creek spring-run salmon that are unable to pass through BSOG result in a reduction in spawning run size.

Documented evidence indicates that adult Butte Creek CV spring-run Chinook salmon are straying into other nearby watersheds. Parental stream of origin genetic analysis of CV spring-run Chinook salmon sampled in Mill and Deer Creek in 2021 found that 100% (N=4) and 33% (N=3) of sampled CV spring-run Chinook salmon were of Butte Creek origin, respectively (sample size=N) (Johnson 2021). Similar genetic sampling of post-spawn spring-run Chinook salmon below the Keswick Dam in 2020, 2021, and 2022 found that 59% of samples in 2020 (N=46), 18% of samples in 2021 (N=11), and 28% of samples in 2022 (N=7) were of Butte Creek origin, respectively (Rodzen 2022). Additional stream-of-origin sampling for post-spawn salmon is pending for samples collected in Clear Creek (Wingerter 2024). Extensive straying affects the genetic integrity of Butte Creek CV spring-run Chinook salmon.

Threats to the genetic integrity of spring-run Chinook salmon were identified as a serious concern to the species when it was listed in 1999. Listing factors and threats to Central Valley spring-run Chinook salmon fall into three broad categories: loss of historical spawning habitat; degradation of remaining habitat; and threats to genetic integrity. Genetic integrity of all salmonids is further compounded by hatchery influence. Preferential survival of hatchery fish over time may disrupt gene complexes of the natural population with those inherited through artificial selection. Taylor (1991) reports that because hatchery fish are adapted to the hatchery environment, natural spawning with wild fish reduces the fitness of the natural population. Additionally, Lindley *et al*. (2007) recommend that in order to maintain a low risk of genetic introgression with hatchery fish, no more than five percent of the naturally spawning population should be composed of hatchery fish.

Until the dramatic population declines observed in 2023 and 2024, Butte Creek supported one of the most productive spring-run Chinook salmon streams in the Sacramento Valley. Butte Creek is one of only three streams that harbor genetically distinct populations of spring-run Chinook; therefore, the viability of the Central Valley spring-run Chinook salmon ESU is reliant upon sustaining a robust Butte Creek spring-run Chinook salmon population (NMFS 2014).

McElhany *et al.* (2000) suggested that the viability of salmonid populations (VSP) should be assessed in terms of abundance, productivity, spatial structure, and genetic and life-history diversity. ESUs can be assessed using these same terms. While providing a useful conceptual framework for thinking about the viability of Pacific salmon, McElhany *et al.* (2000) did not establish quantitative criteria that would allow one to assess whether particular populations or ESUs are viable. For quantitative analysis, Lindley *et al.* (2007) developed an approach for determining the viability of Pacific salmonid populations and ESUs, which is presented below.

The risk of extinction is assessed as high, moderate, or low. Risk categories are defined by various quantitative criteria and correspond to specific risks of extinction within distinct time horizons (Table 4). Populations are classified as "data deficient" when there is insufficient data to classify them otherwise. It is possible to classify a population as "high" risk with incomplete data (*e.g.*, if it is known that Ne < 50, but trend data and hatchery straying are lacking). A low-risk classification must be met with all criteria. The first set of criteria deals with direct estimates of extinction risk from population viability models. If such analyses exist, such assessments may be sufficient for assessing risk. Lindley *et al.* (2007) recommend that population viability analysis (PVA) results be compared to the results of applying the simpler criteria, described below.

Table 4. Criteria for assessing the level of risk of extinction for populations of Pacific salmonids. Overall risk is determined by the highest risk score for any category (Lindley *et al.* 2007).

Criterion	High	Moderate	Low
Extinction risk from PVA	> 20% within 20 years Or any ONE of the following:	> 5% within 100 years Or any ONE of the following:	< 5% within 100 years Or ALL of the following:
Population size[1]	$Ne \leq 50$ -or- $N \leq 250$	$50 < Ne \leq 500$ -or- $250 < N \leq 2500$	$Ne > 500$ -or- $N > 2500$
Population decline	Precipitous decline[2]	Chronic decline[3]	No decline apparent
Catastrophe, rate and effect[4]	Order of magnitude decline within one generation	Smaller but significant decline[5]	Not apparent
Hatchery influence[6]	High	Moderate	Low

[1] Population size per generation (*N*) can be used if effective size (*Ne*) is not available, assuming $Ne/N = 0.02$.
[2] Decline with last two generations to annual run size is ≤ 500 spawners, or run size is > 500 but is declining at ≥ 10% per year. Historically small but stable populations not included.
[3] Run size has declined to ≤ 500 but is now stable
[4] Catastrophes occurring within the last 10 years
[5] Decline is < 90% but biologically significant
[6] See figure 1 of Lindley *et al.* (2007) for assessing hatchery impacts

The NMFS 2023 viability assessment analyzed data through escapement year 2019 and determined that the total population size per generation (N) is estimated as the sum of the estimated run sizes over the most recent 3 years (2017–2019); the reported N was 17,740 (Johnson *et al.* 2023). Based on current spawning run size estimates from Azat and Killam (2024) and Henley (2024), as of 2024, N =3,834. The criteria in Lindley *et al.* (2007) indicate that the population size of the Butte Creek spring-run Chinook salmon is consistent with a low risk of extinction. However, the population decline criteria indicate that a subsequent precipitous decline occurred in 2023 and 2024 with the last two years of annual returns each < 500 spawners (95 and 51, respectively).

In summary, the Action Area in the Sacramento River and Butte Slough contains PBFs of critical habitat for adult and juvenile CV spring-run Chinook salmon and is vital for the recovery of the species. The water quality in the action area is likely limited by pollutants and warm water in the summer months (SWRCB 2018). Sparse vegetation does not provide ideal shade or habitat to rearing juveniles; however, nearby rearing habitat is present upstream and downstream of the Action Area. Past and present operations of BSOG affect CV spring-run Chinook salmon. Adult migrants are drawn to the facility via attraction flow. Adult fish that queue at the facility eventually either pass through, become trapped and perish before spawning, are poached, or find less suitable habitat for spawning. Delays to spawning that decrease the spawning run size result in decreased overall fitness, because fish that spawn in less suitable habitat are unable to pass diverse alleles to the next generation.

Downstream migrating juveniles are either able to pass through the facility, are trapped within the facility, or swim volitionally into the Sutter Bypass. High summer water temperatures in the Sutter Bypass can exceed 72°F (22.2°C) and create a thermal barrier to the migration of juvenile salmonids (Kjelson *et al.* 1982). Those elevated water temperatures compel many salmon juveniles to migrate out quickly and forgo adequate rearing time before summer heat creates temperatures unsuitable for salmonids. Those fish that remain either succumb to the elevated water temperatures or are crowded into river reaches with suitable environmental conditions where they are more susceptible to disease outbreaks (NMFS 2014). In addition, water diversions for agriculture can reduce in-stream flows to intermittent or low-flow levels, and rearing juveniles may become entrained when water is diverted for agricultural purposes.

Although the value of the habitat present in the action area has been degraded from its historic condition, the remaining habitat is important for the recovery of the species.

2.4.2.3. CCV steelhead and critical habitat in the Action Area

The Sacramento River and Butte Slough contain designated critical habitat for CVV steelhead, and the Butte Slough within the Action Area contains one of two locations through which the Butte Creek watershed connects with the Sacramento River (CDFW 2024b; Cordoleani *et al.* 2017). The Action Area in the Sacramento River and the Butte Slough contains rearing and migratory habitat for adult and juvenile CCV steelhead. While no current research is monitoring the movement of CCV steelhead through BSOG, it is a migratory pathway to spawning ground and an emigration pathway out of the system, thus it is probable that CCV steelhead pass through the structure (McReynolds 2024).

When water flows through BSOG, it triggers olfactory cues to Butte Creek species to swim toward the facility. These water releases can lead to migration delays and stranding as fish can only pass through BSOG under specific conditions. Flows through BSOG also decrease water diversion into the Sutter Bypass, further reducing attraction flow to fish at the downstream entrance to the Sutter Bypass at the Sacramento Slough (CDFW 2024c).

Adult CCV steelhead migration occurs much of the year, with peak migration occurring in the fall or early winter. Steelhead generally begin spawning in December and continue through March/April. While fish can pass through the facility, adequate conditions for passage are inconsistent and fish that queue to pass through BSOG are negatively affected by delayed spawning, potential straying into other watersheds, decreased fecundity, and pre-spawn mortality due to the expenditure of limited energy while trying to bypass impediments. CCV steelhead that are unable to pass through BSOG result in a reduction in spawning run size.

Adult CCV steelhead that emigrate to other spawning grounds worsen genetic drift within the existing population, which can decrease genetic variation and reduce heterozygosity across the genome. This can result in harmful recessive genotypes becoming more common within the remaining population, allowing for populations that are more susceptible to disaster or predation (Robinson *et al.* 2023). Threats to the genetic integrity of the species were identified as a serious concern when it was listed in 1996. Threats to CCV steelhead are similar to those for CV spring-run Chinook salmon: loss of historical spawning habitat, degradation of remaining habitat, and threats to genetic integrity. The genetic integrity of all salmonids is further worsened by hatchery influence.

Population data for CCV steelhead are limited. Few studies track the migration of CCV steelhead, and their movement through BSOG is unknown; however, Butte Creek juvenile out-migration studies have shown that the Butte Creek steelhead population is limited in numbers (CDFW 2024d, 2024e). While there is no escapement data for CCV steelhead in Butte Creek, 2023–2024 juvenile outmigration data collected in Butte Creek at the Parrot-Phelan Dam in October–June, found that 55 unmarked steelhead/rainbow trout were captured in a canal diversion trap (CDFW 2024d) and 59 unmarked steelhead/rainbow trout were captured in a rotary screw trap (CDFW 2024e). CDFW developed a monitoring plan for CCV steelhead in 2014 and began capturing and tagging adult steelhead in the Sacramento River during the fall of 2015. When fully implemented, this monitoring plan will provide CCV steelhead abundance data for several watersheds in the Central Valley. It will allow for the long-term tracking of populations in a way that currently exists for the three species of Chinook salmon in the Central Valley.

The Action Area in the Sacramento River and Butte Slough contains PBFs of critical habitat for adult and juvenile CVV steelhead and is important for the recovery of the species. The water quality in the action area is likely limited by pollutants and warm water in the summer months. Sparse vegetation does not provide ideal shade or habitat to rearing juveniles; however, nearby rearing habitat is present upstream and downstream of the Action Area. Past and present operations of BSOG may affect CVV steelhead. Adult migrants are drawn to the facility via attraction flow. Adult fish that queue at the facility eventually either pass through, become trapped and perish, are poached, or find less suitable habitat for spawning. Delays to spawning that decrease the spawning run size result in decreased overall fitness because fish that spawn in less suitable habitat are unable to pass diverse alleles to the next generation.

Downstream migrating juveniles are either able to pass through the facility, are trapped within the facility, or swim volitionally into the Sutter Bypass. High water temperatures can limit habitat availability for listed salmonids in the Sutter Bypass. High summer water temperatures in the Sutter Bypass can exceed 72°F (22.2°C) and create a thermal barrier to the migration of juvenile salmonids (Kjelson *et al.* 1982). Those elevated water temperatures compel many salmon juveniles to migrate out quickly and forgo adequate rearing time before summer heat creates temperatures unsuitable for salmonids. Those fish that remain either succumb to the elevated water temperatures or are crowded into river reaches with suitable environmental conditions where they are more susceptible to disease outbreaks (NMFS 2014). In addition, water diversions for agriculture can reduce in-stream flows to intermittent or low-flow levels, and rearing juveniles may become entrained when water is diverted for agricultural purposes.

Although the conservation value of the habitat present in the action area has been degraded from its historic condition, the remaining habitat is important for the recovery of the species.

2.4.2.4. sDPS green sturgeon and critical habitat in the Action Area

The Action Area in the Sacramento River contains PBFs of critical habitat for adult and juvenile sDPS green sturgeon including food resources, water flow, migratory corridors, and water depth. These PBFs are important for the recovery of the species. The water quality in the action area is likely limited by pollutants and warm water in the summer months. Sparse vegetation does not provide ideal shade or habitat to rearing juveniles; however, nearby rearing habitat is present upstream and downstream of the Action Area. Past and present operations of BSOG may affect sDPS green sturgeon. Adult migrants are not likely to be attracted to the facility as there is no upstream attraction flow to draw them near; however, rearing juveniles could theoretically become trapped in or pass through the facility; however, there are no documented incidents of this occurring. While degraded from historic conditions, the remaining habitat is important for the recovery of the species.

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 but that are not part of the action. A consequence is caused by the proposed action if it would not occur but for the proposed action and it is reasonably certain to occur. Effects of the action may occur later in time and may include consequences occurring outside the immediate area involved in the action (see 50 CFR 402.02).

The following analysis explores the potential effects to listed species and critical habitat that may occur as a result of implementing the proposed action. NMFS analyzed the expected effects from the following proposed activities: Effects of all construction activities associated with the proposed repair of the BSOG facility.

2.5.1. Bank and channel modification

The salmonid recovery plan (NMFS 2014) identifies loss of riparian habitat and in-stream cover as a primary stressor affecting the recovery of the species. This threat primarily affects the juvenile rearing and outmigration life stage of these species, from the upper reaches of their watershed of origin through the Delta. Riprap reduces shoreline habitat that could otherwise be riparian. Further, Windell *et al.* (2017) found that riprapped reaches of the Upper Sacramento River typically have low habitat complexity and abundance of food organisms, and offer little protection from predators.

