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 ECO #: WCRO-2025-03493

May 29, 2026

Michael S. Jewell
Chief, Regulatory Division
U.S. Army Corps of Engineers
1325 J Street
Sacramento, CA 95814

Re: Endangered Species Act Section 7(a)(2) Biological Opinion and Magnuson–Stevens Fishery Conservation and Management Act Essential Fish Habitat Response for the Delta Conveyance Project

Dear Mr. Jewell:

Thank you for your letter, dated August 22, 2025, 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 Delta Conveyance Project.

This document transmits NMFS's final biological opinion (opinion) based on information provided in the U.S. Army Corps of Engineer's (Corps), and the applicant's, California Department of Water Resources (DWR), final biological assessment and associated attachments and appendices.

Thank you also for your request for essential fish habitat (EFH) consultation. NMFS also reviewed the proposed action for potential effects on EFH designated under the Magnuson-Stevens Fishery Conservation and Management Act (MSA) (16 U.S.C. 1855(b)). This review was pursuant to section 305(b) of the MSA, implementing regulations at 50 CFR 600.920, and agency guidance for use of the ESA consultation process to complete EFH consultation. NMFS concluded that the action would adversely affect EFH designated under the Pacific Salmon Fishery Management Plan (FMP), and the Pacific Groundfish FMP. However, conservation recommendations were not provided since NMFS determined the proposed project adequately addressed, mitigated, or offset the adverse impacts. The results of EFH consultation are contained herein.

Based on the best scientific and commercial information, the biological opinion concludes that the proposed action as described in the Biological Assessment for the Delta Conveyance Project is not likely to jeopardize the continued existence of the federally listed: Sacramento River winter-run Chinook salmon, Central Valley spring-run Chinook salmon, California Central Valley steelhead, and the southern Distinct Population Segment of North American green sturgeon; 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 proposed action. The Corps has informed NMFS of their analysis and "No Effect" determination for the Southern Resident killer whale. The Corps is not seeking consultation for killer whale and the species is therefore not included in the biological opinion.

Please contact me if you have any questions concerning this consultation, or if you require additional information.

Sincerely,

A. Catherine Marcinkevage

Cathy Marcinkevage
Assistant Regional Administrator for
California Central Valley Office

Enclosure

cc: To the file ARN 151422-WCR2024-SA00024
Carolyn Buckman, DWR, Carolyn.Buckman@water.ca.gov

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

Delta Conveyance Project
NMFS Consultation ECO Number: WCRO-2025-03493

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

Fishery Management Plan That Identifies EFH in the Project Area	Does Action Have an Adverse Effect on EFH?	Are EFH Conservation Recommendations Provided?
Pacific Coast Salmon	Yes	No
Pacific Coast Groundfish	Yes	No

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: **May 29, 2026**

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Acronym List

ACID	Anderson-Cottonwood Irrigation Dam
AMMs	Avoidance and Minimization Measures
BA	Biological Assessment
BMPs	Best Management Practices
CCV	California Central Valley
CCWD	Contra Costa Water District
CDFW	California Department of Fish and Wildlife
CESA	California Endangered Species Act
CFR	Code of Federal Regulations
cfs	Cubic feet per second
CMP	Compensatory Mitigation Plan
COA	Coordinated Operation Agreement
Corps/USACE	U.S. Army Corps of Engineers
CV	Central Valley
CVP	Central Valley Project
CVPIA	Central Valley Project Improvement Act
CWT	Coded Wire Tag
dB	Decibels
DCP	Delta Conveyance Project
Delta	Sacramento-San Joaquin River Delta
DIDSON	Duel-Frequency Identification Sonar
DPS	Distinct Population Segment
DQA	Data Quality Act
DWR	California Department of Water Resources
EFH	Essential Fish Habitat
EPA	Environmental Protection Agency
ESA	Endangered Species Act
ESU	Evolutionarily Significant Unit
FEIR	Final Environmental Impact Report
FERC	Federal Energy Regulatory Commission
FHWG	Fisheries Hydroacoustic Working Group
FMP	Fishery Management Plan
FR	Federal Register
FRFH	Feather River Fish Hatchery
HAPC	Habitat Area of Particular Concern
ITP	Incidental Take Permit
LSNFH	Livingston Stone National Fish Hatchery
LTO	Long-term Operation
MSA	Magnuson–Stevens Fishery Conservation and Management Act
NEP	Non-essential experimental population
NMFS	National Marine Fisheries Service
NOAA	National Oceanic and Atmospheric Admistration
NTU	Nephelometric Turbidity Unit
μPa	micropascal

PA	Proposed Action
PAHs	polycyclic aromatic hydrocarbons
PBF	physical or biological features
PCB	polychlorinated biphenyls
PCE	primary constituent element
PG&E	Pacific Gas and Electric Company
Reclamation	U.S. Bureau of Reclamation
RPM	Reasonable and Prudent Measure
RTM	Reusable Tunnel Material
SAIL	Salmon and Sturgeon Assessment of Indicators by Life Stage
SCARF	Salmon Conservation and Research Facility
sDPS	Southern Distinct Population Segment
SEL	sound exposure level
SEP	Scientific Evaluation Process
SJRRP	San Joaquin River Restoration Program
SR	Sacramento River
SRKW	Southern Resident Killer Whale
SRWTP	Sacramento Regional Wastewater Treatment Plant
SWFSC	Southwest Fisheries Science Center
SWP	State Water Project
TBM	Tunnel Boring Machine
USFWS	U.S. Fish and Wildlife Service
WQCP	Water Quality Control Plan

1. INTRODUCTION

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

1.1. Background

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

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

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

1.2. Consultation History

From January 2020 to the issuance of this consultation, DWR and the Corps convened a series of weekly and monthly multi-agency coordination and technical meetings to develop the final BA. The following section outlines key milestones in the consultation history for the DCP.

On May 19, 2022, the Corps and DWR requested agency review of their draft BA and other materials intended to support their Incidental Take Permit (ITP) application to the California Department of Fish and Wildlife (CDFW).

On June 8, 2022, NMFS provided preliminary, high-level, written comments via email to the Corps and DWR on relevant portions of the draft BA chapters and appendices.

On August 23, 2022, the Corps and DWR requested agency review of additional draft BA and ITP application sections.

On October 14, 2022, NMFS provided written comments via email to the Corps and DWR in response to the August 23, 2022, request for review. In addition, NMFS provided more detailed comments on the relevant chapters and appendices in response to the May 19, 2022, request for review.

On October 23, 2023, the Corps and DWR notified NMFS that their administrative draft BA for construction of DCP was available for review.

On December 8, 2023, NMFS provided written comments via email to the Corps and DWR on the administrative draft BA for construction of DCP.

On May 15, 2024, the Corps requested initiation of formal consultation for a Department of the Army permit application, Section 408 permission request, and real estate easement for DCP.

On June 14, 2024, NMFS requested the opportunity to discuss a mutually agreed upon extension of the consultation period with the Corps and DWR.

On February 21, 2025, NMFS provided written comments on the BA to the Corps and DWR and requested additional information.

From March 2025 through July 2025, the Corps and DWR held biweekly interagency discussions to address written comments and outline additional information to be provided in response to NMFS' February 21, 2025, request.

On July 22, 2025, NMFS requested that the Corps and DWR submit a revised BA that incorporates additional information and revisions responding to NMFS' written comments and clarifies the proposed consultation approach.

On August 22, 2025, the Corps and DWR provided NMFS with a revised BA. NMFS determined there was sufficient information to initiate consultation.

From October 1, 2025, through November 12, 2025, the consultation was held in abeyance for 43 days due to a lapse in appropriations and resulting government shutdown.

On February 6-11, 2026, NMFS recommended the Corps include SRKW in the consultation request. On February 17-18, 2026, the Corps informed NMFS that they determined the proposed action would have "No Effect" on SRKW and clarified they are not seeking ESA section 7 consultation for SRKW. Accordingly, NMFS has not included SRKW in this consultation (CCVO 2026[1]). The applicant, DWR, included an effects analysis and "not likely to adversely affect" (NLAA) determination for SRKW in the BA.

On March 30, 2026, in Center for Biological Diversity v. Burgum, No. 24-cv-04651 (N.D. Cal.), the U.S. District Court for the Northern District of California vacated aspects of four provisions from the 50 CFR part 402 regulations governing interagency consultation under section 7 of the Endangered Species Act and reinstated the provisions that were previously in effect. Consistent with the Court's ruling, these are the governing provisions for this consultation:

"Destruction or adverse modification means a direct or indirect alteration that appreciably diminishes the value of critical habitat for the conservation of a listed species. Such alterations may include, but are not limited to, those that alter the physical or biological features essential to

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[1] California Central Valley Office (CCVO) staff. 2026. Memorandum to the Administrative Record for the Delta Conveyance Project through Cathy Macinkevage, Assistant Regional Administrator, CCVO, West Coast Region.

the conservation of a species or that preclude or significantly delay development of such features." (50 CFR 402.02 (2018)).

"Effects of the action refers to the direct and indirect effects of an action on the species or critical habitat, together with the effects of other activities that are interrelated or interdependent with that action, that will be added to the environmental baseline. The environmental baseline includes the past and present impacts of all Federal, State, or private actions and other human activities in the action area, the anticipated impacts of all proposed Federal projects in the action area that have already undergone formal or early section 7 consultation, and the impact of State or private actions which are contemporaneous with the consultation in process. Indirect effects are those that are caused by the proposed action and are later in time, but still are reasonably certain to occur. Interrelated actions are those that are part of a larger action and depend on the larger action for their justification. Interdependent actions are those that have no independent utility apart from the action under consideration."[2] (50 CFR 402.02 (2018)).

50 CFR 402.14(g)(8): "In formulating its biological opinion, any reasonable and prudent alternatives, and any reasonable and prudent measures, the Service will use the best scientific and commercial data available and will give appropriate consideration to any beneficial actions taken by the Federal agency or applicant, including any actions taken prior to the initiation of consultation." (50 CFR 402.14(g)(8) (2018)).

50 CFR 402.16(a): "(a) Reinitiation of consultation is required and shall be requested by the Federal agency or by the Service, where discretionary Federal involvement or control over the action has been retained or is authorized by law and . . . ." (50 CFR 402.16(a) (2023)).

1.3. Proposed Federal Action

Under the ESA, "action" means all activities or programs of any kind authorized, funded, or carried out, in whole or in part, by federal agencies (see 50 CFR 402.02). We considered, under the ESA, whether or not the proposed action would cause any other interrelated or interdependent actions. "Interrelated actions" are those that are part of a larger action and depend on the larger action for their justification. "Interdependent actions" are those that have no independent utility apart from the action under consideration (50 CFR 402.02). NMFS has not identified any activities that are interrelated or interdependent with the proposed action as described in the BA.

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).]

This opinion is in response to the U.S. Army Corps of Engineers' (Corps) request for formal consultation with the National Marine Fisheries Service (NMFS) on their issuance of a

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[2] This definition includes the second sentence of the definition of "effects of the action." That sentence provided the definition of "environmental baseline" in effect as of 2018. In the 2019 rule amending the 50 CFR part 402 regulations, the Services established "environmental baseline" as a stand alone definition. 84 Fed. Reg. 44976, 45016 (August 27, 2019). In the 2024 rule, the Services made minor revisions to the "environmental baseline" definition. 89 Fed. Reg. 24268, 24298 (April 5, 2024). The Court's ruling did not touch upon that definition of "environmental baseline," and it therefore remains valid. The definition is also fully consistent with the definition of "effects of the action" from 2018.

Department of the Army permit application, Section 408 permission request, and real estate easement for the construction of California Department of Water Resources' (DWR) proposed Delta Conveyance Project (DCP/Proposed Action [PA]).

The Corps is proposing to issue permits to DWR for the construction of new facilities, including new points of diversion. These proposed new facilities would work in conjunction with and modify the existing State Water Project (SWP). Ultimately, modifications to and operation of the SWP would continue to be coordinated with the federal Central Valley Project (CVP) operated by the U.S. Bureau of Reclamation (Reclamation). Neither the SWP or CVP operations are within Corps jurisdiction. On December 6, 2024, NMFS issued an opinion for the Long-Term Operations of the CVP and SWP (2024 LTO opinion; NMFS 2024a) to Reclamation. NMFS also completed a separate consultation for essential fish habitat (EFH) under the MSA on April 14, 2025 (NMFS 2025). The 2024 LTO opinion included a framework-level programmatic component to evaluate the potential impacts of the proposed future operations of the DCP on federally listed species and designated critical habitat. As part of this framework, Reclamation committed to initiating additional consultations in the future to address both near-field and far-field effects of the DCP operations, providing detailed information at that time for site-specific analyses. This current consultation, proposed by the Corps, includes construction and pre-operations maintenance (i.e., the non-operational components), which were not included in the 2024 LTO opinion.

On February 14, 2025, the California Department of Fish and Wildlife (CDFW) issued an Incidental Take Permit (ITP) to DWR, pursuant to the California Endangered Species Act, for the construction and operation of the DCP (herein referred to as the 2025 ITP; CDFW 2025).

Construction for the proposed action (refer to Section 1.3 of this opinion) is anticipated to occur over approximately 13 years. Therefore, for the purposes of this consultation, project-specific effects associated with the construction of DCP facilities, including in-water work, as well as both temporary and permanent construction-related impacts, will be assessed in this biological opinion. Operations and maintenance-related effects which include near- and far-field effects within the Sacramento River, and potential associated effects to aquatic biological resources are evaluated within this opinion. However, this opinion does not provide exemption for incidental take prohibitions for effects associated with the north Delta diversion intake operations and maintenance. Before operation commences, incidental take for the operations and maintenance of the DCP will be assessed in a future ESA consultation which, as described in the programmatic 2024 LTO opinion, would be combined with or tiered off of that consultation. Once constructed, the DCP operations will be part of the SWP's integrated water delivery system and therefore would be considered within the SWP and CVP long-term operations as a part of the SWP Delta operations subject to the Reclamation and DWR Coordinated Operations Agreement (COA). In this opinion, NMFS evaluated the proposed action as a "mixed programmatic" action since it includes some framework-level action components that will be subject to subsequent future tiered project-level ESA section 7 consultation. For more details, refer to Section 3 Analytical Approach.

1.3.1. Summary of the Construction for the Proposed Action

The DCP construction is described in the BA, Chapter 3 (ICF 2025), and is incorporated here by reference. The PA includes construction of water diversion Intakes B and C that would convey up to 3,000 cubic feet per second (cfs) individually, for a total of up to 6,000 cfs of water from the Sacramento River in the north Delta (Figure 1). From Intakes B and C (refer to Figure 1), the underground tunnel alignment would then follow a southernly route to:

- Twin Cities Complex double launch shaft
- New Hope Tract maintenance shaft
- Canal Ranch Tract maintenance shaft
- Terminous Tract reception shaft
- King Island maintenance shaft
- tunnel under Ridge Tract
- Lower Roberts Island double launch shaft
- Upper Jones Tract maintenance shaft
- tunnel under Lower Jones Tract
- tunnel under Victoria Island
- Union Island maintenance shaft
- tunnel under Coney Island, and
- Clifton Court Tract to the Bethany Complex's Surge Basin reception shaft

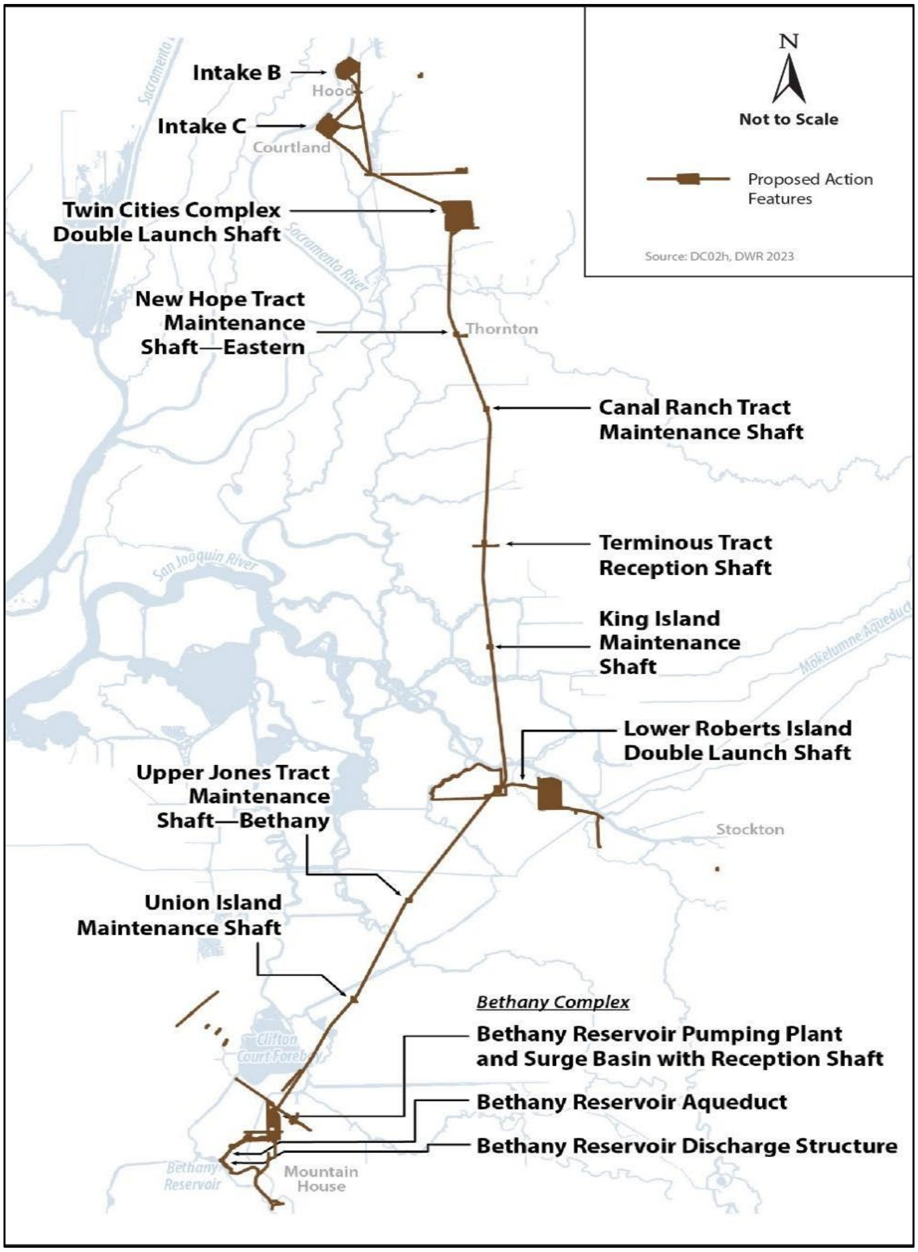


Figure 1. Overview of the Proposed Project facilities that will be constructed within the Sacramento- San Joaquin River Delta Figure from the BA (ICF 2025).

The proposed action includes constructing a new Bethany Reservoir Pumping Plant and Surge Basin located to the south of Clifton Court Forebay, and a new Bethany Reservoir Aqueduct that conveys flows to a new Bethany Reservoir Discharge Structure on the shore of Bethany Reservoir. The aqueduct would consist of four pipelines including tunneled segments under the existing Central Valley Project C. W. "Bill" Jones Pumping Plant (Jones Pumping Plant) discharge pipelines and existing conservation easements adjacent to Bethany Reservoir. Collectively, these facilities are called the Bethany Complex.

The tunnel from the intakes to the Bethany Complex would have an inside diameter of 36 feet and outside diameter of 39 feet and extend approximately 45 miles from the intakes to the surge basin at the Bethany Reservoir Pumping Plant. The Twin Cities double shaft will be used to bore one tunnel north to the intake shafts and one south to the Terminous Tract reception shaft. Lower Roberts Island would have a double launch shaft, which would allow one tunnel boring machine (TBM) to bore north to the Terminous Tract reception shaft and one to bore south toward the final reception shaft at the Bethany Reservoir Surge Basin. New shaft pads would be constructed of soil excavated from either the shaft site or nearby shaft sites. Excess soil from excavation at the Twin Cities Complex would provide soil for the Twin Cities tunnel launch shaft pad and shaft pads at New Hope Tract, Canal Ranch Tract, Terminous Tract, and King Island. Similarly, soil from Lower Roberts Island would be used to construct Upper Jones Tract and Union Island shaft pads.

Delivery of tunnel segments, Tunnel Boring Machines (TBM), other soil materials, and equipment would occur by road. Rail lines would also be used to deliver tunnel segments to the Lower Roberts Island tunnel launch shaft site. Access roads would be modified to accommodate large construction vehicles as necessary.