In addition, riprap halts the meander migration and reworking of floodplains, which reduces habitat renewal, diversity, complexity, food resources, and heterogeneity. This, in turn, has adverse effects on aquatic ecosystems, ranging from carbon cycling to altering salmonid population structures and fish assemblages (Schmetterling *et al.* 2001). Riprapping decreases river sinuosity, which increases the river channel slope, increasing the bedload transport and possible bed degradation and scour near the toe of the riprapped bank (Kimball and Kondolf 2002). Bank modification will occur during construction on the Sacramento River. Bank modification on the Sacramento River side will include the removal of a sandbar willow and the potential for bank stabilization using riprap.

Disturbance of benthic substrates will occur as part of the proposed action. Dewatering the streambed will temporarily reduce the amount of benthic habitat available and may temporarily affect essential habitat types and the PBFs of adequate prey/food resources. Upon completion of construction, the disturbed area would be relatively biologically sterile due to the removal of detritus, macroinvertebrates, and nutrients contained within the channel substrate, and the physical changes would include a small reduction in benthic habitat availability. Temporary impacts resulting from this reduction of benthic habitat will change the foraging behavior of juveniles that return to the site after construction is completed; however, disturbed areas should recolonize by drifting organisms and sediments from abundant upstream sources within one to two months (Attrill and Thomas 1996; Harvey 1986). Cofferdam placement and dewatering will prevent the migration of Butte Creek spring-run Chinook salmon and non-listed species.

During the times that stage management operations would result in the gates being open, the dewatering and cofferdam will prevent water from flowing through the facility into the Sacramento River, and prevent any juvenile fish present from passing. Instead, these fish will be diverted into the Sutter Bypass where elevated water temperatures compel many salmon juveniles to migrate out quickly and forgo adequate rearing time before summer heat creates temperatures unsuitable for salmonids. Those fish that remain either succumb to the elevated water temperatures or are crowded into river reaches with suitable environmental conditions where they are more susceptible to disease outbreaks (NMFS 2014). In addition, water diversions for agriculture can reduce in-stream flows to intermittent or low-flow levels, and rearing juveniles may become entrained when water is diverted for agricultural purposes.

During construction activities, juvenile and, particularly, adult fish may be able to detect areas of active disturbance and avoid those portions of the Action Area where equipment is actively operated or a turbidity plume occurs. Juveniles in particular may also instead hide in the activity zone. After completion of the project, habitat in the previously dewatered area will be sterile until the natural recruitment of sediments and organisms. Juvenile rearing fish will likely seek adjacent habitat until it is able to support their cover and foraging needs.

2.5.1.1. Effects of bank and channel modification on federally listed species

There is a high probability that adult and juvenile SR winter-run Chinook salmon and sDPS green sturgeon will be present in the Action Area in the Sacramento River and CV spring-run Chinook salmon and CCV steelhead will be present in the Action Area in the Sacramento River and Butte Slough. During construction, the proposed activities will likely result in behavioral changes, such as reduced feeding, habitat avoidance, increased predation risk, and a probable change in fitness or reduced growth and survival of federally listed species. Fish that do not relocate during bank and channel modification may be injured or killed. After construction, the proposed action will likely result in short-term behavioral changes, such as reduced feeding, habitat avoidance, increased predation risk, and a probable change in fitness or reduced growth and survival of federally listed species until natural recruitment returns the habitat to its previous condition. With the use of proposed AMMs, a small number of each of the above listed species are expected to be injured or killed due to bank and channel modification. Nearby habitat improved by mitigation banking will help to provide additional shelter to displaced juvenile fish.

2.5.1.2. Effects of bank and channel modification on species critical habitat

Effects of the action contributing to the loss of riparian habitat, in-stream cover, and ecosystem functioning, diminish the value of critical habitat PBFs. The action will have temporary and permanent negative impacts on critical habitat. Project activities will temporarily affect the PBFs of critical habitat including adequate water quality, adequate prey, and migration. Total temporary impacts will affect 1.06 acres of the action area. Total permanent impacts will affect <0.07 acres of the action area. Temporary impacts to critical habitat, such as streambed alteration and disturbance of benthic substrate, should stabilize through natural recruitment and recolonization. Permanent impacts to critical habitat will result from reinforcing the structure with a cement slurry, the installation of new piles for the catwalk, and the placement of riprap on the bank of the Sacramento River. Proposed BMPs are expected to minimize the effects of both temporary and permanent impacts.

2.5.2. Fish capture-relocation or entrapment

Fish relocation activities pose a risk of fish injury or mortality to federally listed species. Fish that volitionally relocate in response to in-stream construction may endure short-term stress from being forced away from their rearing area, crowding, and competition with resident fish for food and habitat. Manually relocated fish face stressors that increase their risk for mortality. Any fish relocation has some associated risks to fish, including stress, disease transmission, injury, or death. The amount of unintentional injury and mortality attributable to fish relocation varies widely depending on the method used, the duration of handling, ambient conditions, and the experience of the field crew.

Harassment caused by capturing, handling, and releasing fish generally leads to stress and other sub-lethal effects that are difficult to assess in terms of their impact on individuals, populations, and species (Sharpe *et al*. 1998). Handling of fish may cause stress, injury, or death, which typically are due to differences in water temperatures between the river and holding buckets, depleted dissolved oxygen in holding buckets, holding fish out of the water, and physical trauma. Excessive air exposure causes gill lamellae to collapse, ceasing aerobic respiration and causing hypoxia. High water temperature can contribute to high mortality following air exposure (Patterson *et al*. 2017). Loss of protective mucus is a common injury during capture and handling which increases susceptibility to disease (Cook *et al*. 2018). Mucus contains antibacterial proteins, and its loss makes fish vulnerable to pathogens that may cause infections and latent mortality. Fish held at higher water temperature have a higher risk of infection post-sampling (Patterson *et al*. 2017).

Stress on salmonids increases rapidly from handling if the water temperature exceeds 18ºC or dissolved oxygen is below saturation. Exhaustion from excess physical activity can result in death through acidosis or latent mortality due to the inability to recover from exhaustion. Fish that survive physiological imbalances caused during handling can lose equilibrium and have impaired swimming abilities, increasing their susceptibility to predation (Cook *et al*. 2018). Fish transferred to holding buckets can experience trauma if care is not taken in the transfer process, and fish can experience stress and injury from overcrowding in traps, nets, and buckets. Capture and handling stressors can combine to cause cumulative effects that greatly increase the likelihood of fish mortality.

Seines, traps, and hand or dip net methods are often used to capture fish. Beach seines and small traps (such as minnow traps, or similar) are used to collect juvenile fish in shallow-water habitats. Boat seines (such as purse seines) and large traps (such as fyke traps, or similar) are used to collect or observe adults. Nets can injure fish by removing protective mucus and tearing gills (Patterson *et al*. 2017). Wearing gloves during handling and using soft rubber or knotless nets minimizes damage to fish gills, scales, and mucus. In general, handling should be conducted with soft, smooth, and pre-wetted gear. Based on years of sampling at hundreds of locations under hundreds of scientific research authorizations, we would expect the mortality rates for fish captured by seines, traps, or hand/dip nets to be three percent or less.

If the applicant cannot relocate fish by seining or net fishing, they will use electrofishing. One of the most commonly reported fish injuries associated with electrofishing is spinal injuries; these injuries are not always externally evident; thus, a practitioner may underestimate the full scope of harm related to the action (Nielsen 1998). Ainslie *et al.* (1998), estimated that injury rates from electrofishing can vary from 15–39% and that mortality rates were negligible (~1%). In their study, they exposed *O. mykiss* to 300-V continuous DC or 30Hz pulsed DC for 1–3 electroshocking passes. These settings are within federal electrofishing limits (NMFS 2000). McMichael *et al.* (1998) found that injury rates in small *O. mykiss* were low (5.1%) but that injury rates in larger *O. mykiss* were higher (27.7%), indicating that larger subadult and adult fish face greater risks associated with electrofishing than smaller fish. McMichael *et al.* 1998 also found that injury rates for juvenile spring-run Chinook salmon were low (2%).

2.5.2.1. Effects of fish relocation or entrapment on federally listed species

There is a high probability that adult and juvenile SR winter-run Chinook salmon and sDPS green sturgeon will be present in the Action Area in the Sacramento River and CV spring-run Chinook salmon and CCV steelhead will be present in the Action Area in the Sacramento River and Butte Slough. Fish that are captured and relocated are at risk of injury or mortality. Of the methods proposed by the applicant, seining appears to present the least risk to listed species. Electrofishing appears to present the greatest amount of risk. Given the proposed AMMs, a small number of each of the above listed species is expected to be injured or killed due to fish relocation or entrapment.

2.5.2.2. Effects of fish relocation or entrapment on species critical habitat

Migration PBFs will be unavailable during fish relocation activities. These activities will have temporary impacts on the migration PBFs of critical habitat and will cease to alter critical habitat once complete.

2.5.3. Noise and sound pressure

Noise generated by pile driving and construction activity could adversely affect federally listed species. The potential effects of noise on fish and other organisms depend on several biological characteristics (*e.g.,* fish size, hearing sensitivity, behavior) and the physical characteristics of sound (*e.g.,* frequency, intensity, duration) to which they are exposed (Mickle and Higgs 2017). Potential direct effects of noise include behavioral effects, physiological stress, physical injury (including hearing loss), and mortality (Wysocki *et al.* 2007). The applicant will use a vibratory hammer to install sheet piles for the coffer dam, which will produce underwater sound pressure waves. If the conditions of the substrate are not responsive to vibratory pile driving, the applicant will use an impact hammer with a cushion block.

Vibratory hammers use counter-rotating eccentric weights to transmit vertical vibrations into the pile, causing the sediment surrounding the pile to liquefy and allow the pile to penetrate the substrate. The vibratory hammer produces sound energy that is spread out over time and is generally 10 to 20 decibels (dB) lower than impact pile driving for the same type and size pile (Molnar *et al.* 2020).

Pressure waves generated from pile driving may cause adverse physiological effects on fish and marine mammals over relatively long distances, including damage to internal organs (Washington *et al.* 1992). Extended exposure to low-level or higher-level sound pressure for a shorter period may adversely affect listed species. Sound pressure impacts on fish can include auditory and non-auditory (*e.g.,* fish bladder, capillaries, eyes) tissue damage, neuro-trauma, temporary or permanent hearing loss, reduced fitness, reduced success in locating prey, inability to communicate, or inability to sense their physical environment (Oestman *et al.* 2009). Table 7 shows the onset of fish injury relative to fish size and sound exposure.

Table 7. The onset of fish injury relative to fish size and sound exposure. Lp,0-pk is a measure of peak sound pressure while flat indicates that the peak sound pressures are unweighted within the generalized hearing range of fish species. LE,p, is the cumulative sound exposure level. NMFS acoustic thresholds for the onset of behavioral disturbance (underwater and in-air) are determined by the root-mean-square (RMS) received levels (NMFS 2023).

Fish Size	Onset of Physical Injury (Received Level) Impulsive
Fishes ≥ 2 g	$L_{p,0\text{-}pk,flat}$: 206 dB $L_{E,p,12h}$: 187 dB
Fishes < 2 g	$L_{p,0\text{-}pk,flat}$: 206 dB $L_{E,p,12h}$: 183 dB
Source Type	**Threshold for the Onset of Behavioral Disturbance**
All sources	L_{RMS} 150dB

Exposure level and distance from sound, length of exposure, and fish size and anatomy can influence the severity of the impact, with smaller fish being more susceptible to damage. Eggs, larvae, and juvenile fish might be affected more acutely than other life stages because they lack the physical ability, or have reduced ability compared to adults, to move away from loud noise (Oestman *et al.* 2009). For instance, the burst speed of adult Chinook salmon is 20 times greater than that of juveniles (Bell 1986). Pile driving has been identified as a specific threat to Pacific Coast Chinook salmon EFH (Stadler *et al.* 2011) and may reduce the availability of critical resources, such as food, because of substrate disturbance or impeded fish passage.

Pile-driving activities will result in noise that startles federally listed fish. Startled fish may hide, move to adjacent suitable habitats, or cease activities, such as feeding or holding, until the disturbance has ended. In addition, sound associated with pile driving may mask environmentally relevant noise that could prevent federally listed fish from detecting predators or conspecifics.

The applicant proposes that noise will not exceed a peak of 206 dB or an accumulated 187 dB. This value exceeds both the onset of physical harm to fishes < 2 g and the threshold for the onset of behavioral disturbance. All in-water work will occur from June 15 to October 31.

2.5.3.1. Effects of noise and sound pressure on federally listed species

There is a high probability that adult and juvenile SR winter-run Chinook salmon and sDPS green sturgeon will be present in the Action Area in the Sacramento River and CV spring-run Chinook salmon and CCV steelhead will be present in the Action Area in the Sacramento River and Butte Slough. Once pile driving starts producing increased in-stream noise, individual fish will likely detect the sounds and vibrations and avoid the immediate area. Smaller fish with lower mass are more susceptible to the impacts of elevated sound fields and more at risk for non-auditory tissue damage (Popper and Hastings 2009) than larger fish (yearlings and adults) of the same species. With the use of AMMs, in-stream pile driving is expected to cause harm and harassment to a small number of each of the above listed species resulting in behavioral changes, such as reduced feeding, habitat avoidance, and increased predation risk. Pile driving will contribute to delayed migration for adult spring-run Chinook salmon, and late-arriving migrants will experience delayed spawning, straying into other watersheds, spawning in less suitable habitat, decreased fecundity, and pre-spawn mortality due to the expenditure of limited energy while trying to bypass impediments.

2.5.3.2. Effects of noise and sound pressure on species critical habitat

Project activities are expected to cause increases in instream noise, motion, and vibrations throughout the implementation of the proposed action, which can temporarily decrease the value of the PBFs of critical habitat for federally listed species including adequate prey, adequate cover, unimpeded access to and from spawning grounds, and safe passage conditions for migration. Critical habitat effects from noise, motion, and vibration are expected to be temporary and limited to the direct vicinity of activities over the lifetime of the proposed action. Potential temporary effects related to a short-term reduction in PBFs of salmonid and sturgeon critical habitat will be minimized by the BMPs included in the proposed action; thus, the proposed action is not expected to reduce the value of the critical habitat for salmonids and sDPS green sturgeon.

2.5.4. Sediment and turbidity

Sediment mobility and turbidity may increase because of project actions. Construction-related increases in sedimentation and turbidity above the background level could affect fish species and their habitat by reducing juvenile survival, interfering with feeding activities, causing the breakdown of social organization, and reducing primary and secondary productivity. The magnitude of potential effects on fish depends on the timing and extent of sediment loading and flow in the river before, during, and immediately following construction.

Highly suspended sediment can have short- and long-term effects on salmonids and green sturgeon. The severity of these effects depends on the sediment concentration, duration of exposure, and sensitivity of the affected life stage. Based on the types and duration of proposed in-water construction methods, short-term increases in turbidity and suspended sediment may disrupt feeding activities or result in the avoidance or displacement of fish from their preferred habitat. Juvenile salmonids have been observed to avoid chronically turbid streams (Lloyd 1987) or move laterally or downstream to avoid turbidity plumes (Sigler *et al.*1984). Bisson and Bilby (1982) reported that juvenile Coho salmon (*O. kisutch*) avoid turbidities exceeding 70 NTUs. Sigler *et al.* (1984) found that prolonged exposure to turbidities between 25 and 50 NTUs reduced growth and increased emigration rates of juvenile Coho salmon and steelhead trout compared to controls. These findings are generally attributed to reductions in the ability of salmon to see and capture prey in turbid water (Waters 1995). Chronic exposure to high turbidity and suspended sediment may also affect growth and survival by impairing respiratory function, reducing tolerance to disease and contaminants, and causing physiological stress (Waters 1995).

Berg and Northcote (1985) observed changes in social and foraging behavior and increased gill flaring (an indicator of stress) in juvenile Coho salmon at moderate turbidity (30- 60 NTUs). In their study, behavior returned to normal quickly after turbidity was reduced to lower levels (0-20 NTU). In addition to direct behavioral and physical effects on fish, increased sedimentation can alter downstream substrate conditions, as suspended sediment settles and increases the proportion of fine particles in the system. Deposited fine sediment can impair the growth and survival of juvenile salmonids (Harvey *et al.* 2009; Suttle *et al.* 2004). Less is known about the specific detrimental physical and physiological effects of sedimentation and turbidity on sturgeon. However, it is thought that high turbidity generally results in gill fouling, reduced temperature tolerance, reduced swimming capacity, and reduced forage capacity in lotic fishes (Wood and Armitage 1997).

Any increase in turbidity associated with the project is likely to be brief, attenuating downstream as suspended sediment settles out of the water column. Increased turbidity will occur during the installation and removal of cofferdams and dewatering of the project area. These temporary spikes in suspended sediment may result in behavioral avoidance of the site by fish; several studies have documented active avoidance of turbid areas by juvenile and adult salmonids (Servizi and Martens 1992; Lloyd 1987; Sigler *et al.* 1984); however, proposed BMPs (such as turbidity curtains and daily monitoring) will lessen increased turbidity from project activity.

2.5.4.1. Effects of sediment and turbidity on federally listed species

There is a high probability that adult and juvenile SR winter-run Chinook salmon and sDPS green sturgeon will be present in the Action Area in the Sacramento River and CV spring-run Chinook salmon and CCV steelhead will be present in the Action Area in the Sacramento River and Butte Slough. Individual fish encountering increased turbidity or sediment concentrations would likely move laterally, downstream, or upstream of the affected areas. For juveniles, this may increase their exposure to predators if forced to leave protective habitat, and migrating adults may experience delays in upstream movement. Sedimentation and turbidity from site construction is expected to adversely affect a small number of each of the above listed species due to behavioral changes, including reduced feeding, habitat avoidance, and increased predation risk. Increased sediment and turbidity will contribute to delayed migration for adult spring-run Chinook salmon, and late-arriving migrants will experience delayed spawning, straying into other watersheds, spawning in less suitable habitat, decreased fecundity, and pre-spawn mortality due to the expenditure of limited energy while trying to avoid turbidity.

2.5.4.2. Effects of sediment and turbidity on species critical habitat

Cofferdam placement and stream dewatering are expected to cause increased sedimentation and turbidity in the Action Area. The applicant will use BMPs to reduce turbidity, including daily monitoring, turbidity curtains, and project cessation if average weekly levels exceed 50 NTUs. All work occurring in or near the water can cause temporary increases in turbidity and suspended sediment levels within the project area and downstream areas. The deposition of suspended sediments is expected to temporarily reduce food availability and feeding efficiency due to the natural substrate being coated with a new layer of sediment. Short-term increases in turbidity and suspended sediment levels may temporarily affect feeding, rearing and migration critical habitat PBFs through reductions in food availability, reduced feeding efficacy, and avoidance or displacement from preferred habitat (Bjornn and Reiser 1991). Increased turbidity can reduce primary productivity and photosynthesis activity (Cordone and Kelley 1961), and affect inter-gravel permeability and dissolved oxygen levels (Zimmermann and Lapointe 2005). However, these adverse effects are expected to be minimal and temporary, lasting only as long as project construction actions (*e.g.,* placing and removing cofferdams) or until the first fall storm flushes out the work site, removing any residual fine-grained sediments.

2.5.5. Contaminants

During construction, refueling, and equipment storage, toxic substances could spill or leak into the Action Area. In addition, the applicant will backfill the scour area beneath the concrete headwork with a concrete slurry to stabilize the outlet headwall and prevent future scouring. Such pollutants include fuels, lubricants, concrete, sealants, and oil. High concentrations of contaminants are lethal to fish. Effects include mortality from exposure, or increased susceptibility to disease that reduces the overall health and survival of the exposed fish. The severity of the impact from exposure depends on the contaminant, concentration, duration of exposure, and sensitivity of the affected life stage. Site contamination may reduce prey availability making food scarcer for listed species. Fish consuming contaminated prey may also absorb toxins directly and be exposed to biomagnification of the contaminant as it moves up the food chain.

Petroleum-contaminated waterways are associated with reduced growth rates (Lundin *et al.* 2021; Yanagida *et al.* 2012), reduced disease resistance, and impaired reproduction (Lundin *et al.* 2021) in Chinook salmon. When they come in contact with oil, fish are also susceptible to enlarged livers, changes in heart and respiration rate, and fin erosion. Fish eggs and larvae are especially sensitive to lethal and sublethal impacts (NOAA 2024). Oil and chemical spills affect sDPS green sturgeon egg survival and larval development, and could result in stress, injury, or death to adults and juveniles. In general, contamination can lead to acute toxicity and death when concentrations are sufficiently elevated. When concentrations are lower, chronic or sublethal effects of toxicity reduce the physical health of the organism and lessen its survival over an extended period.

Uncured concrete can significantly raise the pH of water to levels that are harmful to aquatic species (pH 11-13) (Wojtastic *et al.* 2019). Capillary pores in concrete can contain a high-pH solution of hydroxides, and capillary continuity allows for the diffusion of dissolved ions through the concrete into the surrounding environment, thus raising the surrounding pH. As concrete cures, diffusivity decreases as capillary pores become discontinuous (CTC & Associates 2016). The onset of capillary discontinuity varies with water-cement ratio (Table 8). The applicant will use a water-cement ratio between 0.45 and 0.50, and the project area will stay dewatered for 9–10 weeks; therefore, the cement curing time is well within the dewatered window.

Table 8. Cement curing time required for capillary discontinuity depending on the water-cement ratio (Mindess, Young, and Darwin 2003).

Water-cement ratio	Mindess, Young, and Darwin (2003)
0.40	3 days
0.45	7 days
0.50	28 days
0.60	180 days
0.70	365 days
>0.70	Never

2.5.5.1. Effects of contaminants on federally listed species

There is a high probability that adult and juvenile SR winter-run Chinook salmon and sDPS green sturgeon will be present in the Action Area in the Sacramento River and CV spring-run Chinook salmon and CCV steelhead will be present in the Action Area in the Sacramento River and Butte Slough. During construction, refueling, equipment storage, and maintenance activities, toxic substances could spill or leak into the Action Area and pose a risk to federally listed species; however, we are not expecting any spills at the project site. BMPs detailed in the Water Quality Control Plan will reduce the likelihood of contaminant-related harm to critical habitat, and the length of the concrete curing time will negate the risk of cement contamination; thus, potential negative effects from hazardous materials are not expected to occur.

2.5.5.2. Effects of contaminants on species critical habitat

The operation of power equipment, such as an excavator, in or near aquatic environments increases the potential for toxic substances to enter the watershed (Feist *et al.* 2011). Toxic spills could negatively affect PBFs of critical habitats including freshwater migratory corridor, freshwater spawning, and freshwater rearing habitat for salmonids and green sturgeon.

During construction, refueling, equipment storage, and maintenance activities, toxic substances could spill or leak into the Action Area and pose a risk of contamination and impacts on species critical habitat. BMPs detailed in the Water Quality Control Plan will reduce the likelihood of contaminant-related harm to critical habitat; thus, potential negative effects from hazardous materials on designated critical habitat are not expected to occur.

2.5.6. Artificial lighting at night

Construction activity may require artificial lighting at night (ALAN). ALAN on the water's surface can alter fish behavior and predator-prey interactions in marine and freshwater environments. It often shifts nocturnal behaviors toward more daylight-like behaviors, and it can affect light-mediated behaviors, such as migration timing (Becker *et al.* 2013; Celedonia and Tabor 2015; Tabor *et al.* 2017). Tabor *et al.* (2017) found that sub-yearling Chinook, Coho, and sockeye salmon exhibit strong nocturnal phototactic behavior when exposed to levels of 5 to 50 lumens per square meter, with phototaxis positively correlated with light intensity. This response is associated with species' movement toward the light source. Conversely, larval green sturgeon may exhibit negative phototaxis in response to artificial light (Nguyen and Crocker 2005), though other research found that white sturgeon displayed positive phototaxis depending on light color and strobe rate (Ford *et al.* 2018); thus, more research would help to describe how *Acipenser* respond to light inputs throughout all life stages.

Celedonia and Tabor (2015) found that juvenile Chinook salmon in the Lake Washington Ship Canal were attracted to artificially lit areas at 0.5 to 2.5 lumens per square meter. The authors also reported that attraction to artificial lights may delay the onset of morning migration by up to 25 minutes for some juvenile Chinook salmon migration through the Lake Washington Ship Canal. Nelson *et al.* (2022) reported significant increases in rainbow trout densities at the Sundial Bridge on the Sacramento River when any amount of ALAN was present.

In the Sacramento-San Joaquin Delta, specifically, Nelson *et al.* (2020) reported that juvenile salmonid predation risk increased with ALAN due to predator densities. The authors noted that supplemental statistical analysis found predation risk did not increase until after 8–10 lux was reached; however, this level should be interpreted with caution, and previous work has suggested that ALAN intensities should remain as low as possible (<0.1 lux) to mitigate the impacts to salmonids during out-migration (Tabor *et al.* 2004; Tabor *et al.* 2017). Past studies have demonstrated that juvenile Chinook Salmon do not have different behavioral responses when exposed to different spectral wavelengths of light (Hansen *et al.* 2018, Tabor *et al.* 2021).

2.5.6.1. *Effects of ALAN on federally listed species*

There is a high probability that adult and juvenile SR winter-run Chinook salmon and sDPS green sturgeon will be present in the Action Area in the Sacramento River and CV spring-run Chinook salmon and CCV steelhead will be present in the Action Area in the Sacramento River and Butte Slough. The applicant may need to perform construction that requires ALAN. The applicant will use BMPs to reduce the negative effects of ALAN on listed species; however, these BMPs will not prevent nocturnal phototactic behavior. With the use of AMMs, ALAN is expected to adversely affect a small number of the above-mentioned federally listed species due to increased predation risk and behavioral changes, such as altered migration timing and reduced feeding.

2.5.6.2. Effects of ALAN on species critical habitat

The applicant will use BMPs to reduce the negative effects of ALAN on critical habitat. ALAN is expected to affect freshwater migratory and rearing PBFs of critical habitat and will cease to alter critical habitat once the project is completed.

2.5.7. Mitigation/conservation bank credit transfer

To address the impacts of the project on aquatic habitat, DWR proposes to transfer pre-purchased bank credits for 1.06 acres of temporary impacts and for 0.07 acres of permanent impacts. Mitigation banks can provide conservation benefits to listed species because the NMFS-approved mitigation banks that serve the project area provide a high level of certainty that the benefits of a credit purchase will be realized. The Bullock Bend Mitigation Bank includes mechanisms to ensure credit values are met over time. Such mechanisms include legally binding conservation easements, long-term management plans, detailed performance standards, credit release schedules that are based on meeting performance standards, monitoring plans and annual monitoring reporting to NMFS, non-wasting endowment funds that are used to manage and maintain the bank and habitat values in perpetuity, performance security requirements, a remedial action plan, and site inspections by NMFS.

2.5.6.3. Effects of Mitigation/conservation bank credit purchase on federally listed species

The transfer of purchased mitigation credits will address the loss of 1.27 acres of ecosystem functions due to construction-related activities. These pre-purchased credits are ecologically relevant to the impacts and the species affected because all banks include floodplain credits with habitat values that are already established and meeting performance standards. The credits are specifically targeted to salmonids and are not meant to offset impacts of the proposed action on sDPS green sturgeon. Bullock Bend's service area is within the action area of the proposed action, and benefits the salmonids that are affected by the proposed action.