The double launch shaft at Lower Roberts Island would require a shaft site to accommodate a double launch shaft with a figure eight configuration, reusable tunnel material (RTM) storage area, and corresponding access roads. Material excavated on-site would be used to construct the shaft pad. The RTM site would also house a rail-served materials depot. Rail access to Lower Roberts Island would be provided from existing tracks located on the Port of Stockton. Rail lines would be extended from one of the existing rail facilities in the Port of Stockton. Rail access would be extended over a new bridge crossing over Burns Cutoff and continue to the tunnel segment storage area near the RTM storage area.

Construction also includes interconnection facilities for Contra Costa Water District (CCWD). The facilities would consist of an interconnection pump station with water intake from the Union Island maintenance shaft on the main tunnel, and a new 1.6-mile conveyance pipeline extending from the pump station to connect to the existing CCWD Victoria Island Pipeline downstream of the CCWD's existing Middle River Intake and Pumping Plant. The interconnection pipeline would be installed in a trench with open cut and cover construction along existing roadways and within agricultural fields. The pipeline construction easement would be 100 feet wide for the entire length of the trench, including a 30-foot temporary construction easement around the 70-foot permanent easement. Dewatering may occur along the open trench, with flows collected, treated, and reused on-site. The portion of the interconnection pipeline that crosses Victoria Canal would be micro-tunneled.

Launch and retrieval pits, approximately 35 feet wide by 50 feet long, would be placed within the 100-foot open trench construction easement on Union Island and Victoria Island to launch and receive micro-tunneling equipment. A permanent 70-foot-wide easement would be maintained along the length of the pipeline in Union Island and Victoria Island. Air valves, blow-offs, and manway access points would be placed along the pipeline within the permanent easement. Pumped flow from the new Interconnection Pump Station would convey raw water from the Union Island shaft to CCWD's existing Transfer Pumping Station through the new conveyance pipeline and subsequently through CCWD's existing Victoria Island and Old River

Pipelines. During periods when CCWD's existing Middle River and Old River Pumping Plants are in simultaneous operation with the Interconnection Pump Station, a maximum combined pumped flow of up to 250 cfs could be conveyed through the Victoria Island Pipeline and a maximum combined flow of up to 320 cfs could be conveyed through the Old River Pipeline.

1.3.1.1 North Delta Intakes and Pre-Operation Maintenance

The two new intake facilities (B and C) will be constructed along the east bank of the Sacramento River and act as new points of diversion in the north Delta. Intake B will be situated just north of Hood and Intake C between Hood and Courtland. The two intakes, operating alone or in combination, will have the capacity to convey up to a total of 6,000 cfs of water from the north Delta. The water would then be conveyed via a single tunnel that would terminate at the Bethany Complex. Intake components will include cylindrical tee fish screens, intake structures, sedimentation basins, sediment drying lagoons, flow control structures, tunnel inlet, and other inlet structures. For detailed information on the construction of the new intake facilities, we incorporate by reference section 3.2.2 of the BA. The fish screens installed on the new intake will follow NMFS fish screen criteria (NMFS 2022). Prior to operations, some maintenance for the new intakes may be required given the timeframe for construction. These pre-operation maintenance activities (referred to as "Maintenance during Construction") are described in the BA, section 3.3.5, and are incorporated here by reference.

1.3.1.2 Tunnels and Tunnel Shafts

The tunnel from the intakes to the Bethany Complex would have an inside diameter of 36 feet and outside diameter of 39 feet and extend 45 miles from the intakes to the surge basin at the Bethany Reservoir Pumping Plant. TBMs would be used to bore the tunnels. Tunnel shafts to launch, remove, and/or maintain the TBMs would be constructed at intakes, along the alignment, and at the Bethany Complex. Because the TBM cutterhead would need inspection and maintenance, maintenance shafts would be located approximately every 4 to 6 miles between launch and reception shafts to provide access for TBM maintenance, repair, access or evacuation, and logistic support in a free-air (not pressurized) environment. All tunnel shafts would be maintained during operations to provide access, as needed. For more detailed information on the construction of the tunnels and tunnels shafts, we incorporate by reference sections 3.2.3 and 3.2.4 of the BA, respectively.

1.3.1.3 Bethany Complex

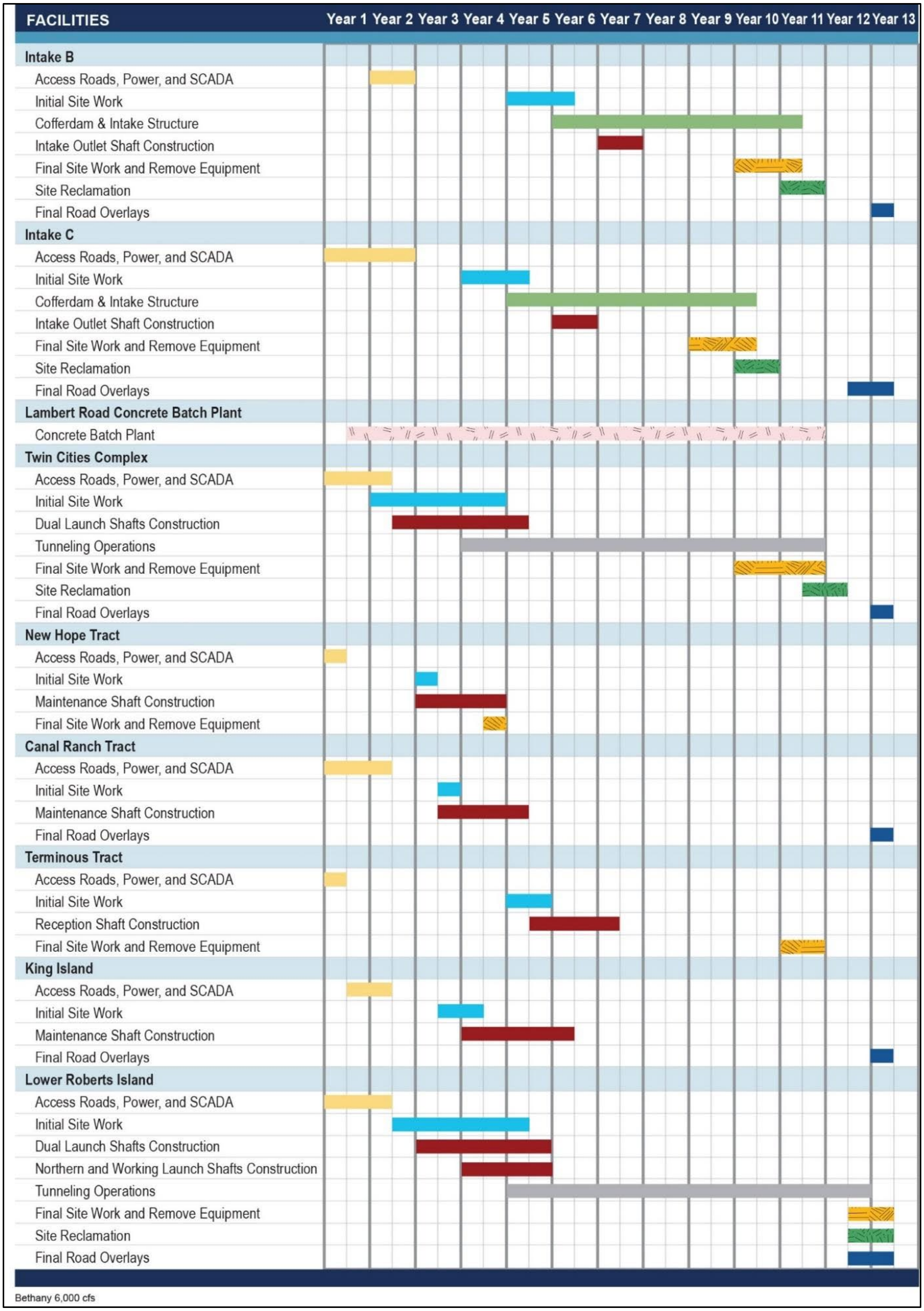
The Bethany Complex would be constructed southeast of Clifton Court Forebay. The Bethany Reservoir Pumping Plant and Surge Basin would be located along Mountain House Road approximately 0.5 mile south of the intersection with Byron Highway. The Bethany Reservoir Aqueduct would extend approximately 2.8 miles from the pumping plant to a new discharge structure on the banks of Bethany Reservoir. The main tunnel from the intakes would terminate at a reception shaft within the surge basin on the north side of the Bethany Reservoir Pumping Plant. Water would enter the Bethany Reservoir Pumping Plant and be conveyed directly to Bethany Reservoir in a concrete-mortar-lined, welded steel aqueduct system. The Bethany Reservoir Pumping Plant would be a multilevel underground structure with twelve 500-cfs pumps, including two standby pumps, to achieve a total flow capacity ranging from a minimum of 300 cfs to a maximum of 6,000 cfs. For more detailed information on the construction of the Bethany Complex, we incorporate by reference section 3.2.6 of the BA.

1.3.1.4 Disposition of Reusable Tunnel Material (RTM)

RTM would be generated at launch shafts as the TBMs bore the tunnel. RTM is the soil removed by the TBM boring the tunnel, mixed with conditioners, and lifted to the ground surface through the launch shaft. After RTM is removed from the tunnel, it would be tested for hazardous materials, managed on-site to dry naturally, then stockpiled and transported for reuse or permanently stored. Excavated RTM would be placed in temporary stockpile areas and tested in accordance with the requirements of the Central Valley Regional Water Quality Control Board and the Department of Toxic Substances Control for the presence of hazardous materials at concentrations above their regulatory threshold criteria. For more detailed information on the handling and disposition of RTM, we incorporate by reference section 3.2.5 of the BA.

1.3.1.5 Construction Schedule

Construction for all components of the project is expected to take approximately 13 years to complete. In-water construction activities within the Sacramento River channel would be conducted during the in-water work window, from June 1-Ocober 31, for approximately six years (refer to Figure 3) as described in the BA, Appendix 3A, section 3A.1.15, *AMM-14: Construction Best Management Practices for Biological Resources*, which is incorporated here by reference (ICF 2025). Construction would not take place in all locations at the same time. Rather, it would proceed in stages, starting with access roads and site work at the intakes and launch shafts, then concurrent tunnel and facility construction, and finally proceeding to commissioning, site reclamation, and road overlays in the final years, as summarized in Figure 2 (ICF 2025). Underground tunnel boring is expected to require approximately 13 years for completion.



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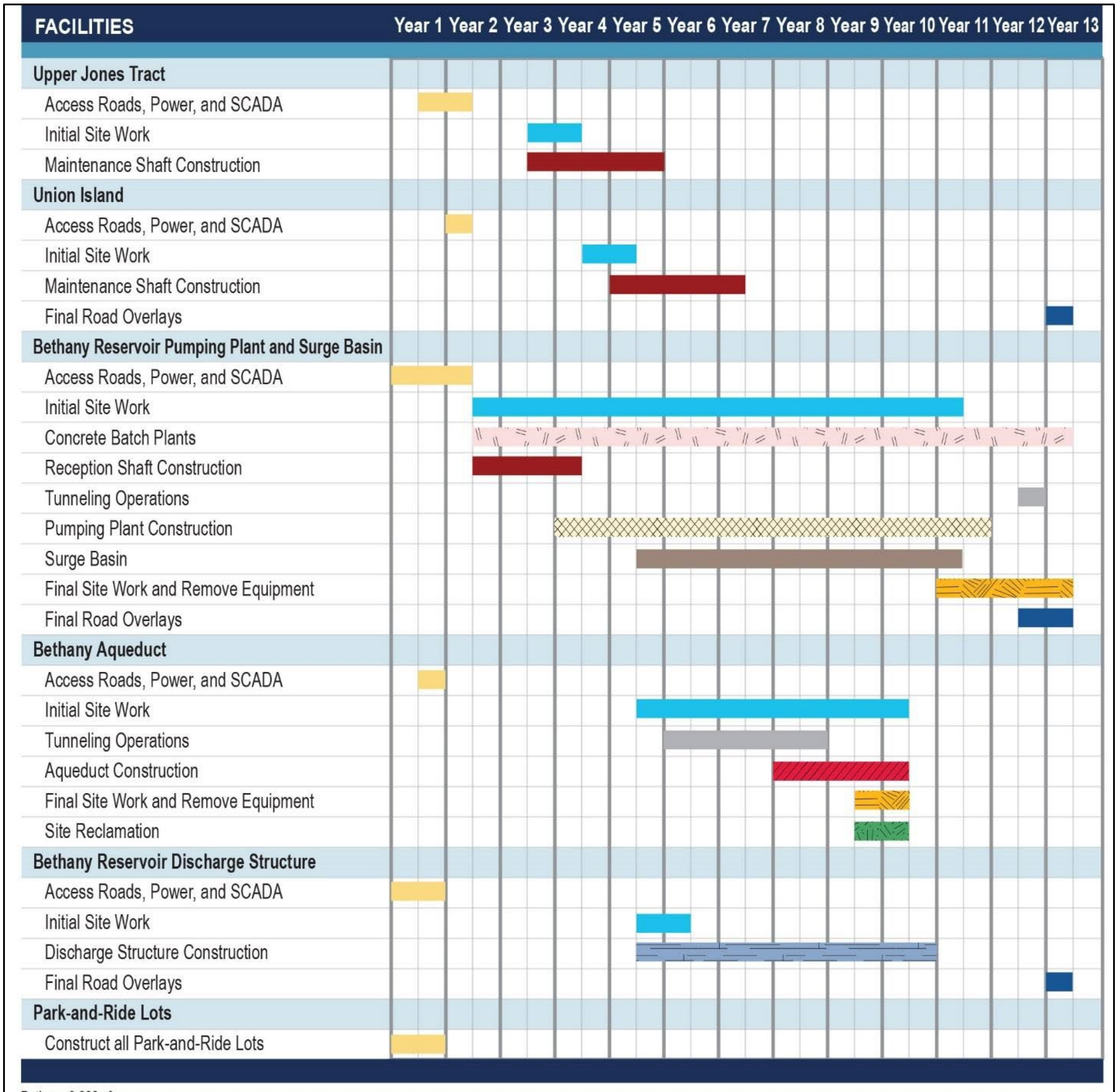

LEGEND

🟨	**Access Roads, Power, SCADA, and Park-and-Ride Lots**	Clear & Grub, Construct Base, Place Surface Material, and Install Power and SCADA Utilities
🟦	**Initial Site Work**	Clear & Grub, Demolition, Ground Improvement, Foundations, Levees (if applicable)
🟩	**Intake Structure**	Cofferdam, Temporary and Final Levee/SR160, Fish Screen, Connections to Sedimentation Basin
🟥	**Tunnel Shafts**	Raise Shaft Pad, Install Cutoff Walls, Excavate Shaft, Install Concrete Liner, and Dewater Shaft
▨	**Final Site Work**	Sedimentation Basin, Sediment Drying Lagoons, Buildings, Utilities, and Finish Site Work.
🟦	**Final Overlays**	Final Pavement Restoration on Access Roads and Adjacent Roads
▨	**Site Reclamation**	Reclaim Land outside of Final Fence Lines
⬜	**Tunneling Operations**	Boring of Tunnel and Removal of RTM
▨	**Concrete Batch Plant**	Construct/Erect and Operate Batch Plant
▩	**Bethany Reservoir Pumping Plant**	Pumping Plant
🟫	**Bethany Reservoir Surge Basin**	Surge Basin
▨	**Bethany Reservoir Aqueduct**	Aqueduct Tunnels under Jones Aqueduct and Environmental Conservation Areas
▤	**Bethany Reservoir Discharge Structure**	Cofferdam and Final Discharge Structure on banks of Bethany Reservoir

Figure 2. Overview of the estimated construction schedule from the BA, Chapter 3 (ICF 2025).

1.3.2. Conservation Measures

The Corps and DWR have included conservation measures intended to avoid, minimize, and offset effects of the proposed action on listed species and to provide for their conservation and management as part of the PA. The proposed conservation measures provide general avoidance and minimization measures (AMMs) that either prohibit an impact from occurring or reduce the severity of the effect if the impact cannot be avoided. AMMs are described in Appendix 3A of the BA and are incorporated here by reference.

1.3.3. Framework-Level component: Operations and Maintenance for the Proposed Action Summary

The north Delta intakes would operate in conjunction with the existing SWP intakes the south Delta. Operations of the existing SWP facilities, in coordination with CVP operations pursuant to the COA, will be governed by the applicable regulatory requirements specified under the State Water Resources Control Board (State Water Board) *Water Quality Control Plan for the San Francisco Bay/Sacramento–San Joaquin Delta Estuary* (Bay-Delta WQCP) and assigned to the SWP in the applicable water right decision, applicable biological opinions under ESA, applicable ITPs under the California Endangered Species Act (CESA), and the Corps' Clifton Court diversion limits. The operations of the north Delta intakes are expected to remain consistent with these existing regulatory requirements since the project is a new point of diversion and not an expansion of water right quantity for diversion. In addition, diversions at the proposed north Delta intakes would be governed by new operational criteria specific to these intakes, such as the fish screen approach velocity requirements, bypass flow requirements, and pulse protections. These new criteria, in combination with screening criteria, are expected to provide additional protections to fish species in proximity to, and downstream from, the intakes. An overview of operational criteria is provided in the BA in Table 3.3-1, with additional detail for the north Delta intakes in the BA in Table 3.3-2 (ICF 2025), and is incorporated here by reference.

In addition to the Delta Conveyance Project operational and maintenance information presented in the BA, Section 3.3, refer to Appendix 3D, *Delta Conveyance Project Operations Plan*, for a description of the DWR commitments related to Delta Conveyance Project operations. These commitments have all previously been presented in public documents, including the Delta Conveyance Project Final Environmental Impact Report (FEIR), certified in December 2023, and the Delta Conveyance Project ITP Application submitted to CDFW in April 2024. Appendix 3D in the BA also includes operational refinements included in the ITP issued by CDFW on February 14, 2025.

Operational criteria and maintenance for the new Sacramento River intake in the north Delta are described in the BA, section 3.3, and are incorporated here by reference (ICF 2025). Operations of the new intakes in the Sacramento River would remain consistent with various existing requirements. Those requirements are described in the BA, section 3.3.2, and are incorporated here by reference (ICF 2025). The decision-making process for real-time operations are described in the BA, section 3.4, and are incorporated by reference (ICF 2025). An Operations Adaptive Management and Monitoring Plan is described in the BA, section 3.5, and is incorporated by reference (ICF 2025).

Fisheries monitoring studies for the operations and maintenance of the proposed action are generally described at a programmatic framework-level in the BA, Appendix 5B, and are incorporated here by reference (ICF 2025).

In addition, a Fisheries Tidal Habitat Mitigation Framework Compensatory Mitigation Plan (CMP) has been prepared that describes project-specific and programmatic actions that are intended to offset the impacts associated with the proposed action. For more detailed information on the proposed conservation measures and CMP, we incorporate by reference Appendix 3B of the BA. Since the specifics of the CMP are not known yet, individual projects under the CMP that are intended to avoid, minimize, or offset the adverse effects to designated critical habitat for listed anadromous fish are considered at a framework level and will undergo a separate tiered ESA consultation at a future date.

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 for the conservation of a listed species" (50 CFR 402.02).

The designations of critical habitat for CV spring-run Chinook salmon, CCV steelhead, and sDPS of North American green sturgeon included in this consultation uses 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.

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

- Evaluate the rangewide status of the species and critical habitat expected to be adversely affected by the proposed action.
- Evaluate the environmental baseline of the species and critical habitat.
- Evaluate the effects of the proposed action on species and their critical habitat using an exposure–response approach.
- Evaluate cumulative effects.

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

NMFS has evaluated the proposed action for this consultation as a "mixed programmatic" action as defined by 50 CFR 402.02 because it includes some action components for which no additional authorization will be necessary and others that are considered at a framework level (see Figure 1) and will be subject to future tiered consultations. Programmatic consultations allow the Services (NMFS and USFWS) to consult on the effects of programmatic actions such as: (1) multiple similar, frequently occurring, or routine actions expected to be implemented in particular geographic areas; and (2) a proposed program, plan, policy, or regulation providing a framework for future proposed actions. Proposed action components that are considered at a framework level are analyzed at a broad scale such that exemption from take prohibitions are not provided in the incidental take statement of this opinion. Once framework-level action components are further developed and sufficient detail is available to determine the amount and extent of incidental take, they will require additional ESA section 7 consultation before implementation; this subsequent consultation will include an incidental take statement for those components. Components that do not require additional authorization are analyzed in this opinion and exemptions from take prohibitions are provided in the incidental take statement of this opinion.

For components of the proposed action that lack specificity in their description that are otherwise required to analyze a particular effect in detail, NMFS applies the best scientific and commercial data available, accepted scientific techniques, and best professional judgment to analyze the range of effects that could result. We identify the lines of evidence to support NMFS' conclusions in the Effects of the Action and Integration and Synthesis sections of this opinion.

2.1.1. Assumptions in the Analysis

To address the uncertainties related to the proposed action components which require no additional authorization , NMFS established reasonable assumptions to provide information critical to our analysis of the effects of expected activities. General assumptions include the following:

- The level of impacts for construction activities that occur within the action area (refer to section 2.3.1 of this opinion) is assumed to be the same each year that construction occurs within the Sacramento River channel. The exception is that the impacts from fish handling due to fish rescue behind the cofferdams are assumed to occur one time for each intake construction area and are not assumed to occur again once the cofferdams are completed and the area behind them are dry.

2.2. Rangewide Status of the Species and Critical Habitat

This opinion examines the status of each species that is likely to be adversely affected by the proposed action. The status is determined by the level of extinction risk that the listed species face, based on parameters considered in documents such as recovery plans, status reviews, and listing decisions. This informs the description of the species' likelihood of both survival and recovery. The species status section also helps to inform the description of the species' "reproduction, numbers, or distribution" for the jeopardy analysis. The opinion also examines the condition of 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 (SR) Winter-Run Chinook Salmon

The SR winter-run Chinook salmon ESU includes SR winter-run Chinook salmon spawning naturally in the Sacramento River and its tributaries, as well as SR winter-run Chinook salmon that are part of the conservation hatchery program at the Livingston Stone National Fish Hatchery (LSNFH) (70 FR 37204). In 1989, NMFS listed SR winter-run Chinook salmon under the ESA and classified it as a threatened species (54 FR 32085; Table 1). This initial classification, as threatened, was reaffirmed in 1990 (55 FR 46515), but the species was subsequently uplisted to endangered in 1994 (59 FR 440).

Table 1. Summary of the listing history under the Endangered Species Act for the Sacramento River winter-run Chinook salmon Evolutionary Significant Unit.

Salmonid Species	ESU/DPS Name	Original Listing	Revised Listing(s)
Chinook Salmon (*O. tshawytscha*)	Sacramento River winter-run Chinook salmon	**FR Notice:** 54 FR 32085 **Date:** August 4, 1989 **Classification:** Threatened (emergency interim rule)	**FR Notice:** 55 FR 12191 **Date:** April 2, 1990 **Re-affirmation:** Threatened (emergency interim rule) **FR notice:** 55 FR 46515 **Date listed:** November 5, 1990 **Classification:** Threatened **FR notice:** 59 FR 440 **Date:** January 4, 1994 **Re-classification:** Endangered **FR notice:** 70 FR 37160 **Date listed:** June 28, 2005 **Classification:** reaffirmed classification as Endangered

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 the SR winter-run Chinook should remain listed as endangered (81 FR 33468, NMFS 2016a). On February 2, 2024, in the agency's most recent 5-year review for SR winter-run Chinook salmon, NMFS again concluded that the species should remain listed as endangered (NMFS 2024c).

2.2.1.1 Life History

SR winter-run Chinook salmon are unique among Central Valley salmonids because they spawn during summer months when air temperatures usually achieve their yearly maximum. As a result, SR winter-run Chinook salmon require stream reaches with cold water sources that will protect embryos and juveniles from the warm ambient conditions in summer. 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 January through April (USFWS 1995). SR winter-run Chinook salmon are sexually immature when upstream migration begins, and they must hold for several months in suitable habitat prior to spawning. SR winter-run Chinook salmon primarily spawn in the main stem Sacramento River between Keswick Dam (river mile 302) and the Red Bluff Diversion Dam (river mile 243). Spawning occurs between late-April and mid-August, with a peak in June and July as reported by CDFW annual carcass and redd surveys (Killam 2023). SR winter-run Chinook salmon embryo incubation in the Sacramento River can extend into October (Vogel and Marine 1991).

SR winter-run Chinook salmon fry rearing in the upper Sacramento River exhibit peak abundance during September, with fry and juvenile emigration past Red Bluff Diversion Dam primarily occurring from July through November (Poytress et al. 2014). Emigration of SR winter-run Chinook salmon juveniles past Knights Landing, located approximately 155.5 river miles downstream of the Red Bluff Diversion Dam, occurs between November and March, peaking in December, with some emigration continuing through May in certain years (Snider and Titus 2000, Roberts 2007).

2.2.1.2 Population Structure

In the previous 5-year review (NMFS 2016a), NMFS defined the SR winter-run Chinook salmon ESU as being composed of all naturally spawned SR winter-run Chinook salmon originating from the Sacramento River and its tributaries, as well as SR winter run Chinook salmon from the artificial propagation program at the LSNFH (70 FR 37160). The addition of the artificial propagation program to the ESU represents NMFS' determination that the artificially propagated stock is no more divergent relative to the local natural population than would be expected between closely related natural populations within the ESU (70 FR 37204). This determination is supported by the fact the source of fish for both the captive broodstock program and the supplementation program is local, natural-origin SR winter-run Chinook salmon from the upper Sacramento River. Ultimately, the Hatchery Listing Policy helped to guide the NMFS analysis of whether individual hatchery programs should be included as part of the ESU and to support the 2020 Final Rule on Revisions to Hatchery Programs as Part of Pacific Salmon and Steelhead Species Listed under the Endangered Species Act (85 FR 81822).

In 2016, the description of the hatchery program at LSNFH was revised to add an additional captive broodstock component, which was restarted in 2015 after being implemented from 1991 to 2007 (85 FR 81822). Starting in 2017, efforts were initiated to establish a viable, self-sustaining, and locally adapted population of SR winter-run Chinook salmon in Battle Creek to add to the spatial diversity (i.e., spatial structure) and abundance of the SR winter-run Chinook salmon ESU (USFWS 2020). Although not an independently viable population yet, efforts are underway to restore the Battle Creek watershed and reintroduce salmon and steelhead to the historical habitats therein (ICF International 2016).

2.2.1.3 Viability Status and Trends

2.2.1.3.1 Spatial Structure and Diversity

Spatial structure and diversity are two of the four core parameters of the viability of salmonid populations and ESUs (McElhany et al. 2000). The lack of population redundancy in the SR winter-run Chinook salmon ESU is the primary factor contributing to its high extinction risk. The “jumpstart” of the Battle Creek reintroduction efforts initiated in 2017 is a milestone towards the goal of establishing a second SR winter-run Chinook salmon spawning population (ICF International 2016, USFWS 2020), a priority recovery action identified in the recovery plan (NMFS 2014). The most recent returns of 942, 167, 127, and 11 (2020–2023) adult SR winter-run Chinook salmon to Battle Creek are another indication that reintroduction efforts are beginning to take hold (Azat and Killam 2025).

Geographically dispersed spatial structure also promotes life history diversity, which has been shown to improve the resilience of salmon populations (Schindler et al. 2010, Johnson et al. 2017). Diverse habitats provide variation in localized temperature and food resources, which influences growth and phenotypic diversity (size and timing of out-migration) in salmon populations. Recent work by Phillis et al. (2018) suggests that SR winter-run Chinook salmon may rely on more diverse rearing habitats than previously considered. This work identifies the influence of non-natal Sacramento River tributaries and the Delta on juvenile rearing and survival (Phillis et al. 2018).

During the 2012–2016 drought, LSNFH increased the number of adults used in the supplementation program from 120 (target) adults to 164, 388, 257, and 137 in 2013– 2016, respectively (Azat and Killam 2025). This expanded production resulted in a significant increase in the proportion of hatchery-reared fish that returned to spawn (greater than 80 percent) in 2017 and 2018. The numbers of natural-origin spawners in 2017 and 2018 were low (153 and 461 individuals, respectively), resulting in a significant increase in the relative contribution of LSNFH hatchery-origin fish and potential reduction in genetic diversity during years of poor environmental conditions and high in-river mortality. Hatchery collection of adults was again increased to 191, 298, 482, and 507 to address drought impacts in 2020–2023.

Recent increases in hatchery influence emphasize the reliance on hatchery production to prevent a precipitous decline in overall abundance. However, hatchery influence and the potential loss of genetic diversity described by the percentage of hatchery spawners over the last four generations was greater than 30 percent, placing the population at a high risk of extinction. The long-term hatchery influence over seven generations (i.e., 21 years) is now at 20 percent. More recently, the decrease in hatchery influence in the 2019 returns supported by the return of a larger number of natural-origin adults (run = 5,000 individuals) indicates a potential for naturally spawning SR winter-run Chinook salmon to rebuild during periods of favorable environmental conditions (Southwest Fisheries Science Center [SWFSC] 2023).

2.2.1.3.2 Abundance and Productivity

The abundance of the SR winter-run Chinook salmon ESU has declined during recent periods of unfavorable ocean conditions (2005–2006) and prolonged drought (2007–2009, 2012–2016, and 2020–2022), underscoring the risk posed by catastrophic events to a species reduced to a single population. Temperature conditions during egg development and fry emergence were harmful for much of SR winter-run Chinook salmon freshwater rearing in 2014 and 2015, reaching lethal levels in both years. The egg-to-fry survival estimate for brood year 2014 is five percent, which is a significant departure from the average of 26.4 percent for brood years 2002–2012 measured at Red Bluff Diversion Dam (Poytress et al. 2014, Johnson et al. 2017). Warm temperatures in both freshwater and ocean ecosystems likely contributed to the low numbers of natural-origin adults observed in 2017 and 2018. These two consecutive years of poor returns increased the vulnerability of the overall population. Despite the poor returns, water year 2017 was one of the wettest years on record and may have contributed to the high survival of SR winter-run Chinook salmon, including those returns observed in 2019 (Killam 2023).

In 2012, the Red Bluff Diversion Dam gates (river mile 243) were removed to provide unimpaired salmon passage year-round, an action recommended in the recovery plan (NMFS 2014). This modification also changed the ability to count SR winter-run Chinook salmon adults at the Red Bluff Diversion Dam fish ladders (Williams et al. 2016). Based on estimates and counts provided in the CDFW escapement data (Azat and Killam 2025), SR winter-run Chinook salmon abundance has declined since 2006 with recent decadal lows of 795 in-river spawners in 2017 (Figure 3). Escapement improved in 2018–2021 such that both the current total population size (sum of last 3 years [2020–2022]; N: LSNFH = 971, Sacramento River = 21,640) and 3-year mean run sizes (Ne: LSNFH = 324, Sacramento River = 7,213) satisfy the low-risk abundance criterion (N > 2500 or Ne > 500).

The point estimate for the 10-year trend in 3-year mean run size is 3.28, suggesting a 3-fold increase in the 3-year average run size over the last 10 years, primarily bolstered by the relatively large escapement in 2019–2021 (average run size = 8,603; Figure 3). However, the recent maximum year-to-year decline in population size is 58.8 percent (2018). While the percent decline does not exceed the catastrophic decline criteria (greater than 90-percent decline in one generation or annual run size less than 500 spawners, Lindley et al. 2007), the 2012–2016 drought had a biologically significant effect on annual run sizes for natural-origin spawners in 2017 and 2018 (153 and 461 individuals, respectively) which would otherwise place the population at a moderate risk of extinction (SWFSC 2023).

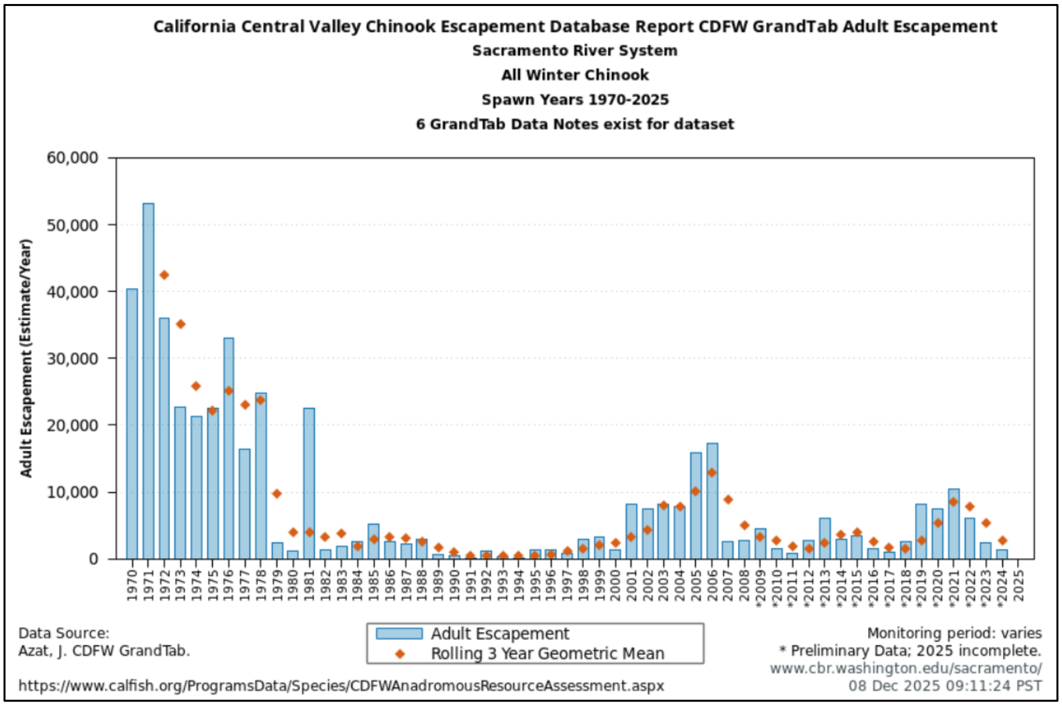

Figure 3. Sacramento River winter-run Chinook salmon annual adult escapement. Source: SacPAS. Available at: https://www.cbr.washington.edu/sacramento/cohort/

2.2.1.4 Recovery

Federal rules and regulations define "recovery" as "means improvement in the status of listed species to the point at which listing is no longer appropriate under the criteria set out in section 4(a)(a) of the [ESA]" (51 FR 19926). Section 4(a)(1) of the ESA directs NMFS to determine whether any species is threatened or endangered because of any of the following five limiting factors: (a) the present or threatened destruction, modification, or curtailment of its habitat or range; (b) overutilization for commercial, recreational, scientific, or educational purposes; (c) disease or predation; (d) the inadequacy of existing regulatory mechanisms; or (e) other natural or man-made factors affecting its continued existence. Therefore, the status of each listing factor provides the necessary context for evaluating the effects of an action to recovery of the species.

The NMFS Recovery Plan for Central Valley Salmon and Steelhead (Recovery Plan; NMFS 2014) developed watershed classifications to assess the potential for populations to contribute to species recovery. There are three categories Core 1, Core 2, and Core 3. The Recovery Plan also identifies primary, candidate and non-candidate watersheds for reintroduction to historical habitats. Primarily reintroduction watersheds have the highest reintroduction priority.

- Core 1 populations meet or have the potential to meet the long-term objective of low extinction risk. These populations possess the known ability or potential ability to support a viable population.
- Core 2 populations meet or have the potential to meet the biological recovery criteria for moderate risk of extinction. These populations have lower potential to support viable

populations due to lower abundance or amount and quality of habitat. They can contribute to increase diversity for a species and may provide resilience from catastrophic events that impact other populations.

- Core 3 populations are present in watersheds on an intermittent basis and require straying from other populations for their persistence. They can contribute to increased diversity for a species and may provide resilience from catastrophic events that impact other populations.

The SR winter-run population in the Basalt and Porous Lava Diversity Group is the only Core 1 population in the ESU. Battle Creek and the McCloud River are described in the Recovery Plan (NMFS 2014) as the primary reintroduction watersheds for establishing new populations. There are no designated Core 2 or Core 3 populations of SR winter-run Chinook salmon.

2.2.1.5 Environmental Variability

Crozier et al. (2019) conducted a recent assessment of environmental variability vulnerability for Pacific salmon species. It was found that several factors contribute to the overall ranking of the SR winter-run Chinook salmon ESU as “very highly vulnerable” to environmental variability (Crozier et al. 2019). The poor population viability of this single population spawning outside of its historical range was the greatest risk, as the ESU is not thriving under current environmental conditions which are expected to worsen. The SR winter-run Chinook salmon ESU was found sensitive to hydrologic regime changes, increases in stream temperature, and summer water deficits, such that the ESU is vulnerable to cumulative life cycle impacts over multiple life stages. Juveniles are also vulnerable to changes in flooding, as decreased stream flows and incidents of flooding may limit their ability to use productive floodplain habitat for rearing. Sea level rise is also expected to reduce the availability of tidal marsh habitats for rearing juveniles.

The marine stage of SR winter-run Chinook salmon was ranked moderately vulnerable to environmental variability impacts, with a high risk of exposure to changes in upwelling because of the unique migratory behavior of the ESU. These fish enter the ocean earlier than other Central Valley Chinook salmon and have a more southerly and nearshore marine distribution compared to other Central Valley ESUs. This contracted range may make the ESU more vulnerable to localized upwelling conditions compared to other Pacific salmon. Sacramento River winter-run Chinook salmon were ranked low in overall adaptive capacity because they are in the southernmost region of the range of Chinook salmon on the West Coast, and the California Central Valley offers the fewest opportunities for adaptive capacity of the Chinook salmon recovery domains. The limited phenotypic and genetic diversity remaining in the extant population is also likely to limit this ESU’s ability to adapt to future environmental variability (Crozier et al. 2019).

2.2.1.6 Summary

Overall, the SR winter-run Chinook salmon ESU remains at a high risk of extinction. Although abundance and productivity have shown modest improvement in the most recent years, the full effects of the 2020–2022 drought have yet to be fully understood of the species. Meanwhile, the spatial structure of the ESU remains limited to the single population found in the main stem Sacramento River, and the genetic and life history diversity of the ESU may have been negatively affected by the increased hatchery production implemented to address drought conditions. The ESU also continues to face threats from disease; predation; habitat loss, alteration, and degradation; and is particularly susceptible to environmental variability and drought (NMFS 2024c).

2.2.2. Designated Critical Habitat for Sacramento River Winter-Run Chinook Salmon

Critical habitat for SR winter-run Chinook salmon is defined as specific areas (listed below) that contain the PBFs considered essential to the conservation of the species. This designation includes the river water, river bottom (including those areas and associated gravel used by SR winter-run Chinook salmon as spawning substrate), and adjacent riparian zone used by fry and juveniles for rearing (58 FR 33212). NMFS limits "adjacent riparian zones" to only those areas above a stream bank that provide cover and shade to the near shore aquatic areas. Although the flood bypasses (e.g., Yolo, Sutter, and Colusa) are not designated critical habitat for SR winter-run Chinook salmon, NMFS recognizes that they may be used when inundated during flood flows and are important rearing habitats for juvenile SR winter-run Chinook salmon. Also, juvenile SR winter-run Chinook salmon use many of the tributaries of the Sacramento River for non-natal rearing (Phillis et al. 2018). Critical habitat also includes the estuarine water column and essential foraging habitat and food resources used by SR winter-run Chinook salmon as part of their juvenile out-migration or adult spawning migration. The action area for the proposed project includes critical habitat for SR winter-run Chinook salmon.

The following PBFs are considered essential for the conservation of SR winter-run Chinook salmon and a review of the status of the PBFs is discussed in 58 FR 33212:

- Access from the Pacific Ocean to appropriate spawning areas.
- The availability of clean gravel for spawning substrate.
- Adequate river flows for successful spawning, incubation of eggs, fry development and emergence, and downstream transport of juveniles: Water temperatures at 5.8°C to 14.1°C (42.5°F to 57.5°F) for successful spawning, egg incubation, and fry development.
- Habitat and adequate prey free of contaminants.
- Access downstream so that juveniles can migrate from the spawning grounds to San Francisco Bay and the Pacific Ocean.

2.2.2.1 Summary of the Essential Features of Sacramento River Winter-Run Chinook Salmon Critical Habitat

Critical habitat for SR winter-run Chinook salmon is composed of PBFs that are essential for the conservation of SR winter-run Chinook salmon, including upstream and downstream access, and the availability of certain habitat conditions necessary to meet the biological requirements of the species. Currently, many of these PBFs are degraded and provide limited high-quality habitat. Additional features that lessen the quality of the migratory corridor for juveniles include unscreened diversions, altered flows to and in the Delta, and the lack of accessible floodplain habitat. In addition, changing hydrology and water operations during periods of drought that limit the extent of cold water below Shasta Dam have reduced the available spawning habitat. Although the habitat for SR winter-run Chinook salmon has been highly degraded, the importance of the remaining spawning habitat, migratory corridors, and rearing habitat is of high conservation value.