2.5.6.4. Effects of Mitigation/conservation bank credit purchase on species critical habitat

Bullock Bend Conservation Bank is located on the mainstem Sacramento River within critical habitat for federally listed species affected by the project. Pre-purchased riparian floodplain forest/salmonid habitat restoration mitigation credits benefit federally listed salmonid rearing habitat and migration corridors by providing suitable floodplain and riparian habitat. The riparian forest and floodplain habitats in the bank benefit the growth and survival of rearing salmonids by providing habitat with abundant food in the form of aquatic invertebrates, structural diversity, and cooler stream temperatures. Mitigation bank credits will offset the impacts of the proposed action by providing additional shelter to juvenile salmonids that are displaced because of streambed and channel modification, pile driving, and increased turbidity associated with project actions. Bullock Bend's service area is within the action area of the proposed action, and provides the same PBFs of critical habitat that are impacted by the proposed action.

2.6. Cumulative Effects

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

Some continuing non-federal activities are reasonably certain to contribute to environmental variation 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 environmental variation that are properly part of the environmental baseline *vs.* cumulative effects. Therefore, all relevant future environmental conditions in the Action Area are described earlier in the discussion of environmental baseline (Section 2.4).

2.6.1. Agricultural practices and water diversions

Non-Federal actions that may affect the Action Area include ongoing agricultural activities in the Sacramento River watershed. Farming and ranching activities within, 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.

Existing and future non-Federal water withdrawals, diversions, and transfers from the Action Area may entrain, injure, or kill individual fish at unscreened, improperly screened, or poorly maintained diversions.

2.6.2. Increased urbanization

The population and number of jobs will likely increase in Colusa and Sutter County in the coming years. The 2019 County Level Economic Forecast predicts that the population and number of jobs will increase in Colusa County in the coming years. The largest gains are expected in agriculture, manufacturing, and government, which accounted for 80 percent of net job creation in the county between 2018 and 2024 (Caltrans 2019). In Sutter County, the agricultural sector is the second largest labor market, and the 2022 County Level Economic Forecast predicts that the population is expected to grow faster than the California average (Caltrans 2022).

Increased urbanization could result in increased recreational activities in the region. Among the activities expected to increase in volume and frequency is recreational boating. Boating activities typically result in increased wave action and propeller wash in waterways. This may 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 required for the survival of juvenile salmonids and green sturgeon. Increased recreational boat operation could result in more contamination from the operation of gasoline and diesel-powered engines on watercraft entering the associated water bodies.

2.6.3. Levee maintenance

Levee maintenance and bank protection activities can reduce floodplain connectivity, change substrate size, and decrease riparian habitat and shaded riverine aquatic cover. Cumulative effects include non-federal riprap projects for streambank and levee repair, many of which occur annually. 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 and Butte Creek watersheds. The effects of such actions result in continued fragmentation of existing high-quality habitat, and conversion of complex nearshore aquatic habitat to simplified habitats that negatively affect salmonids and sturgeon.

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

Federally listed species in California's Central Valley, including the SR winter-run and CV spring-run Chinook salmon, CCV steelhead, and sDPS green sturgeon, have either declined or remained unchanged in status, despite ongoing conservation efforts. The status of the species (Section 2.2) details the current range-wide status of the ESU and DPS and critical habitat for the above listed species. Many factors have contributed to this species and habitat decline including drought and warm water temperatures, hatchery practices, loss of access to current and historic habitat, agricultural diversions, and over harvest (NMFS 2014).

Population abundances, a crucial factor in the genetic health and viability of ESUs/DPSs, can vary annually, with drought conditions often leading to poor in-river survival. For instance, the decadal lows for SR winter-run Chinook salmon in 2017 and low run sizes for CV spring-run

Chinook salmon from 2015 to 2018 were linked to drought and warm ocean conditions (Johnson *et al*. 2023). While hatcheries like Livingston Stone National Fish Hatchery (SR winter-run Chinook salmon) and Feather River Fish Hatchery (CV spring-run Chinook salmon) have stabilized populations, particularly during periods of poor in-river survival, reliance on hatcheries raises concerns about the genetic integrity and viability of salmonid ESUs. The vast majority of CCV steelhead in the Central Valley originate from Coleman National Fish Hatchery, which is a major concern for the species' DPS (Johnson *et al*. 2023). Hybridization, such as introgression between Feather River spring- and fall-run Chinook salmon and the risk of Nimbus Fish Hatchery broodstock (from genetically distinct Eel and Mad River populations) compromising Central Valley steelhead, poses a serious threat to native fish populations (Johnson *et al. 2023)*.

Restoring fish to their historic spawning grounds is crucial for improving the viability of these ESUs/DPSs. Efforts to reintroduce SR winter-run Chinook salmon into Battle Creek enabled their first successful spawning in over 100 years in 2020 (Johnson *et al*. 2023). Habitat restoration efforts in Battle Creek and its tributaries aim to provide 48 miles of historic salmonid habitat, enhancing the ESU's spatial structure (Jones and Stokes 2005). Conversely, Battle Creek spring-run Chinook salmon show a significant declining trend, and natural origin CCV steelhead abundances remain low (Johnson *et al*. 2023), necessitating continued monitoring to identify how to improve species outcomes. Another successful reintroduction initiative brought CV spring-run Chinook salmon back to the San Joaquin River (Gutierrez *et al*. 2024).

Migration barriers continue to threaten Central Valley ESUs/DPSs, especially sDPS green sturgeon. Several projects have been implemented to reduce entrainment and stranding. The decommissioning of Red Bluff Diversion Dam in 2011 now allows sDPS passage year-round (Vick *et al*. 2021). The 2016 completion of the Knights Landing Outfall Gates and 2018 completion of the Wallace Weir Fish Rescue Facility reduce adult salmonid entry into the Colusa Basin Drain. The 2019 Fremont Weir Adult Fish Passage Modification Project widened and deepened the fish ladder to improve salmon and sturgeon passage (NMFS 2024). The Tisdale Weir Rehabilitation and Fish Passage Project, expected to begin in 2025, should further reduce stranding in the Sutter Bypass. Additionally, various fish screen improvements and installations have enhanced fish migration and critical habitat (NMFS 2024). However, despite these improvements, many migration barriers still exist within the Sacramento River basin.

Diseases pose another significant threat to Central Valley ESUs/DPSs. The 2021 Butte Creek spring-run pre-spawn mortality event was linked to bacterial columnaris disease and parasitic infestation exacerbated by warm water and reduced flows (CDFW 2022). Hatcheries may increase the risk of pathogen outbreaks for listed species, and SR winter-run Chinook salmon are particularly vulnerable due to comprising only one spawning population (NMFS 2024). Thiamine deficiency (TDC) is an emerging threat; in 2019, Central Valley Chinook salmon (fall-, spring-, and late fall-run) were diagnosed with TDC, causing early life stage mortality in Feather River Hatchery spring-run Chinook salmon. The prevailing hypothesis attributes Central Valley salmon TDC to a food web reorganization in the Central California Current, leading to northern anchovy dominance in salmon diets and reduced thiamine in spawner progeny (Johnson *et al*. 2023). Environmental variation and shifting ocean conditions may influence future anchovy abundance and distribution, making TDC a persistent threat to salmonid ESUs/DPSs (Mantua *et al*. 2025).

Despite actions taken to address these numerous threats, the listing status of SR winter-run Chinook salmon (endangered), CV spring-run Chinook salmon (threatened), CCV steelhead (threatened), and sDPS green sturgeon (threatened) remains unchanged. Efforts to address the species decline include reducing hatchery dependence, improving habitat accessibility, facilitating volitional passage, reintroducing species into native habitats, and managing water projects to ensure the availability of cold water during late summer.

The above listed species ESUs/DPSs are constrained by small population sizes and altered habitat that is susceptible to further degradation and environmental variation. If measures are not taken to reverse these trends, the recovery and survival potential of these species will continue to worsen. While the remaining critical habitat for these species is degraded from historical conditions, it is still considered critically important to species' recovery and conservation.

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 action area where the proposed action will occur. Factors affecting listed species in the action area include habitat loss, predation, affected water quality, and agricultural impacts (SR winter-run Chinook salmon; CV spring-run Chinook salmon; CCV steelhead; sDPS green sturgeon), and migration barriers (CV spring-run Chinook salmon and CCV steelhead). Section 2.2.6. discusses the vulnerability of listed species and critical habitat to environmental variation in the California Central Valley. All species are expected to face increasing threats due to environmental variation.

Given the rate of expected growth in Colusa and Sutter counties, cumulative effects (Section 2.6.) will amplify existing species stressors. Agricultural practices will continue to pressure water resources. These practices will adversely affect riparian and wetland habitats through upland modifications of the watershed that lead to increased siltation, discharge of chemicals into the waterway, or reductions in water flow. Increased urbanization and subsequent population growth will also lead to increases in poaching. Loss to poachers is a large threat to the continued existence of salmonids in some streams in California (Moyle *et al.* 1989), and poaching is common in areas where adult salmon migration is blocked. In addition, increased recreational water use further stresses federally listed fish species and riparian habitats and will result in waste and water pollution. Cumulative effects are expected to contribute to ongoing deleterious effects to species and critical habitat, which will further diminish the functional value of critical habitat for the conservation of the species within the action area.

2.7.3. Summary of the effects of the proposed action to listed species

Construction will occur within a single construction season between April 1 and November 31. Dewatering of the construction area will occur between June 15 and October 31. NMFS expects adult and juvenile life stages of SR winter-run Chinook salmon, CV spring-run Chinook salmon, CCV steelhead, and sDPS green sturgeon to be present during the construction period.

The proposed project will affect the above-listed species and life stages and is expected to result in harassment, harm, injury, or death due to increased turbidity, channel modification, fish relocation, and behavioral changes associated with hydroacoustic impacts and ALAN. Behavioral changes will result in reduced feeding, habitat avoidance, and increased predation risk. Adult and juvenile CV spring-run chinook salmon are expected in the action area during construction activity; however, Butte Creek spring-run Chinook salmon are expected to have returned to their natal stream (upstream from the action area) by June (CDFG 2001). Further, according to reports, queuing Butte Creek CV spring-run Chinook salmon at BSOG typically peaks in March (McReynolds 2021; Nichols 2022), and drops off through April (McReynolds 2021). Therefore, the number of individuals present in the action area during construction activity is expected to be small relative to the overall size of the annual run. Butte Creek CV spring-run Chinook salmon adult upstream migration through BSOG will be impacted by the placement of cofferdams in June; however, the proposed action is not expected to noticeably reduce migration through BSOG given that a majority of upstream adult migrants is expected to have already reached their spawning grounds further upstream by this time of year.

2.7.4. Summary of the effects of the proposed action to critical habitat

Designated critical habitat is present in the action area for all four species addressed in this opinion. The project will result in minor intensity, short-term losses of benthic habitat (affecting rearing PBFs) due to cofferdam placement and dewatering of the channel. Short-term impacts related to turbidity are expected due to general construction (affecting rearing and food resources PBFs). In addition, permanent impacts to 0.07 acres of critical habitat will result from the removal of one sandbar willow below the ordinary high water mark (OHWM), bank stabilization, the placement of four new inlet catwalk piles, and the backfilling of the scour area with a concrete slurry (affecting rearing PBFs). Migration, rearing, and potential spawning habitat PBFs will be minimally impacted in the long-term.

2.7.5. Risk to listed ESUs/DPSs and critical habitat at the designation level

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 relative to historical conditions. The current status of listed anadromous fish species has not significantly improved since the species' previous status reviews (NMFS 2016a; NMFS 2021b; NMFS 2024; Johnson *et al*. 2023) and, in some cases, has declined further. Additionally, habitat quality, once degraded by human development, often remains compromised for decades or more. Cumulative effects that are not subject to Federal permitting are likely to worsen these impacts.

The proposed action will affect a small number of individuals in the listed species from three salmonid diversity groups (Basalt and Porus Lava, Northwestern California, Northern Sierra Nevada) and will affect a relatively small portion of salmonid critical habitat in the Northern Sierra Nevada region. The project will also affect a small number of sDPS green sturgeon individuals and a small portion of the species' critical habitat. These fish will be impacted by the proposed action because they will pass through the action area while migrating to/from their spawning/rearing ground. AMMs are in place to ensure minimal impacts to listed species and critical habitat.

The migration timing for upstream adult migrating Chinook salmon occurs during most of the diel cycle (Keefer *et al*. 2012; Eiler *et al*. 2022), but may shift to primarily diurnal based on complex environmental factors (Keefer et al. 2012). Juvenile Chinook salmon typically prefer nocturnal migration (NMFS 2014). Adult and juvenile migration of sDPS green sturgeon are typically nocturnal (NMFS 2018, 2021b). As indicated by the salmonid temporal occurrence and relative abundance tables incorporated by reference in Section 2.2, Status of the Species, most adult SR winter-run and CV spring-run Chinook salmon populations will have reached their spawning grounds during project actions; however, CV spring-run are present in the Sacramento River Basin during the duration of project actions, and a small number of late-arriving adult migrants will experience delayed spawning, straying into other watersheds, spawning in less suitable habitat, slightly reduced ability to migrate compared to baseline conditions, decreased fecundity, and pre-spawn mortality due to the expenditure of limited energy while navigating habitat disturbance associated with cofferdam placement and other project actions. Fish that are handled during dewatering also face an increased risk of injury or mortality.