2.2.3. 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 (Table 2). This initial classification was reaffirmed in 2005 when the Feather River Fish Hatchery (FRFH) population was added to the ESU (70 FR 37160). 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 following (2016) 5-year review it was recommended that CV spring-run Chinook salmon should remain listed as threatened (81 FR 33468, NMFS 2016b).

Table 2. Summary of the listing history under the Endangered Species Act for the Central Valley spring-run Chinook salmon evolutionarily significant unit.

Salmonid Species	ESU/DPS Name	Original Listing	Revised Listing	Critical Habitat Designations
Chinook Salmon (*O. tshawytscha*)	Central Valley spring-run Chinook salmon	**FR Notice:** 64 FR 50394 **Date:** September 16, 1999 **Classification:** Threatened	**FR Notice:** 70 FR 37160 **Date:** June 28, 2005 **Re-affirmation:** Threatened	**FR notice:** 70 FR 52488 **Date:** September 2, 2005

2.2.3.1 Life History

Generally, adult CV spring-run Chinook salmon migrate from the Pacific Ocean in a reproductively immature state and swim upstream into fresh water in the spring months (approximately March through June) using olfactory senses to locate their birth waters. The adult fish then hold over summer months (approximately June through September) and spawn in cold freshwater in the early fall months (approximately September through November). Larval fish, also known as alevins, hatch from eggs and emerge from their gravel nests throughout the fall and early winter months (approximately October through December). Juvenile fish then rear and feed in freshwater from late fall through spring (approximately October through June), or they may choose to rear for a full year (i.e., 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 Delta and then the San Francisco Bay estuary. Once juvenile fish have completed the physiological changes necessary to enter saltwater (called smoltification), they enter the Pacific Ocean and rear into adults over approximately 3 to 4 years. After 3 or 4 years old, they migrate back upstream to their natal freshwater stream to spawn.

In general, wetter water years result in higher survival of juveniles out-migrating during the spring of the same year they emerged. In 3 to 4 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 during spring outmigration and encourage a subset (roughly 10 percent) of juveniles to express the yearling life history strategy (Cordoleani et al. 2021). This results in a lower number of large juveniles out-migrating to the ocean much later in the year than during a wet or normal year. When the dry condition cohort returns to spawn, there are fewer adults because there was less survival during the spring out-migration. Therefore, the number of adult spawners is likely to be lower from a juvenile cohort that experienced drought conditions in freshwater during their out-migration in contrast to a juvenile cohort that experiences high river flows during a wet water year while out-migrating.

2.2.3.2 Population Structure

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 37160). The ESU also includes CV spring-run Chinook salmon from the Feather River Fish Hatchery FRFH spring-run Chinook salmon program. In 2014, FRFH broodstock was used to actively reintroduce CV spring-run Chinook salmon into the mainstem San Joaquin River as an ESA 10(j) nonessential experimental population (NEP)(78 FR 79622)[3]. Since 2019, adults have been observed returning to the San Joaquin River and successfully spawning within the SJRRP Restoration Area.

The ongoing success of the SJRRP reintroduction activities has recently resulted in an increase in the number of adult CV spring-run Chinook salmon migrating into the San Joaquin River tributaries, outside of the SJRRP Area. Many of these adult fish originated as juveniles from the SJRRP Area and SCARF as identified through coded wire tag (CWT) recovery. These adults did not migrate back to the SJRRP Area and instead migrated into the lower San Joaquin River tributaries, thereby mixing with the residual population. Initial and ongoing data collection within the tributaries, including the Mokelumne, Stanislaus, Tuolumne, and Merced Rivers, indicates successful spawning within these rivers (Gutierrez et al. 2024). Continuing to monitor these populations will provide information to evaluate the status of CV spring-run Chinook salmon in the San Joaquin River and its tributaries. This monitoring would also provide a basis for evaluating whether the ESU boundary should be modified to account for CV spring-run Chinook salmon populations repopulating the San Joaquin river basin and/or in CV habitats upstream of currently impassable barriers (Gutierrez et al. 2024).

Wild-spawned juveniles in the San Joaquin River tributaries that originate outside of the area designated by the 10(j) (78 FR 79622) are not part of the NEP. However, these juveniles are

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[3] CV spring-run Chinook salmon are considered to be a nonessential experimental population (NEP) only when, and at such times as, they are found in the San Joaquin River from Friant Dam downstream to its confluence with the Merced River, delineated by a line between decimal latitude and longitude coordinates: 37.348930°N., 120.975174°W. and 37.349099°N., 120.974749°W., as well as all sloughs, channels, floodways, and waterways connected with the San Joaquin River within those coordinates that allow for CV spring-run Chinook salmon access, but excluding the Merced River. Also, Central Valley spring-run Chinook salmon when found in portions of the Kings River that connect with the San Joaquin River during high water years (78 FR 79622)

subject to the *de minimus* clause within the tributaries and the mainstem San Joaquin River until they migrate downstream past Mossdale County Park on the mainstem. Once they are observed or captured past Mossdale County Park (50 CFR 223.301 Section (b)(5)(i)) they are no longer subject to the *de minimus* clause and have full protection of their ESA status.

2.2.3.3 Viability Status and Trends

2.2.3.3.1 Abundance and Productivity

The viability of CV spring-run Chinook salmon has deteriorated since the 2015 assessment with weakening of all independent CV spring-run Chinook salmon populations (Table 3). In fact, Mill, Deer, Battle, and Butte Creeks changed from a low/moderate to a high risk of extinction using one or more viability criteria (Table 3). The total estimated abundance of adult CV spring-run Chinook salmon for the Sacramento River watershed in 2019 was 26,553, approximately half of the population size in 2014 (N = 56,023). Also, population sizes have hit decadal lows, of approximately 14,000 individuals, as recently as the last 2 years (Azat and Killiam 2025). The Central Valley-wide abundance is driven largely by the annual variation in adults returning to Butte Creek.

The Butte Creek population is at a high risk of extinction based on viability analysis according to data through 2021. Pre-spawn mortality in 2021 was 92 percent, representing a biologically significant loss in spawning potential. However, given the robust spawning populations in 2019, the total population size (17,951) and average population size remain well above the criteria for low risk of extinction (greater than 2,500). Still, the rate of decline increased from 5 percent per year through 2019, to 19 percent over the most recent 10 years, indicating that the Butte Creek population is at a high risk of extinction (SWFSC 2023).

The Butte Creek CV spring-run Chinook salmon population is wholly dependent on the reliable, long-term import of cold water from the West Branch of the Feather River to spawning and holding habitat in Butte Creek. In February 2017, Pacific Gas & Electric Company (PG&E) submitted notice to FERC withdrawing their October 2007 application for a new license for the Project (FERC Project No. 803), citing declining power values and the anticipated cost of project operation associated with new license conditions. The Butte Creek CV spring-run population has been a stronghold for the CV spring-run Chinook salmon ESU due to its relatively large population size that has resulted from improvements in water temperature management, extensive fish passage restoration, and the accessibility of floodplain habitat in the Butte Sink and Sutter Bypass for juvenile rearing in the majority of years.

Most dependent CV spring-run Chinook salmon populations experienced continued, and in some cases drastic, declines. For example, while adults were observed in Big Chico Creek from 2014 to 2018, they likely did not survive to spawn due to high summer temperatures resulting in zeros (0) in the escapement estimates (Azat and Killiam 2025, SWFSC 2023). These results underscore the need for improved passage so that these dependent populations and habitats do not become sinks for CV spring-run Chinook salmon. Counteracting recent declines in adult abundance 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 have the potential to support independent and viable CV spring-run Chinook salmon populations (Lindley et al. 2004, NMFS 2014).

Table 3. Summary of Central Valley spring-run Chinook salmon extinction risk by population criteria described in Lindley et al. (2007) for the 2010, 2015, and 2020 viability assessment periods (Johnson et al. 2022) undated with the results from the mid-cycle assessment. Overall risk is determined by the highest risk score for any criterion.

Population	Extinction Risk for Viability Assessment Year 2010	Extinction Risk for Viability Assessment Year 2015	Extinction Risk for Viability Assessment Year 2020	Extinction Risk for Viability Assessment Year 2022 (mid-cycle)
Mill Creek*	High	Moderate	High	High
Deer Creek*	High	Moderate	High	High
Butte Creek*	Low	Moderate	Moderate	High**
Battle Creek*	High	Moderate	High	High
Clear Creek	High	Moderate	High	Moderate
Feather River Hatchery	High	High	High	High

* Mill, Deer, Butte, and Battle Creeks are independent populations.

**The point estimate for the decline in population abundance over the most recent 10 years is 19% per year, placing the population at a high risk of extinction (Lindley et al. 2007). The viability criteria for population decline (<10% per year) are based on the point estimate with no guidance on interpreting confidence intervals. The confidence intervals for Butte Creek overlap '0' which means that the slope is not statistically different from '0'. We apply the Lindley et al. 2007 decline criteria as it stands but note that new criteria perhaps in a Baysean framework would provide a clearer ability to assess the probability of extinction given observed declines.

CV spring-run Chinook salmon populations have experienced a series of droughts over the past decade. From 2007 to 2009, 2012 to 2015, and 2020 to 2022, the Central Valley experienced drought conditions and low river and stream discharges, which are strongly associated with lower survival of Chinook salmon. The impacts of the recent drought series and warm ocean conditions on the juvenile life stage seems to have manifested in the low run sizes in 2015–2018 for most CV spring-run Chinook salmon populations (SWFSC 2022). The 2007–2009 and 2012–2015 droughts impacted CV spring-run Chinook salmon adults on Butte Creek, which experienced lethal temperatures in holding habitats during the summer. Prespawn mortality was observed during drought years, affecting 1,054, 903, and 232 individuals in 2008, 2013, and 2014, respectively (Garman 2016). In 2015, late-arriving adults observed in sections of Butte Creek near the City of Chico experienced exceptionally warm June air temperatures coupled with the PG&E flume shutdown, resulting in a fish mortality event. These conditions likely influenced juvenile production that resulted in low adult returns in 2015–2018.

Fortunately, the favorable hydroclimatic conditions in 2017 appear to have bolstered juvenile survival leading to high adult returns on Butte Creek to approximately 15,000 adults. At the ESU level, the spatial diversity of CV spring-run Chinook salmon is increasing, and CV spring-run Chinook salmon are present (albeit at low numbers in some cases) in all diversity groups. The reestablishment of CV spring-run Chinook salmon to Battle and Clear Creeks starting in the late 1990s and early 2000s, along with the increasing abundance of CV spring-run Chinook salmon on Clear Creek observed in some years, is benefiting the viability of CV spring-run Chinook salmon. Similarly, CV spring-run Chinook salmon have been documented on the San Joaquin River tributaries and may be the beginning of natural dispersal processes into rivers where they were once extirpated[4].

2.2.3.3.2 Spatial Structure and Diversity

Spatial diversity of CV spring-run Chinook salmon ESU is trending in a positive direction towards achieving at least two populations in each of the four historical diversity groups, but the new populations are not well monitored and likely dependent on emigration for their persistence (NMFS 2014). Active reintroduction efforts, like that downstream of Friant Dam on the mainstem San Joaquin River, are necessary to move CV spring-run Chinook salmon towards recovery and additional reintroduction opportunities are being explored on the Yuba River upstream of Englebright Dam, on the Sacramento River upstream of Shasta Dam, on the Tuolumne River upstream of Don Pedro Dam, and on the Feather River upstream Oroville Dam.

In addition, the number of Mill and Deer Creek spawners in 2020 was low (SWFSC 2023) and preliminary genetic results from the 2021 carcass surveys in these streams lacked the genetic signals specific to the Mill and Deer Creek populations (SWFSC 2023). It is therefore possible that consecutive years of very low returns has resulted in extirpation of this unique genetic lineage. More research and analysis are currently being conducted to determine the extent of the damage to this population (SWFSC 2023).

2.2.3.4 Recovery

The rationale for recovery (NMFS 2014) is based on two key principles: it is necessary to have functioning, diverse, and interconnected habitats for population viability, and viability is based on spatial structure, diversity, productivity, and abundance (McElhany et al. 2000). The greatest opportunities for advancing CV spring-run Chinook salmon recovery are to preserve current populations and reintroduce populations into their historical habitat.

Specific recovery goals are: (1) securing adequate flows and temperatures for holding adults and yearling juveniles; (2) improving rearing habitat and increasing survival for out-migrating juveniles; (3) completing major fish passage projects on CV spring-run Chinook salmon habitat on the Sacramento and San Joaquin Rivers and their tributaries; and (4) operating water conveyance and diversion facilities while maintaining and enhancing the function of migration corridors and freshwater and estuarine rearing habitats. Moving towards these goals will create a functioning ecosystem.

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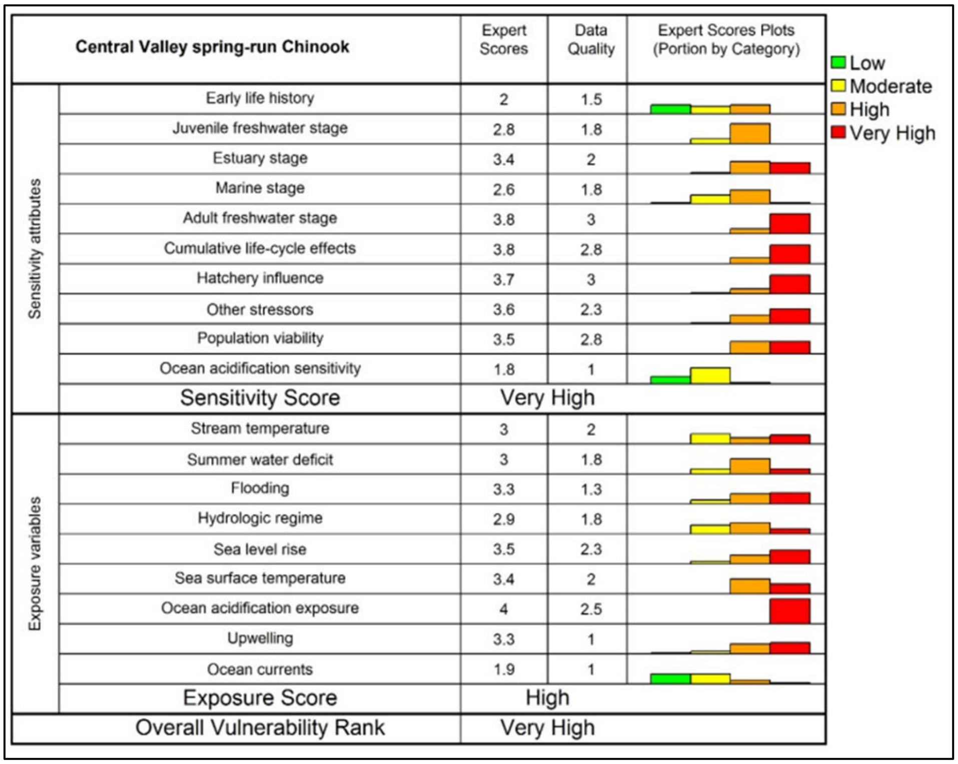
[4] Data for coded wire tag (CWT) recoveries is publicly available at: https://www.rmpc.org/

2.2.3.5 Environmental Variability

Several factors contributed to the ranking of this ESU as very highly vulnerable to environmental variability. The increasingly poor population viability of the remaining extant populations is a significant risk, as the ESU is not thriving under current climate conditions which are expected to worsen. Both adult and juvenile life stages are vulnerable to hydrologic regime changes, increases in stream temperature, and summer water deficits and are therefore also vulnerable to cumulative life cycle impacts over multiple life stages. Juveniles are also vulnerable to changes in spring flooding and snow melt, as decreased stream flows and incidents of flooding may limit their ability to access and occupy productive floodplain habitat for rearing. Sea level rise may also reduce the availability of tidal marsh habitats for rearing juveniles.

CV spring-run Chinook salmon were ranked highly sensitive (Figure 4) because they are in the southernmost region of the range of Chinook salmon on the West Coast, and the California Central Valley offers the fewest opportunities for adaptive capacity of the Chinook salmon recovery domains. The limited phenotypic and genetic diversity remaining in the extant populations combined with the currently inaccessible historical habitat is also likely to limit this ESU's ability to adapt to future environmental variability.



	Central Valley spring-run Chinook	Expert Scores	Data Quality	Expert Scores Plots (Portion by Category)
Sensitivity attributes	Early life history	2	1.5	
	Juvenile freshwater stage	2.8	1.8	
	Estuary stage	3.4	2	
	Marine stage	2.6	1.8	
	Adult freshwater stage	3.8	3	
	Cumulative life-cycle effects	3.8	2.8	
	Hatchery influence	3.7	3	
	Other stressors	3.6	2.3	
	Population viability	3.5	2.8	
	Ocean acidification sensitivity	1.8	1	
	Sensitivity Score	Very High		
Exposure variables	Stream temperature	3	2	
	Summer water deficit	3	1.8	
	Flooding	3.3	1.3	
	Hydrologic regime	2.9	1.8	
	Sea level rise	3.5	2.3	
	Sea surface temperature	3.4	2	
	Ocean acidification exposure	4	2.5	
	Upwelling	3.3	1	
	Ocean currents	1.9	1	
	Exposure Score	High		
Overall Vulnerability Rank		Very High		

Figure 4. Central Valley spring-run Chinook salmon Climate Variability Effects Exposure and Vulnerability. Source: (Crozier et al. 2019)

CV spring-run Chinook salmon evolved multiple life history strategies in response to the hydrologic variability of California's Central Valley. The preservation of these life history strategies is dependent on the preservation of the natural hydrograph and functional freshwater habitats that support survival throughout the juvenile migration timeframe (both early [young-of year] and late migrating [yearlings]). In some years, the early out-migration life history strategy may be more advantageous for juvenile survival due to certain environmental conditions (i.e., wetter hydrologic conditions). In other years, the late out-migration life history strategy may be more advantageous for juvenile survival, such as in drier hydrologic conditions (Cordoleani et al. 2021). This variation in juvenile life history strategies creates multiple generations of adults returning to spawn in freshwater. Multiple age classes of spawning adults are necessary to ensure the overall survival of Chinook salmon against drastic annual hydrologic variations.

However, the effects of environmental variability impact the entire salmonid watershed, from freshwater to saltwater and will likely make survival more difficult during both the juvenile and adult migration timeframes. As discussed above, environmental variability will alter hydrologic conditions throughout the Central Valley and has the potential to significantly reduce or eliminate life history strategies across multiple generations of Chinook salmon. The combined factors of environmental variability, highly managed and unnatural hydrographs, disconnected floodplains, and the lack of passage to historical upper watershed habitats pose a significant and severe threat to the survival of CV spring-run Chinook salmon.

Environmental variability will continue to be a threat towards the recovery of CV spring-run Chinook salmon (NMFS 2014, SWFSC 2023). More frequent and longer duration droughts in the southern Sierra-Nevada Mountain Range will have a significant impact on water supply and reliability for both people and fish. Increased drought frequency, combined with an overall decrease in snow pack, will decrease the quantity of cold water. Lack of access to high elevation spawning and rearing habitats due to impassable dams will result in decreased survival and abundance for both the juvenile and adult life stages of salmon in the San Joaquin River.

2.2.3.6 Summary

The viability of the CV spring-run Chinook salmon ESU has deteriorated since it was added to the ESA (NMFS 2016b, SWFSC 2023). The largest proximate impacts are likely due to the 2012–2015 and 2020–2022 freshwater drought conditions and unusually warm ocean conditions experienced by these cohorts, resulting in weakening viability metrics and greater risks of extinction to most of the CV spring-run Chinook salmon along with reduced of access to historical and floodplain habitat.

Overall, the SWFSC's viability assessment (SWFSC 2023) concluded that the viability of CV spring-run Chinook salmon (through 2021) has declined since the prior viability assessment in 2016 and that the ESU's extinction risk may have increased. This ESU continues to face significant, unyielding threats that are likely to be exacerbated by the impacts of future climate change. Significant habitat and flow improvement actions are urgently needed to recover the species.

2.2.4. Designated Critical Habitat for Central Valley Spring-run Chinook Salmon

Critical habitat was designated for CV spring-run Chinook salmon on September 2, 2005 (70 FR 52488). Critical habitat for the CV spring-run Chinook salmon includes stream reaches of the Feather, Yuba, and American rivers; Big Chico, Butte, Deer, Mill, Battle, Antelope, and Clear Creeks; and the Sacramento River, as well as portions of the northern Delta. Critical habitat includes the stream channels in the designated stream reaches (70 FR 52488). Critical habitat for CV spring-run Chinook salmon is defined as specific areas that contain the PCEs and physical habitat elements essential to the conservation of the species. The following are the PCEs for CV spring-run Chinook salmon. The action area for the proposed project include critical habitat for CV spring-run Chinook salmon.