Adult CCV steelhead are more abundant in the Sacramento Basin beginning in late August, and more likely to experience impacts such as increased turbidity associated with cofferdam removal rather than placement, which will occur in June. Turbidity caused by cofferdam removal is expected to be short term and will contribute to habitat disturbance until the disturbed sediment settles out of solution. Adult sDPS green sturgeon begin their upstream migration in late-winter/early-spring and should be holding in their spawning grounds by the start of project actions. A small number of adult CCV steelhead and sDPS green sturgeon will experience delayed spawning, straying into other watersheds, spawning in less suitable habitat, decreased fecundity, and pre-spawn mortality due to the expenditure of limited energy while navigating habitat disturbance.

Juveniles from all ESUs and DPSs in the affected diversity groups and juvenile green sturgeon could be present in the Sacramento River basin and action area year-round, though rearing and migrating juveniles are likely to avoid the action area during project activities. Juvenile fish forced away from their rearing habitat will experience crowding and competition with resident fish for food and habitat. Behavioral changes will also lead to reduced feeding, habitat avoidance, and increased predation risk. Juvenile foraging and migration occur more often at night when project actions are less likely to occur. Fish that are handled during dewatering also face an increased risk of injury or mortality.

The proposed action is not expected to reduce species abundance, productivity, diversity, or spatial structure. While 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, the proposed action is not expected to render any affected population insufficient to maintain their genetic diversity over the long term. While the Butte Creek spring-run population growth rate has exhibited sustained declines during the last two years of annual returns, the proposed action is not expected to contribute to further declines in productivity. Given spawning and migration timing, the proposed action will result in delayed spawning, decreased fecundity, and pre-spawn mortality; however, these impacts are expected to occur in small numbers so as not to reduce ESU/DPS diversity. Spatial structure will be impacted by temporary and permanent habitat destruction, but mitigation banking will account for spatial reductions in habitat caused by the proposed project and will mitigate adverse project actions. Overall, the number of fish adversely affected by the proposed action are not expected to represent a substantial proportion of populations present in the system; thus, the Viable Salmonid Population parameters of spatial structure, diversity, abundance, and productivity are not expected to be appreciably reduced as a result of the proposed action. We therefore conclude that the action is not likely to jeopardize the listed species because it is not expected to reduce appreciably their likelihood of survival and recovery by reducing their reproduction, numbers, or distribution.

Temporary and permanent impacts to critical habitat will result from project actions. Temporary impacts associated with the proposed action will affect 1.06 acres of habitat and will impact rearing and migration PBFs of critical habitat. Permanent impacts associated with the proposed action will result in the loss of 0.07 acres of habitat and will impact rearing PBFs of critical habitat. These impacts represent a small proportion of existing critical habitat, and will be mitigated by AMMs and the purchase of mitigation banking credits from the Bullock Bend Mitigation Bank at a 1:1 ratio for temporary impacts and 3:1 ratio for permanent impacts associated with the proposed action. These credit purchases are ecologically relevant to the PBFs of critical habitat adversely affected by the proposed action, because the bank includes credits with habitat values that are already established and meeting performance standards. The bank is located below the OHWM on a backwater floodplain on the mainstem of the Sacramento river and is located within salmonid critical habitat and provides habitat for the salmonids affected by this proposed action. The bank serves listed salmonids from three salmonid diversity groups (Basalt and Porus Lava, Northwestern California, Northern Sierra Nevada). Given the small size of the temporary and permanent impacts to critical habitat, the availability of nearby habitat, and the purchase of offsetting mitigation credits, the proposed action is not expected to appreciably diminish the value of critical habitat as a whole for the conservation of the impacted listed 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, and sDPS green sturgeon, 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 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:

> Incidental take of SR winter-run Chinook salmon, CV spring-run Chinook salmon, CCVsteelhead, and sDPS green sturgeon individuals are expected from the action proposed by DWR. The proposed action is expected to result in take from:
>
> - Pile driving,
> - Channel modification,
> - Bank modification,
> - Dewatering and cofferdam placement/removal,
> - ALAN,
> - Seining and dip netting, and
> - Electrofishing

It is not practical to quantify or track the number of individuals taken due to the proposed action, because there is a lot of variation in the timing of spawning and migration, individual habitat use within the action area, and difficulty in observing injured or dead fish. However, it is possible to estimate the extent of incidental take by designating ecological surrogates, and it is practical to quantify and monitor the surrogates to determine the extent of incidental take that is occurring. The most appropriate surrogates for the extent of incidental take that is expected to occur during proposed activities are the following:

2.9.1.1. Pile driving

Take in the form of harm, injury, or death to listed fish from the acoustic effects of pile driving:

The surrogate for take caused by the acoustic effects of pile driving will be the observed sound levels during pile driving. This is causally linked to the extent of this type of take of listed species because sound pressure impacts on fish include auditory and non-auditory tissue damage, neuro-trauma, temporary or permanent hearing loss, reduced fitness, reduced success in locating prey, inability to communicate, or inability to sense their physical environment (Oestman et al. 2009). NMFS anticipates take is exceeded if pile driving exceeds 206 dB or an accumulated 187 dB within 10 meters (33 feet) of the pile-driving site.

2.9.1.2. Channel modification

Take in the form of harm, injury, or death to listed fish from the streambed alteration of channel modification:

The surrogate for take caused by the streambed alteration of channel modification will be the duration of time that the project work is occurring such that the channel is temporarily dewatered. This is causally linked to the extent of this type of take of listed species because the dewatered channel will impact adult and juvenile fish migration and juvenile rearing. Pre-spawn mortality of adult listed species may occur due to the expenditure of limited energy while trying to bypass or avoid disturbances. Juvenile fish will be forced to outmigrate in the Sutter Bypass, which is known to present many hazards to salmonids (Bernard *et al.* 1996; CDFW 2022; CDFW 2024a). Streambed alteration will likely result in behavioral changes of rearing juveniles, such as reduced feeding, habitat avoidance, increased predation risk, and a probable change in fitness or reduced growth and survival of federally listed species. NMFS anticipates take is exceeded if project work exceeds the duration of proposed project activities, that is, if dewatering occurs beyond the period June 15 to October 31 or construction occurs beyond one construction season.

2.9.1.3. Bank modification

Take in the form of harm, injury, or death to listed fish from the habitat destruction of bank modification:

The surrogate for take caused by the habitat destruction of bank modification will be the amount of permanent habitat destruction in acres caused by the proposed action. This is causally linked to the extent of this type of take of listed species because loss of habitat is a primary stressor affecting the recovery of listed species. Habitat destruction primarily affects the juvenile rearing and outmigration life stages of listed species. Permanent habitat destruction will result in behavioral changes, such as reduced feeding, habitat avoidance, increased predation risk, and a probable change in fitness or reduced growth and survival of federally listed species. NMFS anticipates take is exceeded if permanent habitat loss exceeds the acres defined in the proposed action (*i.e.*, 0.07 acres).

2.9.1.4. Dewatering and cofferdam placement/removal

Take in the form of harm, injury, or death to listed fish from the impacts related to water quality from dewatering and cofferdam placement/removal:

The surrogate for take caused by the impacts related to water quality from dewatering and cofferdam placement/removal will be the measure of turbidity caused by project actions that increase the NTUs in the action area. This is causally linked to the extent of this type of take of listed species because highly suspended sediment can have short- and long-term effects on salmonids and green sturgeon. Short-term increases in turbidity and suspended sediment may disrupt feeding activities or result in the avoidance or displacement of fish from their preferred habitat (Lloyd 1987; Sigler et al.1984). Long-term exposure to turbidities between 25 and 50 NTUs reduces growth and increases emigration rates of juvenile Coho salmon and steelhead trout compared to controls (Sigler et al.1984), and may also affect growth and survival by impairing respiratory function, reducing tolerance to disease and contaminants, and causing physiological stress (Waters 1995). Further, high turbidity generally results in gill fouling, reduced temperature tolerance, reduced swimming capacity, and reduced forage capacity in lotic fishes (Wood and Armitage 1997). NMFS anticipates take is exceeded if NTUs exceed the levels required by the California RWQCB for a 401 certification.

2.9.1.5. ALAN

Take in the form of harm, injury, or death to listed fish from the impacts related to light pollution from ALAN:

The surrogate for take caused by the light pollution of ALAN will be the measure of distance that light travels when construction activity is completed at night. This is casually linked to the extent of this type of take of listed species because ALAN can alter fish behavior and predator-prey interactions in marine and freshwater environments by shifting juvenile nocturnal behaviors towards more daylight-like behaviors (Becker et al. 2013; Celedonia and Tabor 2015; Tabor et al. 2017) leading to increased predation risk and behavioral changes, such as altered migration timing and reduced feeding. NMFS anticipates take is exceeded if ALAN extends beyond the 200 foot proposed limit into listed species habitat.

2.9.1.6. Seining and dip netting

Take in the form of harm, injury, or death to listed fish from the impacts related to fish handling and relocation from seining and dip netting:

Take from mortality due to fish handling can be directly observed and does not require a surrogate. The surrogates for other kinds of take caused by fish handling and relocation (such as stress) will be the observed number of fish killed during seining and dip netting and area dewatered. The number of fish killed is causally linked to the extent of other forms of take of listed species from such handling, because seining and dip netting can cause stress, injury, or death, the mechanisms by which are likely due to differences in water temperatures between the river and holding buckets, depleted dissolved oxygen in holding buckets, holding fish out of the water, poor handling technique (not wearing gloves), use of high risk equipment (knotted nets over soft rubber or knotless nets), and physical trauma. The extent of the area to be dewatered will also be used as a surrogate for such take. The number of fish handled will be limited to the number of fish present in the dewatered area. The dewatered area on the western side of the BSOG facility is estimated to cover a 0.52-acre area, and the dewatering area on the eastern side of the BSOG facility is estimated to cover a 0.54-acre area. NMFS anticipates take is exceeded if the dewatered area on either side of the facility exceeds the proposed number of acres to be dewatered by more than 0.2 acres, and if mortality from seining and dip netting activities kill greater than three percent of the total number of ESA-listed fish individuals handled.

2.9.1.7. Electrofishing

Take in the form of harm, injury, or death to listed fish from the impacts related to fish handling and relocation from electrofishing:

The surrogate for take caused by fish handling and relocation will also include the observed number of fish killed during electrofishing activities. This is causally linked to the extent of this type of take of listed species because electrofishing can cause stress, injury, or death, the mechanisms by which are likely due to differences in water temperatures between the river and holding buckets, depleted dissolved oxygen in holding buckets, holding fish out of the water, poor handling technique (not wearing gloves), and physical trauma. One of the most commonly reported fish injuries associated with electrofishing is spinal injuries; these injuries are not always externally evident; thus, a practitioner may underestimate the full scope of harm related to the action (Nielsen 1998). NMFS anticipates take is exceeded if mortality from electrofishing activities kill greater than one percent of the total number of ESA-listed fish individuals handled.

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 when the reasonable and prudent alternatives are implemented.

2.9.3. Reasonable and Prudent Measures

"Reasonable and prudent measures" refer to those actions the Director considers necessary or appropriate to minimize the impact of the incidental take on the species (50 CFR 402.02).

1. Measures shall be taken to ensure the safe handling of fish during relocation activities.
2. Measures shall be taken to retain any individual SR winter-run Chinook salmon, CV spring-run Chinook salmon, CCV steelhead, and/or sDPS of North American green sturgeon killed during project activities.
3. Measures shall be taken to ensure that contractors, construction workers, and all other parties involved with the project implement the AMMs and Terms and Conditions as detailed in the BA and this Opinion.
4. Measures shall be taken to ensure that monitoring incidental take occurs and is reported to NMFS to better assess the effects and benefits of project avoidance, mitigation, and minimization efforts.

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. USACE 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. Total in-water handling time shall not exceed 10 minutes and total in-air handing time shall not exceed 10-60 seconds.
    b. Field supervisors and crewmembers must have appropriate training and experience with electrofishing techniques. Training for field supervisors can be acquired from programs such as those offered from the U.S. Fish and Wildlife Service, National Conservation Training Center (Principles and Techniques of Electrofishing course), where participants are presented information concerning such topics as electric circuit and field theory, safety training, and fish injury awareness and minimization.
    c. The training must occur before any crew begins any electrofishing. Field crew training must include the following elements:
        i. A review of these guidelines and the equipment manufacturer's recommendations, including basic gear maintenance.

        ii. Definitions of basic terminology (*e.g.,* galvanotaxis, narcosis, and tetany) and an explanation of how electrofishing attracts fish.
        iii. A demonstration of the proper use of electrofishing equipment (including an explanation of how gear can injure fish and how to recognize signs of injury) and of the role each crewmember performs.
        iv. A demonstration of proper fish handling, anesthetization, and resuscitation techniques.
        v. A field session where new individuals actually perform each role on the electrofishing crew.
    d. A crew leader having at least 100 hours of electrofishing experience in the field using similar equipment must train the crew. The crew leader's experience must be documented and available for confirmation; such documentation may be in the form of a logbook.
    e. No electrofishing will occur when water temperatures are above 64.4ºF (18ºC) or if they are expected to rise above this temperature prior to concluding the electrofishing survey.
2. The following term and condition implements reasonable and prudent measure 2:
    a. All Chinook salmon, steelhead, and green sturgeon mortalities must be retained, placed in an appropriately sized whirl-pak or zip-lock bag, labeled with the date and time of collection, fork length, location of capture, capture method, and frozen as soon as possible. Frozen samples must be retained until specific instructions are provided by NMFS.
    b. Mortalities will be reported to NMFS within 24 hours of their occurrence.
3. The following term and condition implements reasonable and prudent measure 3:
    a. USACE or DWR shall provide sufficient instruction and oversight to ensure that the prime contractor implements the AMMs of the proposed action and understands the Terms and Conditions of the Opinion. A copy of this Opinion highlighting the AMMs and Terms and Conditions shall be provided to the prime contractor in order to educate and inform all other contractors involved in the project analyzed in this Opinion. The prime contractor shall confirm in writing that they understand the AMMs and Terms and Conditions of the Opinion and will implement them as written. Their confirmation shall be submitted to NMFS before the start of construction activities.
4. The following terms and conditions implement reasonable and prudent measure 5:
    a. DWR shall submit to NMFS a report of the project's monitoring of incidental take, following construction.
    b. The report shall include:
        i. The start and end date of the proposed action
        ii. The amount of time the channel was dewatered
        iii. The relocation and handling methods used, the amount of time fish were handled in-water and out of water, the number of fish handled while implementing the proposed action, and the number of mortality events
        iv. Turbidity measurements as required by the RWQCB for 401 certification
        v. Acoustic measurements within 33 feet and at 961 feet of the pile driving site during pile driving activity, and the time, location, and frequency of additional monitoring while implementing the proposed action

vi. The frequency of use and distance (in feet) of light when using ALAN
vii. The number of days the channel was dry after concrete was poured and any spills associated with the proposed activities
viii. The area (in square feet) of disturbed soil that is revegetated after the completion of the project, and the method of revegetation (native seed mix and/or native vegetation)

c. This report shall be submitted after project completion, preferably by email by December 31 to the NMFS California Central Valley Office:
ccvo.consultationrequests@noaa.gov
National Marine Fisheries Service
Assistant Regional Administrator
California Central Valley Office
650 Capitol Mall, Suite 5-100
Sacramento, California 95814