Spawning Habitat
Freshwater spawning sites are those with sufficient water quantity and quality conditions and substrate supporting spawning, incubation, and larval development. Most spawning habitat in the Central Valley for Chinook salmon is located in areas directly downstream of dams containing suitable environmental conditions for spawning and incubation. Spawning habitat for CV spring-run Chinook salmon occurs on the mainstem Sacramento River between the Red Bluff Diversion Dam and Keswick Dam and in tributaries such as Mill, Deer, and Butte Creeks, as well as the Feather and Yuba Rivers and Big Chico, Battle, Antelope, and Clear Creeks. Even in degraded reaches, spawning habitat has a high conservation value as its function directly affects the spawning success and reproductive potential of listed salmonids.

Freshwater Rearing Habitat
Freshwater rearing sites are those with water quantity and floodplain connectivity to form and maintain physical habitat conditions supporting juvenile growth and mobility; water quality and forage supporting juvenile salmonid development; and natural cover such as shade, submerged and overhanging large woody material, log jams and beaver dams, aquatic vegetation, large rocks and boulders, side channels, and undercut banks. Both spawning areas and migratory corridors comprise rearing habitat for juveniles, which feed and grow before and during their out-migration. Non-natal, intermittent tributaries also may be used for juvenile rearing. Rearing habitat conditions are strongly affected by habitat complexity, food supply, and the presence of predators of juvenile salmonids. Some complex, productive habitats with floodplains remain in the system (e.g., the lower Cosumnes River, Sacramento River reaches with setback levees [i.e., primarily located upstream of the City of Colusa]) and flood bypasses (i.e., Yolo and Sutter bypasses). However, the channelized, leveed, and riprapped river reaches and sloughs that are common in the Sacramento-San Joaquin system typically have low habitat complexity, low abundance of food organisms, and offer little protection from piscivorous fish and birds. Freshwater rearing habitat also has a high intrinsic conservation value even if the current conditions are significantly degraded from their natural state.

Freshwater Migration Corridors
Ideal freshwater migration corridors are free of migratory obstructions, with water quantity and quality conditions that enhance migratory movements. They contain natural cover such as riparian canopy structure, submerged and overhanging large woody objects, aquatic vegetation, large rocks and boulders, side channels, and undercut banks which augment juvenile and adult mobility, survival, and food supply. Migratory corridors are downstream of the spawning areas and include the lower main stems of the Sacramento and San Joaquin rivers and the Delta. These corridors allow upstream passage of adults and the downstream emigration of juveniles. Migratory habitat conditions are strongly affected by the presence of barriers, which can include dams (i.e., hydropower, flood control, and irrigation flashboard dams), unscreened or poorly screened diversions, degraded water quality, or behavioral impediments to migration. For successful survival and recruitment of salmonids, freshwater migration corridors must function

sufficiently to provide adequate passage. The stranding of adults has been known to occur in flood bypasses and associated weir structures (Vincik and Johnson 2013) and several challenges exist on many tributary streams. For juveniles, unscreened or inadequately screened water diversions throughout their migration corridors and a scarcity of complex in-river cover have degraded this PCE. However, since the primary migration corridors are used by numerous populations and are essential for connecting early rearing habitat with the ocean, even the degraded reaches are considered to have a high intrinsic conservation value to the species.

Estuarine Areas
Estuarine areas, such as the San Francisco Bay and the downstream portions of the Delta, free of migratory obstructions with water quality, water quantity, and salinity conditions supporting juvenile and adult physiological transitions between freshwater and saltwater are included as a PCE. Natural cover such as submerged and overhanging large woody material, aquatic vegetation, and side channels are suitable for juvenile and adult foraging.

The remaining estuarine habitat for these species is severely degraded by altered hydrologic regimes, poor water quality, reductions in habitat complexity, and competition for food and space with exotic species. Regardless of the condition, the remaining estuarine areas are of high conservation value because they provide factors which function to provide predator avoidance, rearing habitat, and as an area of transition to the ocean environment.

2.2.5. California Central Valley Steelhead

The CCV steelhead DPS includes naturally spawned anadromous *O. mykiss* originating downstream of natural and manmade impassable barriers from the Sacramento and San Joaquin Rivers and their tributaries and excludes such fish originating from the San Francisco and San Pablo Bays and their tributaries (70 FR 37160). This DPS includes CCV steelhead from the Coleman National Fish Hatchery, FRFH, and the Mokelumne River Hatchery (85 FR 81822). In 1998, NMFS listed CCV steelhead under the ESA and classified it as a threatened species (Table 4). In 2006, following the development of NMFS' Hatchery Listing Policy (70 FR 37204), NMFS re-evaluated the status of this DPS and determined the DPS continued to warrant listing as a threatened species. Furthermore, we determined the Coleman National Fish Hatchery and FRFH stocks of CCV steelhead should be part of the DPS (Table 4). In 2020, NMFS added the Mokelumne River Hatchery to the CCV steelhead DPS because fish in this program are genetically most similar to FRFH Program steelhead, which are included in the DPS (85 FR 81822).

Table 4. Summary of the listing history under the Endangered Species Act for the CCV steelhead DPS.

Salmonid Species	ESU/DPS Name	Original Listing	Revised Listing(s)
Steelhead (*O. mykiss*)	California Central Valley Steelhead	**FR Notice:** 63 FR 13347 **Date:** 03/19/1998 **Classification:** Threatened	**FR Notice:** 71 FR 834 **Date:** 01/05/2006 **Re-affirmation:** Threatened

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 most recent 5-year review, it was recommended the CCV steelhead DPS should remain listed as threatened (81 FR 33468, NMFS 2024d).

2.2.5.1 Life History and Distribution

O. mykiss exhibit a diverse life history (Moyle 2002). Members of this species can be anadromous or freshwater residents, and, under some circumstances, members of one form can yield offspring of another form (Zimmerman et al. 2008). CCV steelhead adult migration from the ocean to spawning grounds occurs during much of the year, with peak migration occurring in the fall or early winter (Moyle 2002). CCV steelhead generally begin spawning in December, continuing through March/April (Moyle 2002). 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, CCV steelhead still have access to many historical spawning areas (McEwan and Jackson 1996).

CCV steelhead spawning occurs mainly in gravel substrates (particle size ranges from about 0.2 to 2.2 inches (Stanislaus River Scientific Evaluation Process (SEP) Team 2019). Adults tend to spawn in shallow areas (6 to 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 and Jackson 1996). Some may return to the ocean and repeat the spawning cycle for two or three years. The percentage of adults surviving spawning is generally thought to be low for CCV steelhead but varies annually and between stocks. Acoustic tagging of CCV steelhead kelts from the Coleman National Fish Hatchery indicates survival rates can be high, especially for CCV steelhead reconditioned by holding and feeding at the hatchery prior to release. Some return immediately to the ocean and some remain and rear in the Sacramento River (Null et al. 2013). Kelts may remain in freshwater for an entire year after spawning (Teo et al. 2011) but that most return to the ocean (Null et al. 2013).

CCV steelhead preferred water temperatures for spawning and egg incubation are approximately 3.8°C and 11°C (39°F and 52°F), and egg mortality likely begins at 13°C (56°F), respectively (CDFG 1996, McEwan 2001, Reiser and Bjornn 1979). After hatching, the young fish (alevins) remain in the gravel for an extra two to six weeks before emerging from the gravel and taking up residence in the shallow margins of the stream. CCV steelhead embryo incubation generally occurs from December through June in the Central Valley and their eggs reportedly have the highest survival rates at water temperature ranges of 7°C to 10°C (44.6°F to 50.0°F) (Myrick and Cech Jr 2001). A sharp decrease in survival has been reported for *O. mykiss* embryos incubated above 14°C (57.2°F) (Kamler and Kato 1983). After hatching, alevins remain in the gravel for an additional two to five weeks while absorbing their yolk sacs and then emerge in spring or early summer (Barnhart 1986). Newly emerged juveniles move to shallow, protected areas associated within the stream margin (McEwan and Jackson 1996). 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 CCV steelhead both as velocity refugia and as a means of avoiding predation (Meehan and Bjornn 1991). Older juveniles use riffles and larger juveniles may also use pools and deeper runs (Barnhart [1986] as cited in McEwan and Jackson [1996]). An upper water temperature limit of 18°C (65°F) is preferred for growth and development of Sacramento River and American River juvenile steelhead (NMFS 2002, Bratovich et al. 2005) and temperatures below 15.5°C (60°F) can reduce the risk of pathogen virulence for steelhead rearing and out-migration while still allowing for strong growth (McCullough 1999, Carter 2005). Most juvenile steelhead spend one to three years in fresh water before emigrating to the ocean as smolts (Shapovalov and Taft 1954). The primary period of CCV steelhead smolt out-migration from rivers and creeks to the ocean generally occurs from January to June (NMFS 2009).

2.2.5.2 Viability Status and Trends

Good et al. (2005) found the CCV steelhead DPS was in danger of extinction, with a minority of the Biological Review Team viewing the DPS as likely to become endangered. The Biological Review Team'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 CCV steelhead abundance evident from 1967 to 1993 dam counts had stopped. Lindley et al. (2007) found that data through 2005 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 proportion of hatchery-origin fish in the Battle Creek returns averaged 29 percent over the 2002–2010 period, elevating the level of hatchery influence to a moderate risk of extinction. The Chipps Island midwater trawl dataset of USFWS indicated the decline in the natural production of CCV steelhead had continued unabated through 2010, with the proportion of adipose fin-clipped CCV steelhead reaching 95 percent. In 2015, population trend data showed significant increases in abundance of Coleman National Fish Hatchery and FRFH populations, but data are still lacking to estimate trends in natural populations.

The Central Valley Salmon and Steelhead Recovery Plan (NMFS 2014) includes biological recovery criteria based on the VSP concept. The Central Valley Salmon and Steelhead Recovery Plan include the following DPS-level 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 for this DPS and thereby delist the species, there must be at least nine populations at a low risk of extinction distributed throughout the Central Valley as outlined above, as well as additional populations at a moderate risk of extinction (NMFS 2014). Currently, no CCV steelhead populations satisfy the low extinction risk criteria. For the 17 populations evaluated in the SWFSC's 2022 viability assessment, 11 are at high extinction risk and six are at moderate extinction risk (SWFSC 2023). Twelve of the populations are at high or moderate extinction risk based on population size, indicating low abundance of natural-origin CCV steelhead (SWFSC 2023).

2.2.5.2.1 Abundance and Productivity

Population trend data remain limited for the CCV steelhead DPS. The total hatchery populations from Coleman National Fish Hatchery, FRFH, and Mokelumne River Hatchery have significantly increased since the 2010 and 2015 viability assessments. In fact, Coleman National Fish Hatchery returns have steadily increased 15 percent 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. A significant proportion of steelhead redds on the American River are made by Nimbus Hatchery steelhead, which are not part of the DPS, and declined eight percent per year over the last decade. Chipps Island midwater trawl data provide information on the trend in abundance for the CCV steelhead DPS. Updated through 2025, the trawl data indicate the production of natural-origin CCV steelhead remains low relative to hatchery production. The lack of improved natural production as estimated by juvenile migrants exiting the river systems at Chipps Island and low abundances coupled with large hatchery influence are cause for concern.

Catch per unit effort has fluctuated and generally increased over the past decade, but the proportion of the catch that is adipose fin-clipped (100 percent of hatchery CCV steelhead production have been adipose fin-clipped starting in 1998) has increased steadily, exceeding 90 percent in recent years and reaching 96 percent during the drought in 2015. This suggests the majority of CCV steelhead out-migrating from the Delta are of hatchery origin.

2.2.5.2.2 Spatial Structure and Diversity

This DPS includes CCV 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 Coleman National Fish Hatchery, FRFH, and Mokelumne River Hatchery. Genetic analysis showed the steelhead stock propagated in the Mokelumne River Hatchery 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 Mokelumne River Hatchery. The Nimbus Hatchery steelhead remain genetically divergent from the Central Valley DPS lineages, consistent with their founding from coastal steelhead stocks, and remain excluded from the DPS (Pearse and Garza 2015).

As overall data remains limited for the CCV steelhead DPS, it is difficult to ascertain if their spatial distribution has changed. From recent monitoring data, CCV steelhead are not noted to have had any substantial changes in spatial distribution or diversity. Hatchery influence continues to be a high threat to diversity of the DPS, and the out-of-basin stock at Nimbus Hatchery poses significant genetic threat to CCV steelhead (SWFSC 2023).

2.2.5.2.3 Summary of California Central Valley Steelhead Viability

Based upon the information available, the overall viability of the CCV Steelhead DPS appears to be unchanged since the NMFS' 2015 5-year review. However, the majority (11 of 16) of populations for which there are data are at a high risk of extinction based on abundance and/or hatchery influence, with no population considered to be at a low risk of extinction. Lack of improved natural production estimates and low abundances coupled with large hatchery influence are causes for continued concern (SWFSC 2023).

2.2.5.3 Recovery

NMFS is directing CCV steelhead recovery efforts at populations that need viability improvement according to DPS-, Diversity Group-, and population-level recovery criteria; the best available scientific information concerning DPS status; the role of the independent populations in meeting DPS and Diversity Group viability; limiting factors and threats; and the likelihood of action effectiveness to guide our recommendations for future actions. NMFS is coordinating with the federal, state, tribal, and local implementing entities to ensure that risk factors and actions are addressed that were identified in the Central Valley Salmon and Steelhead Recovery Plan (NMFS 2014).

2.2.5.4 Environmental Variability

In California, there have been observed changes in air temperatures, annual precipitation, runoff, and sea levels over the past century (Anderson et al. 2008). Regional-scale climate models for California are in broad agreement that temperatures in the future will warm significantly, total precipitation may decline, and snowfall will decline significantly (Lindley et al. 2007). Literature suggests that by 2100, mean summer temperatures in the Central Valley may increase by 2°C to 8°C, precipitation will likely shift to more rain and less snow, with significant declines in total precipitation possible, resulting in changed hydrographs, especially in the southern Sierra Nevada mountains. This information suggests that environmental variation poses an additional risk to the survival of salmonids in the Central Valley. As with their ocean phase, CCV steelhead will be more thermally stressed by stream warming at the southern ends of their ranges.

The distribution of CCV steelhead today is greatly reduced from the historical distribution. Dams and water diversions limit CCV steelhead access to less than 20 percent of their historical spawning and rearing areas in the Central Valley (Yoshiyama et al. 2001, Lindley et al. 2006). Environmental variation will further restrict access to cool water streams. The diversity and variability of their life history complicate management, yet this same attribute reduces their vulnerability to environmental variation. Additionally, low flows during juvenile rearing and out-migration are associated with poor survival through the Delta (Kjelson and Brandes 1989, Baker P.F. and Morhardt 2001, Newman and Rice 2002) and poor returns in subsequent years (Speed 1993). Environmental variation also may impact Central Valley salmonids through community effects. For example, warming may increase the activity and metabolic demand of predators, reducing the survival of juvenile salmonids (Vigg and Burley 1991).

Based upon the information available, the overall viability of the CCV steelhead DPS appears to be unchanged since the NMFS 5-year review (NMFS 2023). However, the majority (11 of 16) of 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 (NMFS 2023).

2.2.6. Designated Critical Habitat for California Central Valley Steelhead

The geographic extent of designated critical habitat includes, but is not limited to, the following: Sacramento, Feather, and Yuba rivers; Clear, Deer, Mill, Battle, and Antelope Creeks in the Sacramento River basin; the San Joaquin River, including its tributaries; and the waterways of the Delta (Figure 5). The proposed action area includes designated critical habitat for CCV steelhead.

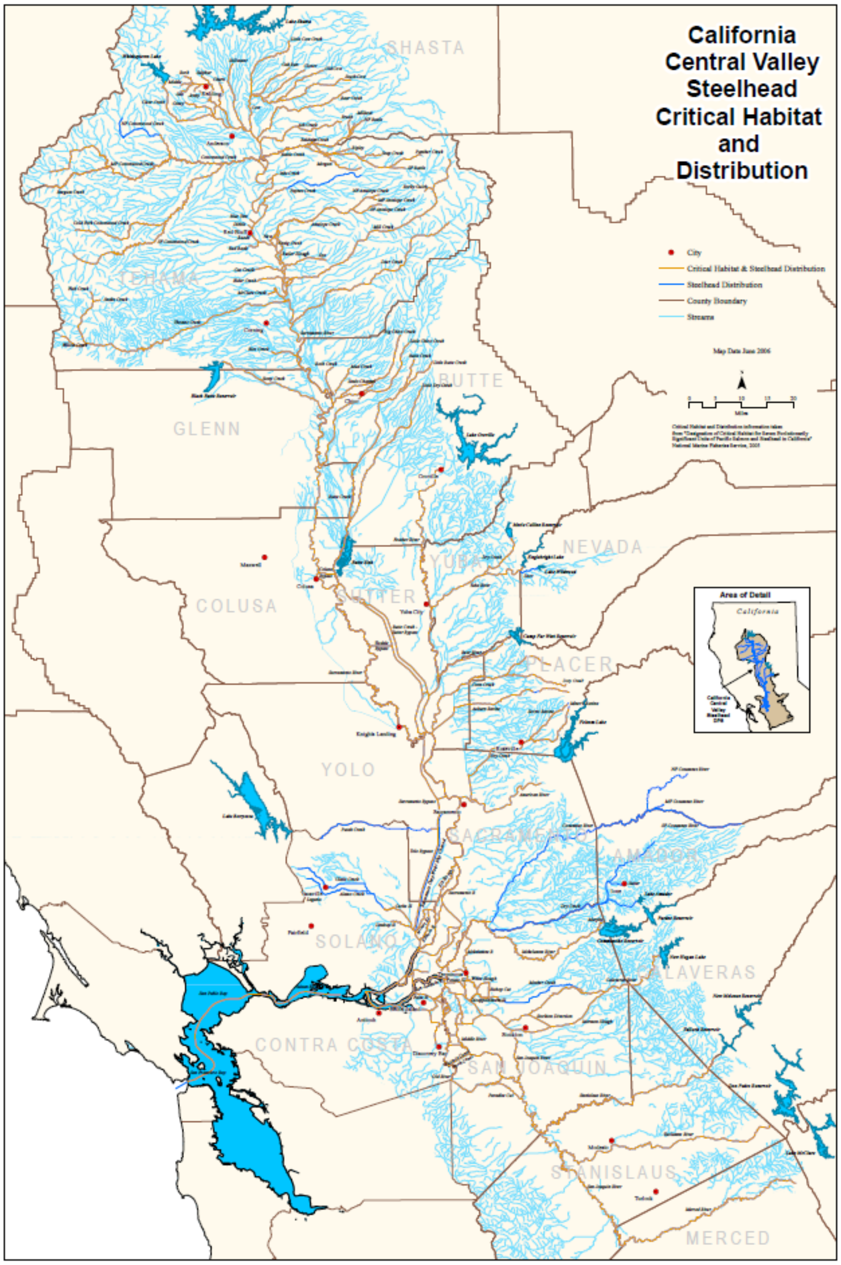


Figure 5. Designated critical habitat for California Central Valley steelhead Distinct Population Segment.

The critical habitat for CCV steelhead lists the essential PBFs (70 FR 52488), 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.
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 freshwater and saltwater; (ii) natural cover such as submerged and overhanging large wood, aquatic vegetation, large rocks and boulders, and side channels; and (iii) juvenile and adult forage, including aquatic invertebrates and fishes, supporting growth and maturation.

Historically, CCV steelhead spawned in many of the headwaters and upstream portions of the Sacramento River and San Joaquin River basin. Similar to SR winter-run and CV spring-run Chinook salmon, passage impediments have contributed to substantial reductions in the number of populations by isolating them from most of their historical spawning habitat. The PBFs of freshwater spawning sites have been degraded within the action area due to high water temperatures, redd dewatering, and loss of spawning gravel recruitment in reaches below Keswick Dam (Wright and Schoellhamer 2004, Good et al. 2005, NMFS 2009, Jarrett and Killam 2014).

Freshwater rearing and migration PBFs have been degraded from their historical 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 (National Marine Fisheries Service 2014b). 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).

CCV steelhead can only access large floodplain areas, such as the Yolo Bypass, under certain hydrologic conditions, typically normal and wet water years. The Yolo Bypass Restoration Salmonid Habitat Restoration and Fish Passage Implementation Plan include notching the Fremont Weir (California Department of Water Resources and U.S. Bureau of Reclamation 2016), which now provides access to floodplain habitat for juvenile CCV steelhead over a longer period.

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 due to the role these areas have in critical portions of this species' life history.

2.2.7. Southern Distinct Population Segment of Green Sturgeon

North American green sturgeon include a Northern DPS consisting of populations originating from coastal watersheds northward of and including the Eel River (i.e., the Klamath and Rogue rivers) and a Southern DPS consisting of populations originating from coastal watersheds south of the Eel River, with the only known spawning population in the Sacramento River Basin (74 FR 52300, October 9, 2009).

The sDPS of green sturgeon was listed as a threatened species under the ESA on April 7, 2006 (71 FR 17757, Table 5). The Northern DPS is not listed under the ESA. NMFS designated 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).

Table 5. Summary of the listing history under the Endangered Species Act for the Southern Distinct Population Segment of green sturgeon.

Sturgeon Species	ESU/ DPS Name	Original Listing	Revised Listing(s)	Critical Habitat Designation
Green Sturgeon (*Acipenser medirostris*)	Southern Distinct Population Segment of North American green sturgeon	**FR notice:** 71 FR 17757 **Date:** April 7, 2006 **Classification:** Threatened	**FR Notice:** 75 FR 30714 **Date:** June 2, 2010 **Classification:** ESA 4(d) rule	**FR Notice:** 74 FR 52300 **Date:** October 9, 2009 **Classification:** Critical habitat designation

On July 29, 2015, NMFS published a 5-year review for the sDPS green sturgeon which concluded that the status of the sDPS green sturgeon should remain “threatened” (NMFS 2015). NMFS finalized a Recovery Plan for sDPS green sturgeon with strategies and actions to support recovery of the species on August 8, 2018 (NMFS 2018). The most recent 5-year review was published on October 26, 2021, which determined no change to the species status (NMFS2021).

2.2.7.1 Population Structure

The California Central Valley green sturgeon includes the genetically isolated sDPS that naturally spawns in the Sacramento River and its tributaries (71 FR 17757). This listing does not include the Northern DPS of green sturgeon that spawn north of the Russian River. The sDPS of green sturgeon are genetically unique from the Northern DPS due to their isolated breeding behavior endemic solely to the Sacramento river basin. The sDPS of green sturgeon is composed of a single, independent population, which principally spawns in the mainstem Sacramento River (Israel et al. 2009), though spawning has now been documented in both the Feather and Yuba Rivers as well (NMFS 2018).

2.2.7.2 Life History

The sDPS of 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 (from late April through late 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). The sDPS of green sturgeon predominantly spawn between (1) the Glenn-Colusa Irrigation Dam area (river kilometer 332.5) to Cow Creek (river kilometer 451) on the Sacramento River, (2) from the Fish Barrier Dam (river kilometer 108.5) to the Thermalito Afterbay Outlet (river kilometer 109) on the Feather River, and (3) at the base of the Daguerre Point Dam (river kilometer 19) on the Yuba River (NMFS 2018).

Eggs require water temperatures around 15°C (59°F) to hatch successfully, and within 10 days the larvae 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 prior to ocean entry (NMFS 2018). After reaching sub-adult sizes (approximately 91 centimeters), 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 (Erickson and Hightower 2007, Lindley et al. 2008, Lindley et al. 2011). Adult sDPS green sturgeon will spawn every two to six years on average, with higher returns upriver during high precipitation years (Benson et al. 2007, Erickson and Webb 2007, Heublein et al. 2009, Poytress et al. 2011, 2012).

2.2.7.3 Viability Status and Trends

Although McElhany et al. (2000) specifically addresses viable populations of salmonids, the science behind the concepts and viability parameters is applicable to sDPS green sturgeon. Since there were no reliable estimates of historical or current sDPS green sturgeon abundance, adult abundance criteria were developed using the best available information from general principles in conservation biology relating population viability to abundance (NMFS 2018). Multiple monitoring methods are needed to track sDPS green sturgeon spawning populations into the future, including continued annual surveys using DIDSON devices, egg mat surveys, subsampling of adult population for individual health, and acoustic tagging efforts.

2.2.7.3.1 Spatial Structure and Diversity

Under current conditions, all sDPS green sturgeon spawn in the Sacramento river basin. There is not enough scientific evidence to distinguish individual spawning subgroups. In general, sub-adult (from the age of ocean entry to age of first spawning) and adult North American green sturgeon spend most of their lives in oceanic environments where they occupy nearshore coastal waters from the Bering Sea, Alaska (Colway and Stevenson 2007) to Baja California, Mexico (Rosales-Casián and Almeda-Jauregui 2009). Telemetry data and genetic analyses suggest that sDPS green sturgeon generally occur from Graves Harbor, Alaska to Monterey Bay, California (Moser and Lindley 2007, Lindley et al. 2008, Lindley et al. 2011), traversing depths shallower than 110 meters (Erickson and Hightower 2007).

The rapid anthropomorphic shifting in Californian landscape from wetland to agriculture in the early 20th century likely had a negative impact on sDPS green sturgeon numbers. Historical sDPS green sturgeon spawning habitat may have extended up into the three major branches of the upper Sacramento River above the current location of Shasta Dam—the Little Sacramento River, Pit River, and McCloud River (NMFS 2009). Additional spawning habitat likely existed upstream of Oroville Dam on the Feather River (National Marine Fisheries Service 2009a). According to NMFS (2009a), reduction of sDPS green sturgeon spawning habitat to only 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 sDPS green sturgeon in other accessible habitats in the Central Valley (i.e., the Feather and Yuba Rivers) is limited, in part, by late spring and summer warm water temperatures and water flow. Currently, no documentation of historical spawning in the San Joaquin River basin has been documented but this is likely a consequence of major habitat alterations prior to potential observations being recorded by early ichthyologists or other observers. Similar to salmonids in the Central Valley, sDPS green sturgeon spawning in the major lower river tributaries to the Sacramento River are likely to be further limited if water temperatures increase over time. Dams and other barriers causing fragmentation and blocking access to suitable spawning grounds for migrating sturgeon is the leading threat in the decline of many sturgeon populations (Rochard et al. 1990, Auer 1996). Since 2014, NMFS has specifically identified the Daguerre Point Dam on the Yuba River and Sunset Pumps boulder weir on the Feather River as key barriers limiting sDPS green sturgeon recovery.

The VSP concept identifies a variety of traits that exhibit diversity within and among populations, and this variation has important effects on population viability (McElhany et al. 2000). For the sDPS of green sturgeon, traits include, but are not limited to fecundity, age at maturity, physiology, and genetic characteristics. Spawning habitat is used as a proxy for diversity because diversity is closely tied with abundance, distribution, and productivity.

Within the sDPS of green sturgeon, diversity is not yet well documented. Little is known about how current levels of diversity (e.g., genetic, life history) compare 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. Since the previous review, available spawning habitat has not increased; therefore, the recovery criteria of “no net loss in diversity” was not met.

2.2.7.3.2 Abundance and Productivity

Recovery criteria for abundance requires the adult sDPS green sturgeon census population to remain at or above 3,000 for three 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.

Due to sparse monitoring data for juvenile, sub-adult, and adult life stages in the Sacramento River and Delta, there are significant data gaps to describe the ecology of this species throughout their distribution range. Juveniles have been detected in the rivers on a yearly basis, with fluctuations of captured juveniles highly dependent upon water years (Thomas et al. 2014, Poytress et al. 2015, Mora et al. 2018). Yearly returns were calculated from 2007 to 2018, and no significant change in abundance trends has been determined for the population as a whole. Yearly adult spawner return estimates fluctuate between 336 to 1,236 individuals dependent upon annual precipitation percentages, for example, with wetter years being generally associated with higher returns (Mora et al. 2018).

The NMFS 2021 5-year review concluded no abundance and productivity-related recovery criteria have been met (NMFS 2021). The estimated total population of sDPS 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 spawner counts have also been less than 500 in the Sacramento River (Mora et al. 2018). Currently, there are no reliable estimates for spawner counts for the Feather and Yuba Rivers.

Parameters of sDPS 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-1990s at Red Bluff Diversion Dam and near the Glenn Colusa Irrigation District diversion show large variability between years. The highest count and density on record was over 30 sDPS green sturgeon per acre-feet of water volume sampled at Red Bluff in 2016, an order of magnitude higher than other years (USFWS 2016). In general, sDPS green sturgeon year class strength appears highly variable, with overall abundance dependent upon a few successful spawning events (75 FR 30714 2010). Other indicators of productivity, such as data for cohort replacement ratios and spawner abundance trends, are not available for sDPS green sturgeon.

2.2.7.4 Recovery

Recovery plan actions and research priorities were developed to achieve recovery criteria listed above and described in Green Sturgeon Recovery Plan (National Marine Fisheries Service 2018e). Each action and research priority are defined as follows:

- Priority 1: action that must be taken to prevent extinction or to identify those actions necessary to prevent extinction;
- Priority 2: an action that must be taken to prevent a significant decline in population numbers, habitat quality, or other significant negative impacts short of extinction; and
- Priority 3: all other actions necessary to provide for full recovery of the species (NMFS 2018).

Each action and research priority falls into six threat categories concerning passage, water flow and temperature, entrainment, take, contaminants, and environmental variation. Undertaking actions in these areas is expected to have the biggest impact in terms of sDPS green sturgeon recovery (NMFS 2018).

There are five criteria for recovery stated in the sDPS green sturgeon 5-year review, and each criterion is determined by successful goal parameters met on a yearly basis (NMFS 2018, 2021): (1) adult population yearly average of 3,000 mature adults, with 500 spawners present in the rivers in any given year for at least 66 years; (2) yearly successful spawning in at least two rivers within their historical range, determined by consistent presence of larvae for at least 20 years; (3) a net positive trend in juvenile and sub-adult abundance for at least 20 years; (4) a population characterized by a broad distribution of class sizes representing multiple cohorts that are stable over the long term for at least 20 years; and (5) no net loss of sDPS green sturgeon diversity from current levels. As of 2026, these criteria have not been met on a yearly basis, reaffirming that the status of sDPS green sturgeon remains listed under the ESA as threatened.

The 2021 5-year review analyzed the five major threat-based recovery criteria to sDPS green sturgeon: (1) altered habitat, (2) overutilization, (3) disease/predation, (4) inadequacy of regulatory mechanisms, and (5) other natural/man-made factors (NMFS 2021). There has been no change in the analysis of these threat-based recovery criteria from the previous 5-year review, and none of the threat-based recovery criteria have been met.

2.2.7.5 Environmental Variability

Threats from altered trends in environmental variability are considered “high” or “very high” in many criteria involved with sDPS green sturgeon recovery. These trends include: (1) changes in flow rates from varying yearly precipitation levels; (2) salinity intrusion into freshwater habitats from rising sea levels (projected 33 percent increase in the 21st century); (3) loss in habitat due to various environmental/anthropogenic factors; (4) altered prey base due to shifting habitat conditions; (5) increased water temperatures from higher frequencies of dry years, reduced spring snowpack, and reduced spring flows; (6) increased threat from harmful algal blooms within the San Francisco Bay Delta Estuary and Sacramento-San Joaquin inland delta; and (7) other altered environmental characteristics from increased/continued anthropogenic actions (Knowles and Cayan 2002, CH2M HILL 2014, NMFS 2018, NMFS 2021). Additional studies are needed to understand the trends in changing environmental conditions in order to determine best managerial practices for the future.

2.2.7.6 Summary

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 and NMFS concluded sDPS green sturgeon remains at a moderate to high risk of extinction (NMFS 2021). Recovery criteria have not been met on a yearly basis as of the latest 5-year review, and the fact that the vast majority of sDPS green sturgeon spawning occurs in the mainstem Sacramento River leaves the species highly susceptible to catastrophic events during spawning season.

The sDPS of green sturgeon remains at substantial risk of future population decline (NMFS 2021). The principal threat is the reduction in available spawning habitat due to dams on Central Valley rivers. The potential threats include enhanced vulnerability due to the reduction of spawning habitat into one reach 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 sDPS 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, subadult, and adult life stages.

Viability is defined as an independent population having a negligible risk of extinction due to threats from demographic variation, local environmental variation, and genetic diversity changes over a 100-year timeframe (McElhany et al. 2000). 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 and NMFS concluded the sDPS remains at a moderate to high risk of extinction (NMFS 2021).

2.2.8. Designated Critical Habitat for Southern Distinct Population Segment of Green Sturgeon

The geographical range of designated critical habitat includes the following:

- In freshwater;
  - The Sacramento River from the Sacramento I-Street Bridge to Keswick Dam, including the Sutter and Yolo bypasses and the Lower American River from the confluence with the mainstem Sacramento River upstream to the highway 160 bridge.
  - The Feather River from its confluence with the Sacramento River upstream to the Fish Barrier Dam.
  - The Yuba River from the confluence with the Feather River upstream to Daguerre Point Dam.
  - The Sacramento-San Joaquin Delta (as defined by California Water Code section 12220, except for listed excluded areas).
- In coastal bays and estuaries; the geographical range includes:
  - San Francisco, San Pablo, Suisun, and Humboldt Bays in California.
  - Coos, Winchester, Yaquina, and Nehalem Bays in Oregon.
  - Willapa Bay and Grays Harbor in Washington.
  - The lower Columbia River estuary from the mouth to river mile 46.

The action area for the proposed project includes designated critical habitat for the sDPS of green sturgeon. The designated critical habitat for sDPS green sturgeon lists the essential PBFs (74 FR 52300), 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 (i.e., structural features of substrates). 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 (i.e., 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 (i.e., 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 (i.e., 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 (i.e., chemical characteristics) necessary for normal behavior, growth, and viability of all life stages.

Physical and biological features for sDPS green sturgeon in the lower reaches of the Sacramento River and the Delta have been significantly altered from their historical condition. Green sturgeon exhibit very different life history characteristics from those of salmonids and therefore use habitat within the action area differently. They are thought to exhibit rearing behavior in the lower reaches of the Sacramento River and the Delta as juveniles and subadults prior to migrating to the ocean, though little is known about the behavior of these life stages in the Delta (Radtke 1966, NMFS 2015). Loss of riparian habitat complexity in the Sacramento River and Delta has likely posed less of a threat because these life stages are benthically oriented. However, it is likely that reverse flows generated by Delta water exports affect the sDPS green sturgeon juvenile and subadult life stages to some degree as evidenced by juvenile captures at CVP and SWP salvage facilities during high water years (California Department of Fish and Wildlife 2026).

Currently, many of the PBFs of sDPS green sturgeon are degraded and provide limited high quality habitat. Factors that lessen the quality of migratory corridors for juveniles include unscreened or inadequately screened diversions, altered flows in the Delta, and presence of contaminants in sediment. Although the current conditions of their designated 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.

2.3. Action Area

"Action area" means all areas to be affected directly or indirectly by the federal action and not merely the immediate area involved in the action (50 CFR 402.02). The Action Area for the proposed action is based on the elements described in section 1.3, Proposed Federal Action, of this opinion.

2.3.1. Construction-related Activities for the Proposed Action

The proposed action's construction of the two new intake facilities would provide new points of diversion in the north Delta along the Sacramento River (refer to Figure 1, which is in section 1.3 and copied below again for convenience). The action area also includes land between Clifton Court Forebay and Bethany Reservoir, where the Bethany Complex and associated features will be constructed. Further details on the proposed action area are found in the BA, Chapter 3, *Description of the Proposed Action*, Section 3.1.3, *Summary of Proposed Action* (ICF 2025).

ESA-listed species, designated critical habitat, and MSA-managed species and habitat under NMFS authorities primarily occur within the Sacramento River channel portion of the action area. Aspects of the proposed action, such as tunneling, occur underneath other waterways and habitat areas for anadromous fish and may be impacted by acoustics effects. Therefore, the action area includes the footprint for those construction activities and facilities as well (Figure 1). In summary, the action area consists of the footprint of the proposed facilities, and includes construction of the intakes within the Sacramento River channel, and 1,000 feet of the river-channel downstream of in-channel construction that are expected to be affected by construction activities (Figure 6, Figure 7).

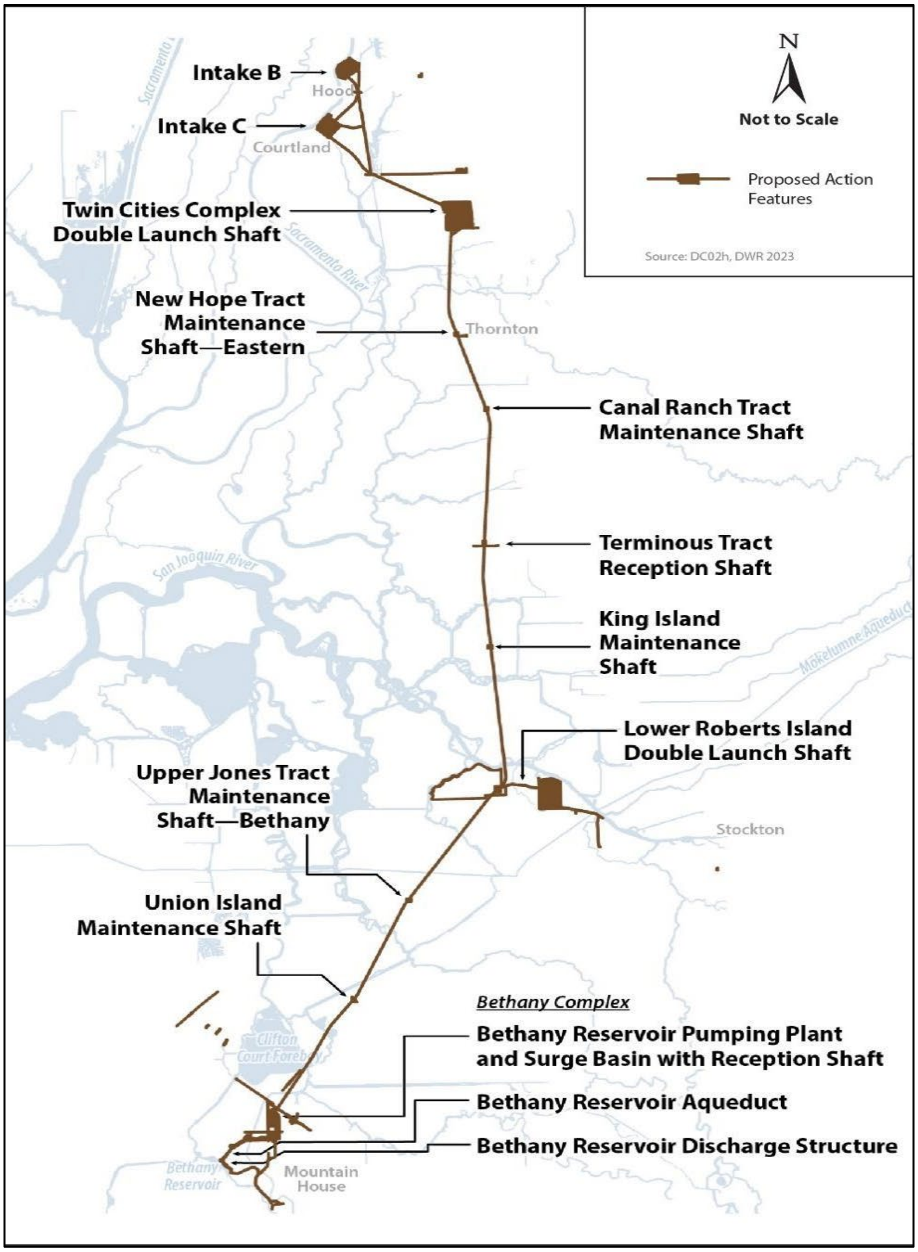


Figure 1 (again). Overview of the Proposed Project facilities that will be constructed within the Sacramento- San Joaquin River Delta Figure from the BA (ICF 2025).

2.3.2. Framework-Level Component: Operations and Maintenance associated with DCP

The proposed action includes the future operations and maintenance of the DCP in coordination with current SWP facilities and some CVP facilities. Based on available information for the proposed action under the framework programmatic approach, we expect the action area for the proposed action to also include the following:

(1) Shasta and Keswick reservoirs, and the Sacramento River from Keswick Reservoir downstream to and including the Sacramento-San Joaquin Delta; (2) San Francisco Bay and Suisun Marsh. and (3) the nearshore Pacific Ocean coastal area off California.

For future ESA consultations that analyze and exempt incidental take of ESA-listed anadromous species for the operations and maintenance of the DCP facilities, the action area may be re-assessed based on updated information and operational details.