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. DWR should participate in open communication and cooperation between the agencies (NMFS, CDFW, and USFWS) and local water users to identify conflicts and minimize impacts (*e.g.* unscreened water diversions for agriculture) that limit restoring high quality species critical habitat in the Butte Slough and Sutter Bypass.
2. DWR should conduct a basin-wide investigation of the entire Butte Creek watershed/Sutter Bypass irrigation system and assist in resolving the conflicts that currently degrade species critical habitat.
3. NMFS recommends that the crane operator remove the sheet piling slowly. This will minimize turbidity in the water column, as well as sediment disturbance.
4. NMFS recommends vibratory extraction as the method of sheet piling removal, because it causes the least disturbance to the streambed and it typically results in the complete removal of the piling from the aquatic environment.
5. NMFS recommends that USACE and/or the applicant post interpretative signage near critical habitat and waters that may contain federally listed species to provide information on those species that occur within the action area and actions that they can take to help and/or prevent further harm to those species. Signage could include information about the salmonid and green sturgeon lifecycles, including how to identify salmon redds, or information on how to report poaching. This conservation recommendation supports recovery action SAR-2.4 in the salmonid recovery plan (NMFS 2014).

2.11. Reinitiation of Consultation

This concludes formal consultation for the Butte Slough Outfall Gate Repair Project.

Under 50 CFR 402.16(a): "Reinitiation of consultation is required and shall be requested by the federal agency, where discretionary federal 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."

For example, reinitiation may be warranted if the proposed action resulted in a change to facility operations and maintenance that affected listed species or critical habitat in a manner or to an extent not previously considered.

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 associated physical, chemical, and biological 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 may result from actions occurring within EFH or outside of it and may include direct, indirect, site-specific or habitat-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 (50 CFR 600.905(b))].

3.1. EFH Affected by the Proposed Action

The proposed project occurs within EFH for various federally managed fish species within the Pacific Coast Salmon Fisheries Management Plan. EFH in the action area consists of adult migration habitat, spawning habitat, and juvenile rearing and migration habitat for SR winter-run Chinook salmon, CV spring-run Chinook salmon, fall- and late fall-run Chinook salmon. Habitat areas of particular concern (HAPCs) for Pacific Coast Salmon include (1) complex channels and floodplain habitats, (2) thermal refugia, (3) spawning habitat, (4) estuaries, and (5) marine and estuarine submerged aquatic vegetation; however, HAPCs are not present in the action area (PFMC 2005, 2014).

3.2. Adverse Effects on EFH

Effects to EFH for Pacific Coast salmon are discussed in the context of effects to critical habitat PBFs as designated under the ESA and described in section 2.4. Effects of the Action. The effects include the following:

- Permanent habitat loss/modification
- Temporary reduction/change in aquatic macroinvertebrate production
- Temporarily reduced shelter from predators
- Temporarily reduced habitat complexity
- Temporarily reduced delivery of oxygenated water to incubating eggs
- Temporarily reduced access to habitat connectivity

3.3. EFH Conservation Recommendations

The BMPs and AMMs outlined in the proposed action will reduce the temporary impacts of the project on EFH; however, the project does not mitigate for the cofferdam created passage barrier to downstream migrating salmonids, especially late-fall-run Chinook salmon. Fish that are prevented from migrating through the facility when cofferdams are present are forced to out-migrate through the Sutter Bypass, which is known to present many hazards to salmonids (Bernard *et al.* 1996; CDFW 2022; CDFW 2024a). NMFS determined that the following conservation recommendations are necessary to avoid, minimize, mitigate, or otherwise offset the adverse effects of the proposed action on EFH:

1. NMFS recommends that DWR should plant riparian habitat on-site at a 3:1 ratio plus an additional 1:1 ratio to account for temporal delays in restoration activities (for each year that restoration activities are delayed). This EFH recommendation reduces the adverse effect of permanent habitat loss/modification, temporarily reduced shelter from predators, and temporarily reduced habitat complexity by improving the conditions of available habitat and increasing shelter from predation and habitat complexity.
2. NMFS recommends vibratory extraction as the method of sheet piling removal, because it causes the least disturbance to the streambed and it typically results in the complete removal of the piling from the aquatic environment. This EFH recommendation reduces the adverse effects of temporary reduction/change in aquatic macroinvertebrate production because it causes the least disturbance to the streambed.
3. NMFS recommends that the crane operator remove the sheet piling slowly. This will minimize turbidity in the water column, as well as sediment disturbance. This EFH recommendation reduces the adverse effect of temporarily reduced delivery of oxygenated water to incubating eggs because it minimizes suspended sediments in the water column.
4. NMFS recommends that DWR seek to improve fish passage in the Sutter Bypass by identifying and working to reduce unscreened diversion to help improve successful upstream/downstream migration of adult/juvenile listed species. This EFH recommendation reduces the adverse effects of temporarily reduced access to habitat

connectivity by improving migration outcomes in the Sutter Bypass where fish will be forced to migrate when the Coffer Dams are in place.

Fully implementing these EFH conservation recommendations would protect habitat, 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, DWR 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)).

3.5. Supplemental Consultation

The USACE 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 USACE. Other interested users could include DWR. Individual copies of this opinion were provided to USACE. 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

Ainslie, B. J., J. R. Post, and A. J. Paul. 1998. Effects of Pulsed and Continuous Dc Electrofishing on Juvenile Rainbow Trout. North American Journal of Fisheries Management 18(4):905-918.

Anderson, N. and J. Sedell. 1979. Detritus Processing by Macroinvertebrates in Stream Ecosystems. Ann. Rev. Entomol 24:351-377.

Attrill, M. J. and R. M. Thomas. 1996. Long-Term Distribution Patterns of Mobile Estuarine Invertebrates (Ctenophora, Cnidaria, Crustacea: Decapoda) in Relation to Hydrological Parameters. Marine Ecology Progress Series:25-36.

Auer, N. A. 1996. Importance of Habitat and Migration to Sturgeons with Emphasis on Lake Sturgeon. Canadian Journal of Fisheries and Aquatic Sciences 53(S1):152-160.

Azat, J. and D. Killam. 2024. Grandtab 2024.05.20 California Central Valley Chinook Escapement Database Report. California Department of Fish and Wildlife.

Azat, J. and D. Killam. 2025. Grandtab 2025.06.09 California Central Valley Chinook Escapement Database Report. California Department of Fish and Wildlife.

Bacher, D. 2022. CDFW: 91% of Endangered Spring Chinooks Died before Spawning on Butte Creek Last Year. Stockton Record.

Becker, A., A. K. Whitfield, P. D. Cowley, J. Järnegren, and T. F. Næsje. 2013. Potential Effects of Artificial Light Associated with Anthropogenic Infrastructure on the Abundance and Foraging Behaviour of Estuary-Associated Fishes. Journal of Applied Ecology 50(1):43-50.

Beechie, T., H. Imaki, J. Greene, A. Wade, H. Wu, G. Pess, P. Roni, J. Kimball, J. Stanford, and P. Kiffney. 2012. Restoring Salmon Habitat for a Changing Climate. River research and applications 29(8):939-960.

Bell, M. C. 1986. Fisheries Handbook of Engineering Requirements and Biological Criteria. US Army Corps of Engineers, 323 pp.

Berg, L. and G. Northcote. 1985. Changes in Territorial Gill-Flaring, and Feeding Behavior in Juvenile Coho Salmon (*Oncorhynchus kisutch*) Following Short-Term Pulses of Suspended Sediment. Canadian journal of fish and aquatic science 42:1410-1417.

Bernard, D. P., A. Gunther, E. Laychak, and C. Darling. 1996. Restoring Central Valley Spring-Run Chinook salmon Populations: Technical Workshop to Identify Candidate Programs and Projects for Category III Funding. Vancouver, B.C.

Bisson, P. A. and R. E. Bilby. 1982. Avoidance of Suspended Sediment by Juvenile Coho Salmon. North American Journal of Fisheries Management 2(4):371-374.

Bjornn, T. C. and D. W. Reiser. 1991. Habitat Requirements of Salmonids in Streams. American Fisheries Society Special Publication 19(837):138.

Bosworth, A. 2022. Sutter Bypass and Butte Creek Coordination. pers. comm. J. Nichols. March 14, 2022.

Bugert, R., T. Bjornn, and W. Meehan. 1991. Summer Habitat Use by Young Salmonids and Their Responses to Cover and Predators in a Small Southeast Alaska Stream. Transactions of the American Fisheries Society 120(4):474-485.

California Department of Fish and Game (CDFG). 1965. California Fish and Wildlife Plan Volume Iii. Sacramento, CA.

CDFG. 1999. Butte Creek Spring-Run Chinook Salmon, *Oncorhynchus tshawytscha*, Juvenile Outmigration and Life History 1995-1998. 99-5, Sacramento Valley and Central Sierra Region.

CDFG. 2001. Butte and Big Chico Creeks Spring-Run Chinook Salmon, *Oncorhynchus tshawytscha* Life History Investigation 1998-2000. 2004-2, Sacramento Valley – Central Sierra Region.

California Department of Fish and Wildlife (CDFW). 2013. Butte Creek Juvenile Chinook Salmon Monitoring 2012-2013. California Department of Fish and Game, Chico, California.

CDFW. 2022. Butte Creek Spring-Run Chinook Salmon Adult Monitoring Annual Report 2021. Chico Field Office.

CDFW. 2024a. Passage Assessment Database. https://nrm.dfg.ca.gov/pad/home.

CDFW. 2024b. Butte Creek Spring-Run Chinook Salmon Annual Adult Monitoring Report 2022. Chico, California.

CDFW. 2024c. Butte Slough Outfall Gates Repair Project Mitigated Negative Declaration Public Comment Response. Department of the Interior, 11 pp.

CDFW. 2024d. Butte Creek Parrot-Phelan Canal Diversion Trap Daily Catch and Effort Summaries. CalFish.

CDFW. 2024e. Butte Creek Parrott-Phelan Rotary Screw Trap Daily Catch and Effort Summaries. CalFish.

California Department of Transportation (Caltrans). 2019. Colusa County Economic Forecast. The California Department of Transportation.

Caltrans. 2022. Sutter County Economic Forecast. The California Department of Transportation.

Celedonia, M. and R. Tabor. 2015. Bright Lights, Big City-Chinook Salmon Smolt Nightlife Lake Washington and the Ship Canal *in* Presentation to the WRIA 8 Technical Workshop.

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.

Cook, K. V., A. J. Reid, D. A. Patterson, K. A. Robinson, J. M. Chapman, S. G. Hinch, and S. J. Cooke. 2019. A Synthesis to Understand Responses to Capture Stressors among

Fish Discarded from Commercial Fisheries and Options for Mitigating Their Severity. Fish and Fisheries 20(1):25-43.

Cordoleani, F., J. Notch, A. S. McHuron, A. J. Ammann, and C. J. Michel. 2017. Movement and Survival of Wild Chinook Salmon Smolts from Butte Creek during Their Out-Migration to the Ocean: Comparison of a Dry Year Versus a Wet Year. Transactions of the American Fisheries Society 147(1):171-184.

Cordoleani, F., W. H. Satterthwaite, M. E. Daniels, and M. R. Johnson. 2020. Using Life-Cycle Models to Identify Monitoring Gaps for Central Valley Spring-Run Chinook Salmon. San Francisco Estuary and Watershed Science 18(4).

Cordone, A. J. and D. W. Kelley. 1961. The Influences of Inorganic Sediment on the Aquatic Life of Streams. California Department of Fish and Game, 38 pp.

CTC & Associates. 2016. Determining the Appropriate Amount of Time to Isolate Portland Cement Concrete from Receiving Waters. Caltrans Division of Research, Innovation and System Information.

Department of Water Resources (DWR). 2005. Bulletin 250 Fish Passage Improvement. California Natural Resources Agency, 263 pp.

DWR. 2022a. Clearing the Corridor for Salmon Migration in the Sutter Bypass. https://www.youtube.com/watch?v=7zz45brfKfM&t=1s.

DWR. 2022b. Provisional Statewide Crop Mapping 2022. Department of Water Resources, CADWR Land Use Viewer.

DWR. 2024. Water Quality Data. https://wdl.water.ca.gov/WaterDataLibrary/

WaterQualityDataLib.aspx

DWR. 2025a. Water Data Library (WDL) Station Map. https://wdl.water.ca.gov/WaterDataLibrary/

DWR. 2025b. CDEC Water Year Type Dataset. https://data.ca.gov/dataset/cdec-water-year-type-dataset

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.