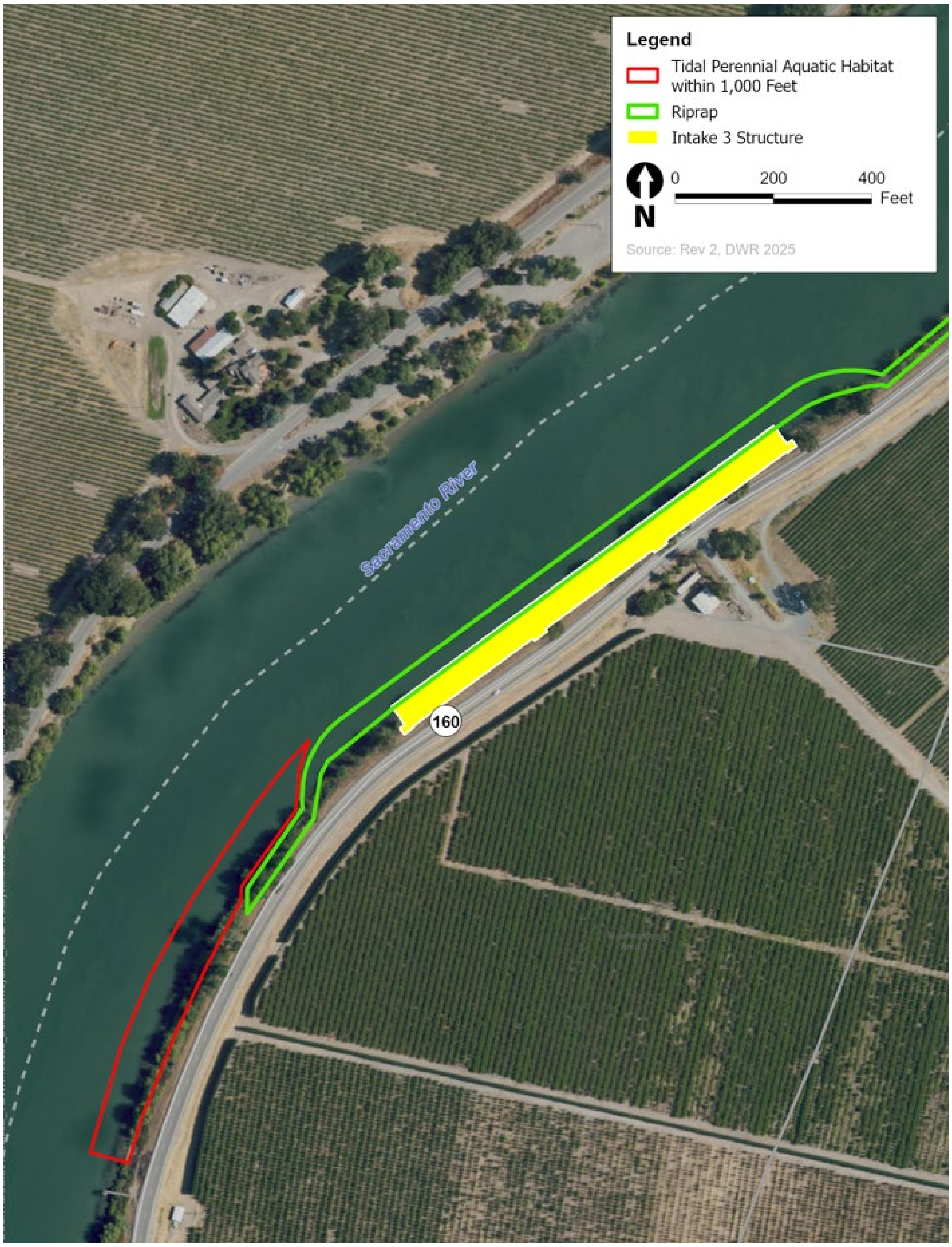


Figure 6. Close up view of the Sacramento River channel with the footprint of Intake B (yellow polygon), proposed riprap area (green outline), and 1,000 feet downstream of the construction area (red outline) where water quality impacts may occur due to construction activities. Figure from DWR and ICF.

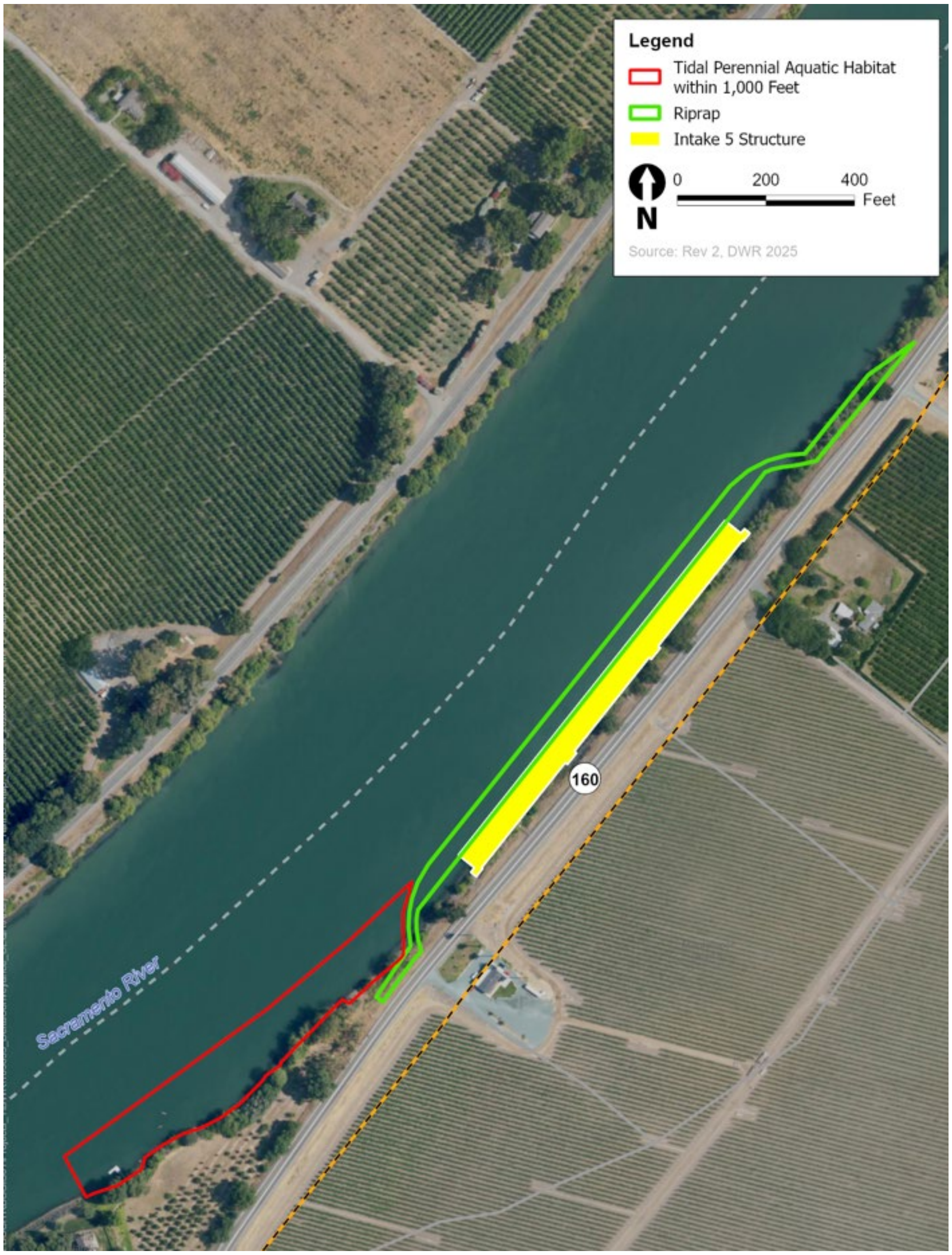


Figure 7. Close up view of the Sacramento River channel with the footprint of Intake C (yellow polygon), proposed riprap area (green outline), and 1,000 feet downstream of the construction area (red outline) where water quality impacts may occur due to construction activities. Figure from DWR and ICF.

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).

In this opinion, the effects of past CVP and SWP operations are also part of the environmental baseline. Effects of those actions have been analyzed through past consultation and contributed to the current condition of the species and critical habitat in the action area. Other past, present, and ongoing impacts of human and natural factors (including proposed federal projects that have already undergone ESA section 7 consultation) contributing to the current condition of the species and critical habitat in the action area are also included in the environmental baseline. With respect to the analysis of extant dams and their effects on the proposed action, the existence of the CVP and SWP dams and their past operations are part of the baseline contributing to the status of the species. In the 2024 LTO opinion, NMFS considers in the proposed action's effects analysis the future daily, monthly, seasonal, and discretionary operational decisions. These decisions include whether to store or release water from CVP and SWP reservoirs and can have effects downstream and through the Delta, relative to a future baseline condition. Depending on flow, quality (e.g., temperature), timing, and location of the water released, as well as life stage and species affected, these effects can be beneficial and adverse.

Since Euro-American settlement of the Central Valley in the mid-1800s, populations of native Chinook salmon, steelhead, and green sturgeon have declined dramatically, largely due to factors that completely reshaped the aquatic ecosystem. These factors include dam construction, water management, hydropower facilities, levee construction, gold mining, urbanization, and conversion of landscapes to agriculture. Many of these changes eliminated or blocked access to important habitats and reduced the abundance, productivity, and distribution of Central Valley salmonids and sturgeon. Habitat simplification, fishing, hatchery impacts, and other stressors led to the loss of genetic and phenotypic (life history, morphological, behavioral, and physiological) diversity in Central Valley salmonids, reducing their capacity to cope with a variable and changing climate (Herbold et al. 2018). Land use changes to support and protect California's rapidly increasing human population combined with substantial and widespread water development, including the construction and operation of the CVP and SWP, have been accompanied by significant declines in nearly all species of native fish (State Water Resources Control Board 2017). The freshwater and estuarine environment has been so dramatically altered by habitat loss and water management that the anadromous life history strategy may no longer be sustainable for Central Valley salmon (Michel 2018).

Central Valley listed fish species are also culturally significant, as many tribes relied on the presence of a healthy ecosystem supporting these fish for their livelihood and for food, cultural, and ceremonial practices. Reduction of salmonid and sturgeon populations and landscape alterations have contributed to the detrimental impacts experienced by California tribes following Euro-American colonization.

Altogether, dams, levees, land conversion to agriculture, urbanization, water management, and gold mining are the main landscape-scale factors that have altered the Central Valley environment to its current condition, with environmental variation providing additional impacts. These landscape-scale factors and their impact on Central Valley listed species and their designated critical habitat are discussed below, followed by a section on more localized, but also important, factors adversely affecting listed species in the Central Valley.

2.4.1. Central Valley Project and State Water Project Operations and Existing Structures

Operations of dams across the Central Valley have resulted in major alteration of water temperatures and flows throughout the year. Large amounts of water are exported throughout the Central Valley to support agricultural, and to a lesser extent industrial and urban demands. Reclamation and DWR implement the coordinated operation of the CVP and SWP to maximize water supply delivery and optimize power generation consistent with applicable laws, contractual obligations, and agreements. Coordinated operations increase operational flexibility by focusing on non-operational measures to avoid significant adverse effects based on the conditions estimated to occur through 2030 (NMFS 2024a). Reclamation and DWR store, divert, and convey water in accordance with existing water contracts and agreements, including water service and repayment contracts, settlement contracts, exchange contracts, and refuge deliveries, consistent with water rights and applicable laws and regulations.

The CVP and SWP combined are one of the world's largest water storage and conveyance systems with both the federal and the state portions of the projects capable of storing, diverting upstream, and exporting millions of acre-feet of water away from the Delta each year. The large volumes exported through the South Delta, combined with the location of the pumps in the South Delta, result in significantly modified hydrologic and biological systems (Cummins et al. 2008).

The Environmental Baseline includes the past and current operation of the CVP and SWP and the presence of existing structures such as dams, reservoirs, export and fish salvage facilities, canals, and other related infrastructure. Since the early 1990s, NMFS has evaluated past and current operations for effects of NMFS listed species through previous ESA consultations. The biological opinions resulting from these consultations include many protective actions required through reasonable and prudent measures and terms and conditions. These actions are also part of the Environmental Baseline (NMFS 2004, 2009, 2019, 2024a).

2.4.2. Impacts of Dams and Other Passage Impediments

Construction of dams and other structures in the Central Valley has blocked anadromous salmonids from most of their historical spawning and initial rearing habitat, eradicating most populations of SR winter-run Chinook salmon, CV spring-run Chinook salmon, and CCV steelhead that were present prior to Euro-American contact. Between 72 to 100 percent of the original Chinook salmon spawning and holding habitat in the Central Valley drainage is no longer accessible due to dam construction (Figure 8; Yoshiyama et al. 2001, Cummins et al. 2008, NMFS 2014). SR winter-run Chinook salmon lost three of its four historical spawning populations following construction of Keswick and Shasta Dams. Approximately 15 of the 18 or 19 historical populations of CV spring-run Chinook salmon are extirpated, with their historical spawning habitats located upstream of impassable dams (Lindley et al. 2007). Currently, impassable dams block access to 80 percent of historically available habitat and block access to all historical spawning habitat for about 38 percent of the historical populations of CCV steelhead (Lindley et al. 2006). Modeling by Mora et al. (2009) indicates about nine percent of historical sDPS green sturgeon habitat is blocked by dams. Impassable barriers are considered the main threat to sDPS green sturgeon because migration corridors are blocked and migration cues (water flow) are altered (NMFS 2018). These impassable barriers have significant adverse effects to the overall viability of the various ESU and DPS'.

Prior to 2012, seasonal closure of Red Bluff Diversion Dam limited sDPS green sturgeon spawning to habitats that were likely unsuitable for egg incubation in some years. With the permanent decommissioning of Red Bluff Diversion Dam gates, sDPS green sturgeon have access to suitable spawning and incubation areas on the Sacramento River under all conditions (e.g., droughts). ACID (Anderson-Cottonwood Irrigation Dam), approximately five miles downstream of Keswick Dam (river mile 302), remains a potential passage barrier to spawning sDPS green sturgeon on the Sacramento River. The percentage of the sDPS green sturgeon spawning run using the uppermost five miles of the Sacramento River between ACID and Keswick Dam is unknown, but is currently estimated to be small based on the absence of acoustic tag detections in this reach.

Flood control weirs of the Yolo and Sutter bypasses can serve as barriers to salmon, CCV steelhead, and sDPS green sturgeon migration during high water events (Thomas et al. 2013). During some high flow events, these fish enter the Yolo and Sutter bypasses and become stranded when the water recedes. In some cases, adult sturgeon remain stranded in small, isolated bypass ponds through the summer or fall, making them vulnerable to poaching and other sources of mortality. In 2011, 24 sDPS green sturgeon individuals were rescued from the Yolo and Sutter bypasses (Thomas et al. 2013). Since relocation efforts cannot prevent all mortality associated with stranding, and the loss of even a few adult fish periodically should be avoided, it is important to construct structures at these weirs that allow volitional passage of upstream migrating sDPS green sturgeon.

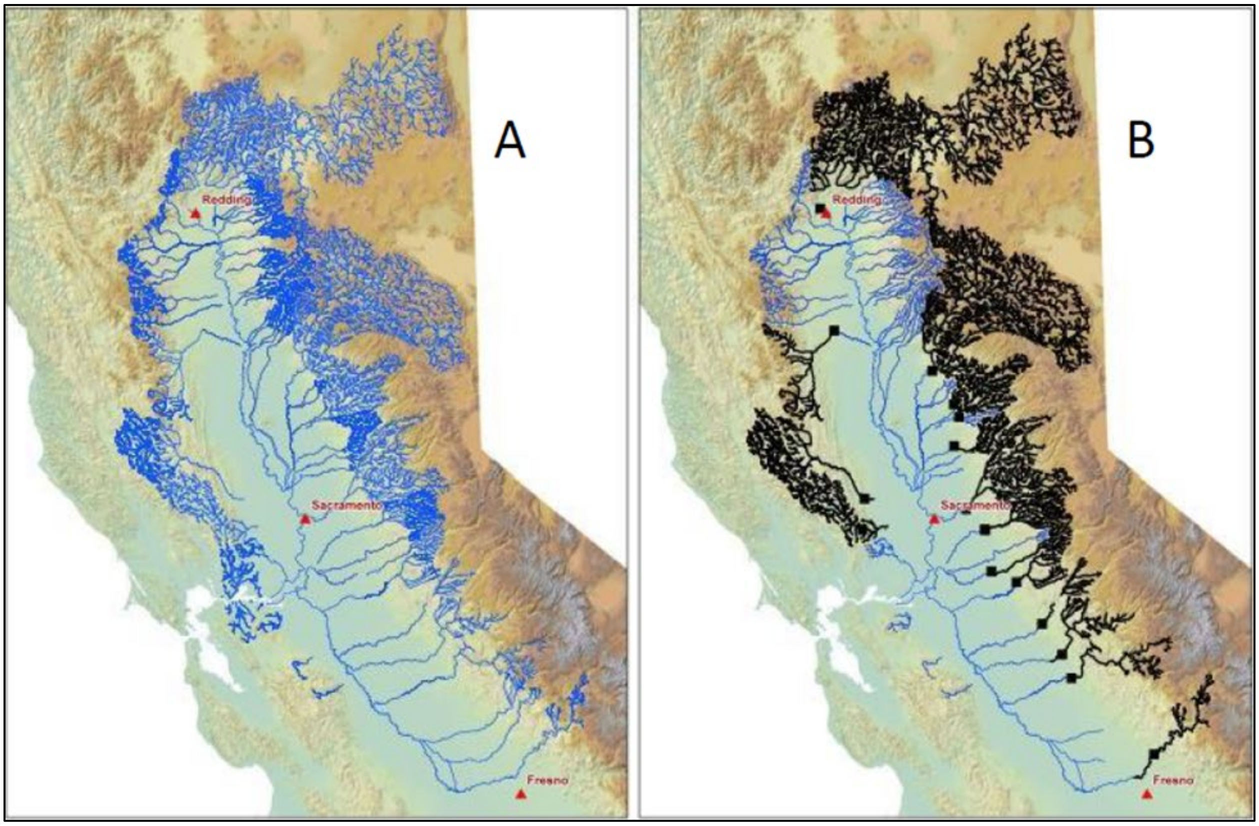


Figure 8. Historical habitat accessible to salmonids (A, in blue) and lost upstream habitat (B, in black) from construction of impassable dams (black squares). Remaining anadromous salmon habitat is confined to the valley floor (B, in blue).

2.4.3. Levees

Levee construction throughout the Sacramento and San Joaquin River watersheds has resulted in a landscape where less than five percent of the native wetland, riparian, and floodplain habitats remain (Whipple et al. 2012). Ninety-three percent of historical floodplain rearing habitat is no longer accessible due to levee construction (Figure 9, Herbold et al. 2018). The shallow water habitats historically providing food-rich areas for rearing salmonids have been almost entirely replaced by urban and agricultural landscapes (Herbold et al. 2018). Because juvenile salmon grow faster when they have access to inundated floodplain habitat than in adjacent river channels (Sommer et al. 2001, Jeffres et al. 2008), it is likely overall salmonid productivity has been diminished with the majority of Sacramento and San Joaquin Rivers confined by levees in all but the wettest years.

Central Valley salmonids evolved with access to a diverse suite of shallow water habitats, which promotes resilience to a variable climate. Now adaptations to historical conditions are mismatched with the current simplified river systems. Important sources of habitat diversity for juvenile salmonids in the current system are Yolo and Sutter flood bypasses, where salmonids can access food rich floodplain habitat under high flows. Still, with so little freshwater habitat now available in the Central Valley, habitat heterogeneity has decreased, and salmonid population diversity and resilience has decreased (Figure 10) and vulnerability to climate variability and change has increased since the pre-dam period (Herbold et al. 2018).