Dimacali, R. L. 2013. A Modeling Study of Changes in the Sacramento River Winter-Run. California State University, Sacramento.

Eiler, J. H., M. M. Masuda, and A. N. Evans. 2023. Swimming Depths and Water Temperatures Encountered by Radio-Archival-Tagged Chinook Salmon during Their Spawning Migration in the Yukon River Basin. Transactions of the American Fisheries Society 152(1):51-74.

Feist, B. E., E. R. Buhle, P. Arnold, J. W. Davis, and N. L. Scholz. 2011. Landscape Ecotoxicology of Coho Salmon Spawner Mortality in Urban Streams. PLoS One 6(8):e23424.

Federal Energy Regulatory Commission (FERC). 2024. Department of Energy, Project No. 803-121, 12 pp.

Ferrari, C. and J. Buchanan. 2022. Hydraulic Model Evaluation of the Butte Slough Outfall/Intake Project.

Flosi, G., S. Downie, J. Hopelain, M. Bird, R. Coey, and B. Collins. 1998. California Salmonid Stream Habitat Restoration Manual. pp. 1-525.

Ford, M. I., C. K. Elvidge, D. Baker, T. C. Pratt, K. E. Smokorowski, M. Sills, P. Patrick, and S. J. Cooke. 2018. Preferences of Age-0 White Sturgeon for Different Colours and Strobe Rates of Led Lights May Inform Behavioural Guidance Strategies. Environmental Biology of Fishes 101:667-674.

Franklin, I. R. 1980. Evolutionary Change in Small Population. Pages 135-149 in Conservation Biology: An Evolutionary-Ecological Perspective, M. Soule and B. Wilcox, editors. Sinauer Associates, U.S.A., Sunderland, Massachusetts.

Garman, C. E. 2018. Memorandum Butte Slough Outfall Gate/Wards Landing Fish Kill. California Department of Fish and Wildlife.

GEI Consultants. 2024a. Biological Assessment and Essential Fish Habitat Assessment for the Butte Slough Outfall Gates Repair Project. Project 1905950, Rancho Cordova, California.

GEI Consultants. 2024b. Notice of Availability and Intent to Consider Adoption of a Proposed Mitigated Negative Declaration for the Butte Slough Outfall Gates Repair Project. Rancho Cordova, California.

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

Gutierrez, M., H. Glenn, M. Colombano, C. Ambrose, J. Rennert, and J. Ambrose. 2024. Central Valley Spring-Run Chinook Salmon in the San Joaquin River Basin. NMFS-SWFSC-706, NOAA, Sacramento, California.

Hallock, R. J. and W. F. Van Woert. 1959. A Survey of Anadromous Fish Losses in Irrigation Diversions from the Sacramento and San Joaquim Rivers. California Department of Fish and Game, Inland Fisheries Branch, CDFG, California.

Hannon, J. and B. Deason. 2008. American River Steelhead (*Oncorhynchus mykiss*) Spawning 2001–2007. Department of the Interior.

Hansen, M. J., D. E. Cocherell, S. J. Cooke, P. H. Patrick, M. Sills, and N. A. Fangue. 2018. Behavioural Guidance of Chinook salmon Smolts: The Variable Effects of Led Spectral Wavelength and Strobing Frequency. Conservation physiology 6(1):032.

Harvey, B. C. 1986. Effects of Suction Gold Dredging on Fish and Invertebrates in Two California Streams. North American Journal of Fisheries Management 6(3):401-409.

Harvey, B. C., J. L. White, and R. J. Nakamoto. 2009. The Effect of Deposited Fine Sediment on Summer Survival and Growth of Rainbow Trout in Riffles of a Small Stream. North American Journal of Fisheries Management 29(2):434-440.

Hedgecock, D., M. Banks, V. Rashbrook, C. Dean, and S. Blankenship. 2001. Applications of Population Genetics to Conservation of Chinook salmon Diversity in the Central Valley. Fish Bulletin 179 1:45-70.

Henley, G. 2024. 2024 Butte Creek Adult Spring-Run Chinook Salmon Holding Snorkel Survey. California Department of Fish and Wildlife, 6 pp.

Heublein, J. C., J. T. Kelly, C. E. Crocker, A. P. Klimley, and S. T. Lindley. 2009. Migration of Green Sturgeon, *Acipenser medirostris*, in the Sacramento River. Environmental Biology of Fishes 84:245-258.

Johnson, R. 2021. Spring-Run Genetic Results. Unpublished data.

Johnson, R. C., K. Pipal, F. Cordoleani, and S. T. Lindley. 2023. Central Valley Recovery Domain. In: Southwest Fisheries Science Center, Viability Assessment for Pacific Salmon and Steelhead Listed under the Endangered Species Act: Southwest. NMFS-SWFSC-686, NOAA Fisheries, Santa Cruz, California.

Jones and Stokes. 2005. Battle Creek Salmon and Steelhead Restoration Project Draft Supplemental Environmental Impact Statement/Revised Environmental Impact Report. Jones & Stokes Associates, Inc., Sacramento, California.

Keefer, M. L., C. C. Caudill, C. A. Peery, and M. L. Moser. 2013. Context-Dependent Diel Behavior of Upstream-Migrating Anadromous Fishes. Environmental Biology of Fishes 96(6):691-700.

Kimball, L. C. and G. M. Kondolf. 2002. Analysis of Channel Geomorphology and Habitat Forming Processes for Feasibility Assessment of Rip-Rap Removal, Muir Woods National Monument, Mill Valley, California. University of California, Berkeley.

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.

Kjelson, M. A., P. F. Raquel, and F. W. Fisher. 1982. Life History of Fall-Run Juvenile Chinook Salmon, *Oncorhynchus tshawytscha*, in the Sacramento-San Joaquin Estuary, California. Pages 393-411 *in* Estuarine Comparisons: proceedings of the Sixth Biennial International Estuarine Research Conference, Gleneden Beach, Oregon, November 1-6, 1981. Academic Press. New York.Lande, R. 1995. Mutation and Conservation. Conservation Biology 9(4):782-791.

Lindley, S. T., R. Schick, B. P. May, J. J. Anderson, S. Greene, C. Hanson, A. Low, D. McEwan, R. B. MacFarlane, C. Swanson, and J. G. Williams. 2004. Population Structure of Threatened and Endangered Chinook Salmon ESUs in California's Central Valley Basin. Department of Commerce, NOAA-TM-NMFS-SWFSC-360, 67 pp.

Lindley, S. T., R. S. Schick, E. Mora, P. B. Adams, J. J. Anderson, S. Greene, C. Hanson, B. P. May, D. McEwan, and R. B. MacFarlane. 2007. Framework for Assessing Viability of Threatened and Endangered Chinook Salmon and Steelhead in the Sacramento–San Joaquin Basin. Department of Commerce.

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

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.

Lundin, J. I., P. M. Chittaro, G. M. Ylitalo, J. W. Kern, D. R. Kuligowski, S. Y. Sol, K. A. Baugh, D. T. Boyd, M. C. Baker, and R. M. Neely. 2021. Decreased Growth Rate Associated with Tissue Contaminants in Juvenile Chinook Salmon out-Migrating through an Industrial Waterway. Environmental Science & Technology 55(14):9968-9978.

Manes, E. 2024. California Department of Fish and Wildlife Additional Comments on the Butte Canal Failure Incident: Desabla-Centerville Hydroelectric Project - FERC Project No. 803-121. FERC eLibrary.

Mantua, N. J., H. Bell, A. E. Todgham, M. E. Daniels, J. Rinchard, J. M. Ludwig, J. C. Field, S. T. Lindley, F. E. Rowland, and C. A. Richter. 2025. Widespread Thiamine Deficiency in California Salmon Linked to an Anchovy-Dominated Marine Prey Base. Proceedings of the National Academy of Sciences 122(26):e2426011122.

Mantua, N., R. Johnson, J. Field, S. Lindley, T. Williams, A. Todgham, N. Fangue, C. Jeffres, H. Bell, and D. Cocherell. 2021. Mechanisms, Impacts, and Mitigation for Thiamine Deficiency and Early Life Stage Mortality in California's Central Valley Chinook Salmon. North Pacific Anadromous Fish Commission, Technical Report 17:92-93.

Mcclure, M. M., M. Alexander, D. Borggaard, D. Boughton, L. Crozier, R. Griffis, J. C. Jorgensen, S. T. Lindley, J. Nye, and M. J. Rowland. 2013. Incorporating Climate Science in Applications of the U.S. Endangered Species Act for Aquatic Species. Conservation Biology 27(6):1222-1233.

McEwan, D., T. A. Jackson, F. Reynolds, and T. Curtis. 1996. Steelhead Restoration Management Plan for California. The Resources Agency Department of Fish and Game California.

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

McElhany, P., M. H. Rucklelshaus, M. J. Ford, T. C. Wainwright, and E. P. Bjorkstedt. 2000. Viable Salmonid Populations and the Recovery of Evolutionarily Significant Units. Department of Commerce, NMFS-NWFSC-42.

McMichael, G. A., A. L. Fritts, and T. N. Pearsons. 1998. Electrofishing Injury to Stream Salmonids; Injury Assessment at the Sample, Reach, and Stream Scales. North American Journal of Fisheries Management 18(4):894-904.

McReynolds, T. R. 2021. Memorandum Sutter Bypass Hydrology and Subsequent Fish Kill. California Department of Fish and Wildlife.

McReynolds, T. R. 2024. Butte Creek CCV Steelhead. pers. comm. K. Swick.

Michel, C. J., A. J. Ammann, S. T. Lindley, P. T. Sandstrom, E. D. Chapman, M. J. Thomas, G. P. Singer, A. P. Klimley, and R. B. MacFarlane. 2015. Chinook Salmon Outmigration Survival in Wet and Dry Years in California's Sacramento River. Canadian Journal of Fisheries and Aquatic Sciences 72(11):1749-1759.

Mickle, M. F. and D. M. Higgs. 2018. Integrating Techniques: A Review of the Effects of Anthropogenic Noise on Freshwater Fish. Canadian Journal of Fisheries and Aquatic Sciences 75(9):1534-1541.

Mindess, S., F. Young, and D. Darwin. 2003. Concrete. Second edition. Pearson Education, Inc., Upper Saddle River, NJ.

Molnar, M., D. Buehler, R. Oestman, J. Reyff, K. Pommerenck, and B. Mitchell. 2020. Technical Guidance for the Assessment of Hydroacoustic Effects of Pile Driving on Fish CTHWANP-RT-20-365.01.04, Sacramento, CA.

Mora, E. A., R. D. Battleson, S. T. Lindley, M. J. Thomas, R. Bellmer, L. J. Zarri, and A. P. Klimley. 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.

Moser, M. L. and S. T. Lindley. 2007. Use of Washington Estuaries by Subadult and Adult Green Sturgeon. Environmental Biology of Fishes 79:243-253.

Moyle, P. B., R. M. Yoshiyama, J. E. Williams, and E. D. Wikramanayake. 1995. Fish Species of Special Concern in California. 2128IF, California Department of Fish and Game.

Myrick, C. and J. J. Cech. 2004. Temperature Effects on Juvenile Anadromous Salmonids in California's Central Valley: What Don't We Know? Reviews in Fish Biology and Fisheries 14:113-123.

National Marine Fisheries Service (NMFS). 2000. Guidelines for Electrofishing Waters Containing Salmonids Listed under the Endangered Species Act Department of Commerce.

NMFS. 2010. Biennial Report to Congress on the Recovery Program for Threatened and Endangered Species. Department of Commerce, 200 pp.

NMFS. 2014. 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. Department of Commerce, 1561 pp.

NMFS. 2016a. 5-Year Review: Summary and Evaluation of Central Valley Spring-Run Chinook Salmon Evolutionarily Significant Unit. Department of Commerce, 41 pp.

NMFS. 2016b. 5-Year Review: Summary and Evaluation of California Central Valley Steelhead Distinct Population Segment. Department of Commerce, 41 pp.

NMFS. 2018. Recovery Plan for The southern Distinct Population Segment of North American Green Sturgeon (*Acipenser medirostris*). Department of Commerce, 120 pp.

NMFS. 2021a. NOAA Fisheries Guidelines for Salmonid Passage at Stream Crossings in California. U.S. Department of Commerce, 18 pp.

NMFS. 2021b. 5-Year Review: Summary and Evaluation of Southern Distinct Population Segment of North American Green Sturgeon (*Acipenser medirostris*). Department of Commerce, 61 pp.

NMFS. 2023. National Marine Fisheries Service: Summary of Endangered Species Act Acoustic Thresholds (Marine Mammals, Fishes, and Sea Turtles). Department of Commerce, 10 pp.

NMFS. 2024. 2024 5-Year Review: Summary & Evaluation of Sacramento River Winter-Run Chinook Salmon. NOAA Fisheries West Coast Region.

National Oceanic and Atmospheric Administration (NOAA). 2024. How Does Oil Impact Marine Life? https://oceanservice.noaa.gov/facts/oilimpacts.html. 09/03/24.

Nelson, T. R., C. J. Michel, M. P. Gary, B. M. Lehman, N. J. Demetras, J. J. Hammen, and M. J. Horn. 2020. Effects of Artificial Lighting at Night on Predator Density and Salmonid Predation. Transactions of the American Fisheries Society 150(2):147-159.

Nelson, T. R., C. J. Michel, M. P. Gary, B. M. Lehman, N. J. Demetras, P. N. Dudley, J. J. Hammen, and M. J. Horn. 2022. Riverine Fish Density, Predator–Prey Interactions, and Their Relationships with Artificial Light at Night. Ecosphere 13(10):e4261.

Nguyen, R. M. and C. E. Crocker. 2006. The Effects of Substrate Composition on Foraging Behavior and Growth Rate of Larval Green Sturgeon, *Acipenser medirostris*. Environmental biology of fishes 76:129-138.

Nichols, J. 2022. Butte Creek Coordination. pers. comm. A. Bosworth. March 15, 2022.

Nielsen, J. L. 1998. Scientific Sampling Effects: Electrofishing California's Endangered Fish Populations. Fisheries 23(12):6-12.

Notch, J., R. Robinson, J. Frey, and C. J. Michel. 2022. Enhanced Acoustic Tagging, Analysis, and Real Time Monitoring of Wild and Hatchery Salmonids in the Sacramento River Valley 2021 Final Report. Report Prepared by the University of California Santa Cruz for the U.S. Bureau of Reclamation under Contract USDI/BOR#R21AC10455.

Oestman, R., D. Buehler, J. Reyff, and R. Rodkin. 2009. Technical Guidance for Assessment and Mitigation of the Hydroacoustic Effects of Pile Driving on Fish. Prepared for California Department of Transportation. IFC Jones & Stokes, Sacramento, CA.

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.

Patterson, D. A., K. A. Robinson, G. D. Raby, A. L. Bass, R. Houtman, S. G. Hinch, and S. J. Cooke. 2017. Guidance to Derive and Update Fishing-Related Incidental Mortality Rates for Pacific Salmon. Canadian Science Advisory Secretariat, Ottawa, ON.

Pearse, D. E. and J. C. Garza. 2015. You Can't Unscramble an Egg: Population Genetic Structure of *Oncorhynchus mykiss* in the California Central Valley Inferred from Combined Microsatellite and Single Nucleotide Polymorphism Data. San Francisco Estuary and Watershed Science 13(4).

Popper, A. N. and M. Hastings. 2009. The Effects of Anthropogenic Sources of Sound on Fishes. Journal of fish biology 75(3):455-489.

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.

Robinson, J., C. C. Kyriazis, S. C. Yuan, and K. E. Lohmueller. 2023. Deleterious Variation in Natural Populations and Implications for Conservation Genetics. Annual review of animal biosciences 11(1):93-114.

Rodzen, J. 2022. 2020-2022 Keswick Chinook Transition Assignments. CDFW, Unpublished data.

Schmetterling, D. A., C. G. Clancy, and T. M. Brandt. 2001. Effects of Riprap Bank Reinforcement on Stream Salmonids in the Western United States. Fisheries 26(7).

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.

Sharpe, C. S., D. A. Thompson, H. Lee Blankenship, and C. B. Schreck. 1998. Effects of Routine Handling and Tagging Procedures on Physiological Stress Responses in Juvenile Chinook Salmon. The Progressive Fish-Culturist 60(2):81-87.

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.

Slotte, A., K. Hansen, J. Dalen, and E. Ona. 2004. Acoustic Mapping of Pelagic Fish Distribution and Abundance in Relation to a Seismic Shooting Area off the Norwegian West Coast. Fisheries Research 67(2):143-150.

Soule, M. 1980. Thresholds for Survival: Maintaining Fitness and Evolutionary Potential. Pages 151-169 in Conservation Biology: An Evolutionary-Ecological Perspective, M. Soule and B. Wilcox, editors. Sinauer Associates, U.S.A., Sunderland, Massachusetts.

Stadler, J. H., K. F. Griffin, E. J. Chavez, B. C. Spence, P. Roni, C. A. Gavette, B. A. Seekins, and A. K. Obaza. 2011. Pacific Coast Salmon 5-Year Review of Essential Fish Habitat Final Report to the Pacific Fishery Management Council.

State Water Resources Control Board (SWRCB). 2018. 2018 California Integrated Report (Clean Water Act Section 303(D) List and 305(B) Report).

https://www.waterboards.ca.gov/water_issues/programs/water_quality_assessment/2018_integrated_report.html.

Suttle, K. B., M. E. Power, J. M. Levine, and C. McNeely. 2004. How Fine Sediment in Riverbeds Impairs Growth and Survival of Juvenile Salmonids. Ecological applications 14(4):969-974.

Tabor, R. A., G. S. Brown, and V. T. Luiting. 2004. The Effect of Light Intensity on Sockeye Salmon Fry Migratory Behavior and Predation by Cottids in the Cedar River, Washington. North American Journal of Fisheries Management 24(1):128-145.

Tabor, R. A., A. T. Bell, D. W. Lantz, C. N. Gregersen, H. B. Berge, and D. K. Hawkins. 2017. Phototaxic Behavior of Subyearling Salmonids in the Nearshore Area of Two Urban Lakes in Western Washington State. Transactions of the American Fisheries Society 146(4):753-761.

Tabor, R. A., E. K. Perkin, D. A. Beauchamp, L. L. Britt, R. Haehn, J. Green, T. Robinson, S. Stolnack, D. W. Lantz, and Z. J. Moore. 2021. Artificial Lights with Different Spectra Do Not Alter Detrimental Attraction of Young Chinook Salmon and Sockeye Salmon Along Lake Shorelines. Lake and Reservoir Management 37(3):313-322.

Taylor, E. B. 1991. A Review of Local Adaptation in Salmonidac, with Particular Reference to Pacific and Atlantic Salmon. Aquaculture 98:185-207.

Teo, S. L., P. T. Sandstrom, E. D. Chapman, R. E. Null, K. Brown, A. P. Klimley, and B. A. Block. 2013. Archival and Acoustic Tags Reveal the Post-Spawning Migrations, Diving Behavior, and Thermal Habitat of Hatchery-Origin Sacramento River Steelhead Kelts (*Oncorhynchus mykiss*). Environmental Biology of Fishes 96:175-187.

Thompson, L. C., M. I. Escobar, C. M. Mosser, D. R. Purkey, D. Yates, and P. B. Moyle. 2012. 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.

United States Fish and Wildlife Service (USFWS). 1992. Shaded Riverine Aquatic Cover of the Sacramento River System: Classification as Resource Category 1 under the FWS Mitigation Policy. Department of the Interior, D-020602.

USFWS. 2024. National Wetlands Inventory Surface Waters and Wetlands. https://fwsprimary.wim.usgs.gov/wetlands/apps/wetlands-mapper/.

United States Geological Survey (USGS). 1954. Sutter Buttes Quadrangle. Department of the Interior.

USGS. 1986. Geology of the Fresh Ground-Water Basin of the Central Valley, California, with Texture Maps and Sections. Department of the Interior.

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 62:257-281.

Vick, P., L. Krasnow, M. Goldsworthy, B. Meux, S. Wang, T. Coleman, and P. Dudley. 2021. Southern Distinct Population Segment of North American Green Sturgeon (Acipenser Medirostris) 5-Year Review: Summary and Evaluation. Department of Commerce, 63 pp.

Wardle, C., T. Carter, G. Urquhart, A. Johnstone, A. Ziolkowski, G. Hampson, and D. Mackie. 2001. Effects of Seismic Air Guns on Marine Fish. Continental shelf research 21(8-10):1005-1027.

Washington, P. M., G. Thomas, and D. Marino. 1992. Successes and Failures of Acoustics in the Measurement of Environmental Impacts. Fisheries research 14(2-3):239-250.

Waters, T. F. 1995. Sediment in Streams: Sources, Biological Effects, and Control. American Fisheries Society Monograph, Bethesda, Maryland 7:79-118.

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):1-417.

Windell, S., P. L. Brandes, J. L. Conrad, J. W. Ferguson, P. A. Goertler, B. N. Harvey, J. Heublein, J. A. Israel, D. W. Kratville, J. E. Kirsch, R. W. Perry, J. Pisciotto, W. R. Poytress, K. Reece, B. G. Swart, and R. C. Johnson. 2017. Scientific Framework for Assessing Factors Influencing Endangered Sacramento River Winter-Run Chinook Salmon (*Oncorhynchus tshawytscha*) across the Life Cycle Department of Commerce, NOAA-TM-NMFS-SWFSC-586 57 pp.

Wingerter, N. 2024. Clear Creek Genetic Sampling (Spring-Run). pers. comm. K. Swick.

Wojtasik, B., M. Zbawicka, L. Grabarczyk, and M. Kurpińska. 2019. The Lethal Effect of Hydrotechnical Concrete on Freshwater Bivalvia. Limnological Review 19(3):137-145.

Wood, P. J. and P. D. Armitage. 1997. Biological Effects of Fine Sediment in the Lotic Environment. Environmental management 21(2):203-217.

Wood Rodgers. 2005. Butte Creek Watershed Floodplain Management Plan.

Wysocki, L. E., S. Amoser, and F. Ladich. 2007. Diversity in Ambient Noise in European Freshwater Habitats: Noise Levels, Spectral Profiles, and Impact on Fishes. The Journal of the Acoustical Society of America 121(5):2559-2566.

Yanagida, G. K., B. F. Anulacion, J. L. Bolton, D. Boyd, D. P. Lomax, O. Paul Olson, S. Y. Sol, M. Willis, G. M. Ylitalo, and L. L. Johnson. 2012. Polycyclic Aromatic Hydrocarbons and Risk to Threatened and Endangered Chinook Salmon in the Lower Columbia River Estuary. Archives of Environmental Contamination and Toxicology 62:282-295.

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.

Zimmermann, A. E. and M. Lapointe. 2005. Intergranular Flow Velocity through Salmonid Redds: Sensitivity to Fines Infiltration from Low Intensity Sediment Transport Events. River Research and applications 21(8):865-881.

6. APPENDIX: HISTORY OF PRIOR BSOG CONSULTATIONS AND TECHNICAL ASSISTANCE (2012-2020)

In September of 2012, DWR requested technical assistance from NMFS for the BSOG Rehabilitation Project. The goal of the project was to make updates to the facility that had begun to show signs of wear. NMFS provided technical assistance, as requested. In June of 2013, NMFS received a request from USACE for informal consultation to permit DWR to conduct geotechnical borings in the Butte Slough and Sacramento River to collect preliminary information for future rehabilitation efforts. After requesting additional information and coordinating with the USACE on project specifics, NMFS initiated consultation for the geotechnical boring project and on August 7, 2013, provided a Letter of Concurrence (SWR-2013-9652) that the Butte Slough Geotechnical Boring Project was not likely to adversely affect listed species.

In January of 2015, NMFS received a request from USACE to initiate formal consultation for their proposal to permit DWR's BSOG Rehabilitation Project. NMFS requested more information regarding effects of pile driving to listed species, and on April 6, 2015, DWR provided NMFS with draft pile driving calculations for the installation of cofferdams for the Project. In the preconsultation process, there were concerns that impacts of the project were not adequately addressed in the proposal. On April 17, 2015, NMFS, DWR, CDFW, and USACE held a conference call to discuss possible participation in an In-Lieu-Fee Program to develop compensation for potential impacts associated with the Project. During this call, it was determined that the In-Lieu-Fee Program would not satisfy CDFW's compensatory mitigation needs. As an alternative, DWR proposed to purchase conservation bank credits at a 1:1 ratio for the potential impacts to critical habitat, and to incorporate this proposal into their Project description.

Additional correspondence via emails and conference calls between NMFS and DWR occurred between March 2 and April 27, 2015 to explore options for further avoidance and minimization of potential impacts to federally listed fish species caused by increases in hydro-acoustics associated with pile driving activities. On April 28, 2015, the NMFS biologist, the NMFS hydro-acoustic lead, and the DWR Project lead, held a conference call and ran the hydro-acoustic calculator using attenuation methods in efforts to avoid and to minimize potential impacts to federally listed fish species during pile-driving activities. DWR agreed to use a cushion block during pile driving, which would result in a 5-decibel reduction of sound pressure.

On June 16, 2015, NMFS requested a detailed description of USACE's regulatory authority and discretion over the proposed ongoing and future operation and maintenance of the BSOG flood control structure as part of the proposed Project. On June 23, 2015, NMFS received an email response from USACE with a description of the scope of their authority over the proposed operation and maintenance activities for the Project. USACE explained that their scope covers only the construction-related activities for the maintenance of BSOG. The post-project operations and maintenance activities not covered under the USACE permit action.

On July 6, 2015, NMFS sent a letter to USACE requesting additional information. NMFS requested that USACE require DWR to submit a Biological Assessment that includes detailed descriptions of the proposed post-project operation and maintenance activities and associated potential effects, and how these operational activities may potentially affect federally listed juvenile and adult fish passage and any associated potential impacts to their designated critical habitat and/or EFH. On December 2, 2015, USACE contacted NMFS to state that their permitting process included both 404 and 408 permits, which cover the full extent of the project description that was originally submitted as part of the original Biological Assessment. NMFS determined that USACE did not address the specific information requested on July 6, 2015 within the specified amount of time, and on February 16, 2016, NMFS sent USACE a letter reiterating information needed in order to reinitiate, and administratively closed the consultation, considering it withdrawn.

In April, 2018, DWR's Flood Maintenance Office organized a meeting with NMFS and other resource agencies to review plans and permits, and to discuss updates to project permitting for long-term operations and maintenance. On June 11, 2018, DWR met with NMFS and CDFW to discuss the 2018 fish kill incident that occurred at BSOG March of the same year, and to brainstorm potential solutions/ideas that could be integrated into the BSOG construction project.

On October 30, 2018, DWR's Flood Maintenance Office held a second meeting with NMFS and CDFW to discuss fish periodicity, passage needs and possible solutions, hydrology and modeling updates, and additional discussions on project and facility design. In the interim between 2018 and 2020, a Biological Assessment was prepared for the proposed action. On May 4, 2020, USACE held an interagency pre-application meeting for the project.