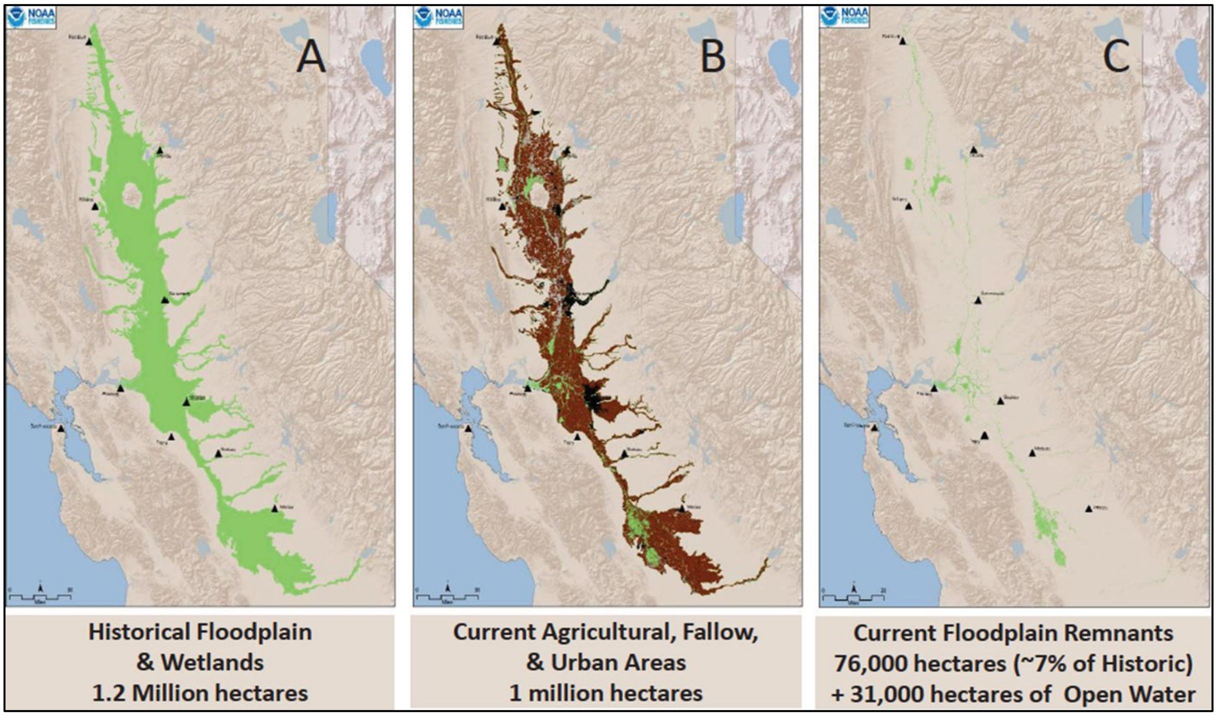


Figure 9. (A) Historical floodplain and Delta wetlands habitat; (B) remnant floodplain and wetland habitat currently in agricultural lands, fallow lands, or urban areas; and (C) floodplain and wetland remnants.

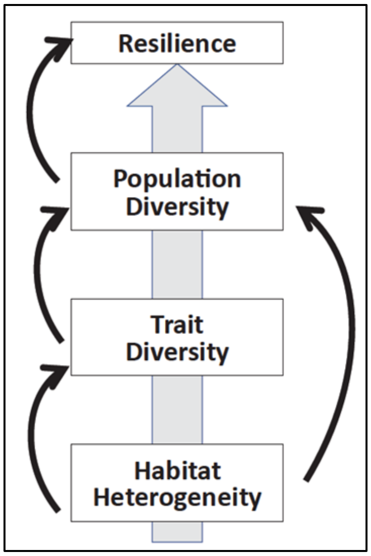


Figure 10. Conceptual model of how habitat heterogeneity creates trait and phenotypic diversity to promote population resilience. Source: (Herbold et al. 2018)

2.4.4. Environmental Variability

A 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 variability. The globally-averaged combined land and ocean surface temperature data, as calculated by a linear trend, show a warming of approximately 1°C (1.8°F) from 1901 through 2016 (Jay et al. 2018). The *IPCC Special Report on the Impacts of Global Warming* (IPCC 2023) noted that human-induced warming reached a global surface temperature of 1.1°C (2.0°F) above pre-industrial levels by 2020, and global surface temperature has increased faster since 1970 than in any other 50-year period over at least the last 2000 years.

Annual average temperatures have increased by 1.8°C (3.2°F) across the contiguous United States since the beginning of the 20th century, with Alaska warming faster than any other state and twice as fast as the global average since the mid-20th century (Jay et al. 2018). Warming across the globe has led to more frequent heat waves in most land regions and an increase in the frequency and duration of marine heatwaves (IPCC 2023). Average warming across the globe up to 1.5°C (2.7°F) as compared to pre-industrial levels is expected to lead to regional changes in extreme temperatures and increases in the frequency and intensity of precipitation and drought (IPCC 2023).

From 2012 to 2016, California experienced the most extreme drought since instrumental records began in 1895. A growing body of evidence suggests that environmental variability has increased the likelihood of extreme droughts in California (California Department of Water Resources 2018). California experienced well below average precipitation during the 2012-2016 drought, as well as record high surface air temperatures in 2014 and 2015 and record low snowpack in 2015 (Williams et al. 2016). Paleoclimate reconstructions suggest the 2012-2016 drought was the most extreme in the past 500 to 1000 years (Williams et al. 2016, Williams et al. 2020, Williams et al. 2022). Anomalously high surface temperatures substantially amplified annual water deficits during 2012-2016. California entered another period of drought from 2020-2022. These drought periods are now likely part of a larger drought event (Williams et al. 2022). Recent multi-year drought periods, as well as the increased incidence and magnitude of wildfires in California, have likely been exacerbated by environmental variability (Diffenbaugh et al. 2015, Williams et al. 2019, Williams et al. 2020, Williams et al. 2022).

Warmer temperatures associated with environmental variability reduce snowpack and alter the seasonality and volume of seasonal hydrograph patterns (Cohen et al. 2000). Central California has shown trends toward warmer winters since the 1940s (Dettinger and Cayan 1995). An altered seasonality results in runoff events occurring earlier in the year due to a shift in precipitation falling as rain rather than snow (Roos 1991, Dettinger et al. 2004). Specifically, the Sacramento river basin annual runoff amount for April to July has been decreasing since about 1950 (Roos 1987, Roos 1991). Increased temperatures influence the timing and magnitude patterns of the hydrograph and strain the ability of reservoir water managers to provide cold water releases for salmonids.

The magnitude of snowpack reductions is subject to annual variability in precipitation and air temperature. Large spring-snow-water-equivalent percentage changes, late in the snow season, are due to a variety of factors including reduction in winter precipitation and temperature increases that rapidly melt spring snowpack (Vanrheenen et al. 2004). Factors modeled by

Vanrheenen et al. (2004) show that melt season shifts to earlier in the year, leading to a large percent reduction of spring snow-water-equivalent (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-snow-water-equivalent (as a percentage) would be greatest in the region of the Sacramento River watershed where snowpack is shallower than in the San Joaquin River watersheds to the south.

Warming attributed to environmental variability is expected to affect Central Valley anadromous salmonids and sDPS green sturgeon in the future. Because Central Valley salmon, CCV steelhead, and sDPS green sturgeon runs are restricted to low elevations as a result of impassable dams, if the climate warms by 5°C (9°F), it is questionable whether any Central Valley Chinook salmon and sDPS green sturgeon populations can persist (Williams 2006, NMFS 2018). Based on an analysis of multiple climate models and emission scenarios over a reference temperature from 1951 to 1980, the most plausible projection for warming over Northern California is 2.5°C (4.5°F) by 2050 and 5°C by 2100, with a modest decrease in precipitation (Dettinger 2005). Chinook salmon in the Central Valley are at the southern limit of their range, and warming will shorten the period that low elevation habitats can support salmonid life stages. Projected 33 percent salinity increases in the Sacramento river basin in the 21st century due to environmental variability may result in declining habitat quality and food web productivity; and could potentially alter the salinity and prey base in sDPS green sturgeon juvenile rearing habitat and adult migration corridors (CH2M HILL 2014, NMFS 2018).

There is a high threat posed by altered water temperatures due to environmental variability. In the Sacramento River basin, environmental variability models predict increased air temperatures in the Central Valley and surrounding mountains (Ficklin et al. 2012), altered precipitation patterns with a higher frequency of dry years, reduced spring snowpack, and reduced spring flows (Knowles and Cayan 2002, CH2M HILL 2014). Water temperatures in the Sacramento River basin could also increase (CH2M HILL 2014). A warming climate with continued changes in precipitation patterns may influence reservoir operations and thus influence water temperature and flow that fish experience in the Central Valley.

Growth and survival rates of salmon in the California Current off the Pacific Northwest can be linked to fluctuations in ocean conditions related to Pacific Decadal Oscillation and the El Nino-Southern Oscillation conditions and events, as well as the recent northeast Pacific marine warming phenomenon (also known as “the blob”; Peterson et al. 2006, Wells et al. 2008). Evidence suggests early marine survival for juvenile salmon is a critical phase in their survival and development into adults. In marine environments, ecosystems and habitats important to juvenile and adult salmonids are likely to experience changes in temperatures, circulation, water chemistry, and food supplies (Feely et al. 2004, Doney et al. 2009, Osgood 2008, Turley 2008, Abdul-Aziz et al. 2011, Doney et al. 2012). Some of these changes, including an increased incidence of marine heat waves, are likely already occurring, and are expected to increase (Frölicher et al. 2018).

The correlation between various environmental indices that track ocean conditions and salmon productivity in the Pacific Ocean, both on a broad and a local scale, provides an indication of the role they play in salmon survival in the ocean. Moreover, when discussing the potential extinctions of salmon populations, climate patterns would not likely be the sole cause, but could certainly increase the risk of extinction when combined with other factors, especially in ecosystems under stress from humans (Francis and Mantua 2003).

2.4.5. Invasive Species/Food Web Disruption

During development of the Central Valley Chinook Salmon and Steelhead Recovery Plan (NMFS 2014), invasive species/food web disruption was identified as a primary stressor affecting the recovery of the species. This threat primarily affects the juvenile rearing and out-migration life stage of these species through the Delta and bays.

Invasive species include plants and animals and most were introduced to the Delta unintentionally through ship ballast water. However, some species have been introduced intentionally by resource agencies for sportfishing or forage. Invasive aquatic plants have become established in many areas of the Delta. Establishment of invasive aquatic plants can harm or kill native aquatic species because they form dense mats that block sunlight and deplete oxygen supplies. Most of these aquatic weeds were introduced to the Delta unintentionally and include water hyacinth (*Eichhornia crassipes*), hydrilla (*Hydrilla verticillata*), and egeria (*Egeria densa*). Within the Delta, the construction of levees and the conversion of adjacent riparian communities to other land uses have substantially changed the ecosystem. These changes have stressed native aquatic flora and fauna allowing infestation of invasive aquatic weeds. Invasive weeds flourish in the disturbed environment and may reduce food web productivity, potentially harming fish and wildlife (CALFED Bay-Delta Program 2000).

The majority of clams, worms, and bottom-dwelling invertebrates currently inhabiting the Delta are non-native species. Non-native species also comprise an increasing proportion of the zooplankton and fish communities in the Bay-Delta system. It is estimated that a new non-native species is identified in the Bay-Delta every 15 weeks (CALFED Bay-Delta Program 2000). Many fish known to prey on juvenile anadromous salmonids were introduced by resource agencies to provide sportfishing. These fish include striped bass, American shad (*Alosa sapidissima*), and largemouth bass (*Micropterus salmoides*). Introductions have been detrimental to many native species, many of which have declined precipitously or become extinct through predation and competition for resources (CALFED Bay-Delta Program 2000). At the same time, some non-native species are performing vital ecological functions, such as serving as primary consumers of organic matter or as a food source for native fish and other wildlife populations (CALFED Bay-Delta Program 2000).

One of the most important habitat attributes of the riverbed to listed anadromous fish species in the action area is the production of food resources for rearing and migrating juveniles, such as drifting and benthic invertebrates, forage fish, and fish eggs. Benthic invertebrates, such as oligochaetes and chironomids (dipterans), are the predominant juvenile salmonid and sDPS green sturgeon food items produced in the silty and sandy substrates of the action area. Although specific information on food resources for sDPS green sturgeon within freshwater riverine systems is lacking, they are presumed to be generalists and opportunists that feed on similar prey to other sturgeons (Israel and Klimley 2008), such as the population of white sturgeon (*Acipenser transmontanus*) present and coexisting with sDPS green sturgeon in the Sacramento River basin. Seasonally abundant drifting and benthic invertebrates have been shown to be the major food items of white sturgeon in the lower Columbia River (Muir et al. 2000). As sturgeon grow, they begin to feed on oligochaetes, amphipods, smaller fish, and fish eggs as represented in the diets of white sturgeon (Muir et al. 2000).

Historically, the San Joaquin River was an important source of nutrients to the Delta. Most of the San Joaquin River is now diverted from the South Delta by CVP and SWP operations. The loss in nutrients has contributed to an overall decrease in fertility of the Delta, limiting its ability to produce food (NMFS 1997). Additionally, pumping operations may result in a loss of zooplankton, reducing their abundance in the Delta. Poor food supply may limit the rearing success of SR winter-run Chinook salmon. Extensive areas of the Delta are below mean high tide, but because of levees and flap gates installed throughout the Delta, these areas are no longer subject to tidal action. This effectively reduces the volume of water subject to tidal mixing and the size of the Delta floodplain. Reduced residence time of Delta water and associated nutrients restricts the development of food web organisms (CALFED Bay-Delta Program 2000).

The Salmon and Sturgeon Assessment of Indicators by Life Stage (SAIL) synthesis teams (Windell et al. 2017) found predation by non-native species affected SR winter-run Chinook salmon (but also CV spring-run Chinook salmon and CCV steelhead) egg survival, timing, and condition and juvenile survival, residence time/migration, and growth.

2.4.6. Loss of Riparian Habitat and Instream Cover

The Central Valley Chinook Salmon and Steelhead Recovery Plan (NMFS 2014) identified loss of riparian habitat and instream cover as a primary stressor affecting the recovery of the species. This threat primarily affects the juvenile rearing and out-migration life stage of these species, from the upper reaches of their watershed of origin through the Delta. Effects of the action that contribute to the loss of riparian habitat and instream cover are likely to result in a probable change in fitness from reduced growth and or survival probability.

Loss of riparian habitat and instream cover is the process where access to riparian habitat and instream cover is lost either by the construction of river features (i.e., levees or flood control structures) or river channelization that disconnect the river from its historical floodplain. Construction of river features involves rip-rapping the river bank and removing vegetation along the bank and upper levees removes instream and overhead cover in nearshore areas. This has negative effects on riparian habitat because riparian species, seedlings, as well as woody debris to deposit elsewhere are no longer naturally recruited. Woody debris and overhanging vegetation within shaded riverine aquatic habitat provide escape cover for juvenile salmonids from predators as well as thermal refugia. Aquatic invertebrates are dependent on the organic material provided by a healthy riparian habitat, and many terrestrial invertebrates also depend on this habitat. Studies have demonstrated a significant portion of the juvenile Chinook salmon diet is composed of terrestrial insects, particularly aphids, which are dependent on riparian habitat (NMFS 1997).

The SAIL synthesis teams identified relevant pathways by which loss of riparian habitat and instream cover is likely to affect SR winter-run Chinook salmon (and similar conceptual models can apply to CV spring-run Chinook salmon and CCV steelhead), as well as how it is likely to interact with other stressors. Specifically, (Windell et al. 2017) focused on the growth and condition of juveniles as being affected by access to riparian habitats. Habitats that provide refuge from high water velocity or predators, without depleting food supply, function to increase growth rates by reducing energy demand to obtain a given food supply. Growth rate may then influence migration timing and success, where a higher growth rate is associated with earlier smoltification and faster downstream migration (Beckman et al. 2007). However, the inability of a juvenile in a particular habitat to supply its metabolic demand and achieve some threshold growth rate may also serve as a strong cue to leave that habitat and migrate downstream, and a satisfactory food supply may induce a juvenile to remain in the habitat for a longer duration of time to rear.

2.4.7. Loss of Natural River Morphology and Function

The Central Valley Chinook Salmon and Steelhead Recovery Plan (NMFS 2014b) identified loss of natural river morphology and function as a primary stressor affecting the recovery of the species. This threat primarily affects the juvenile rearing and out-migration life stage of these species from the upper reaches of their watershed of origin through the Delta.

Loss of natural river morphology and function is the result of river channelization and confinement, decreasing riverine habitat complexity, which then leads to a decrease in the quantity and quality of juvenile rearing habitat. The SAIL synthesis teams also identified relevant pathways by which loss of natural river morphology and function is likely to impact SR winter-run Chinook salmon (and similar conceptual models can apply to CV spring-run Chinook salmon and CCV steelhead) as well as how it is likely to interact with other stressors. Specifically, (Windell et al. 2017) focused on the impact of channelized, leveed, and rip-rapped reaches potentially having low habitat complexity, low abundance of food organisms, and offering little protection from predators—factors which juveniles are dependent on for growth and successful survival.

Water depth modification caused by non-point source sediment was ranked in the Recovery Plan as a high threat to sDPS green sturgeon adults within the Sacramento river basin and a medium threat to other life stages in the Sacramento River basin (NMFS 2018). Impoundments and mitigation and restoration efforts were also considered as contributing to the water depth modification threat to all life stages in the basin. Non-point source sediment includes runoff from urban areas, agriculture, forests, irrigated lands, landfills, livestock, mining operations, nurseries, orchards, etc. Removal of riparian vegetation results in increased erosion and input of fine grain material into the water. Sediment from these sources can be deposited in pools. The sDPS of green sturgeon require deep pools for spawning and holding. Large impoundments (e.g., Oroville and Shasta reservoirs) that reduce the frequency of high flow events may limit pool scouring and result in a reduction of pool depth. Survival and development of early life stages may also be impacted by non-point source sediments through altered turbidity and substrate composition. At the time the Recovery Team conducted its assessment, the high threat ranking for adults was attributed, in part, to the impact of water depth modification on the quantity and habitat quality of deep pools. Mora (2016) indicates 50 to 125 areas with greater than 5-meter depth available on the mainstem Sacramento River depending upon the year. It is uncertain as to whether all of these pools supply sufficient habitat for spawning and holding in terms of depth and substrate.

2.4.8. Loss of Floodplain Habitats

Loss of floodplain habitat and loss of wetland function have been identified as primary stressors affecting the recovery of Central Valley salmonid species (NMFS 2014b) and sDPS green sturgeon (NMFS 2018). This threat primarily affects the juvenile rearing and out-migration life stage of these species from the upper reaches of their watershed of origin through the Delta.

Although riverine floodplains support high levels of biodiversity and productivity, they are also among the most converted and threatened ecosystems globally (Opperman et al. 2010). In California, more than 90 percent of wetlands have been lost since the mid-1800s (Garone 2011, Hanak et al. 2011). Loss of floodplain habitat in the Central Valley is a result of controlled flows and decreases in peak flows which have reduced the frequency of floodplain inundation resulting in a separation of the river channel from its natural floodplain. Channelizing the rivers and Delta has also resulted in a loss of river connectivity with the floodplains that otherwise provide woody debris and gravels that aid in establishing a diverse riverine habitat and that provide juvenile salmonid rearing habitat.

The importance of connectivity for juvenile Chinook salmon to floodplain rearing habitat has been observed in several river systems. Research on the Yolo Bypass, the primary floodplain on the Lower Sacramento River, indicates that floodplains are key juvenile rearing habitats supporting significantly more drift invertebrate consumption and therefore faster growth rates (Sommer et al. 2001a, Katz et al. 2017). Otolith microstructure studies near the City of Chico recorded increased CV fall-run Chinook salmon growth, higher prey densities, and warmer water temperatures in off-channel ponds and non-natal seasonal tributaries compared to the main-channel Sacramento River (Limm and Marchetti 2009). Research of juvenile Chinook salmon on the Cosumnes River noted that ephemeral floodplain habitats supported higher growth rates for juvenile Chinook salmon than more permanent habitats in either the floodplain or river (Jeffres et al. 2008). This growth is important to first-year and estuarine survival, factors which may be key influences of a Chinook cohort's success (Kareiva et al. 2000).

As with other stressors, the SAIL synthesis teams referenced the relevant pathways by which loss of floodplain habitat could SR winter-run Chinook salmon (and similar conceptual models can apply to CV spring-run Chinook salmon and CCV steelhead) as well as how it may interact with other stressors. However, instead of describing the negative effects caused by a loss of floodplain habitat*,* Windell et al. (2017) examined the benefit of juvenile rearing on floodplains as it relates to survival, residence time and migration, and fish condition. The SAIL report notes the interaction with higher flows that activate accessible floodplains and secondary channels, which thereby expand the availability of low-velocity refuge habitat. The SAIL report also identifies inundated floodplains in the Central Valley as being particularly successful habitat for fish growth because it provides optimum water temperature, lower water velocity, higher food quality and density, and reduced predator and competitor density relative to the main channel (Windell et al. 2017).

2.4.9. Physical Habitat Alteration

The Central Valley Chinook Salmon and Steelhead Recovery Plan (NMFS 2014) identified physical habitat alteration as a primary stressor affecting the recovery of the species. This threat primarily affects the spawning life stage of these species in the upper reaches of their watershed of origin.

Physical habitat alteration includes loss of natural river morphology and function. Flood control measures, regulated flow regimes, and river bank protection measures have all had an adverse effect on riparian and instream habitat in the lower Sacramento River. Levees constructed in this reach are built close to the river to maximize land usage, NMFS. Additionally, nearshore aquatic areas have been deepened and sloped to a uniform gradient, such that variations in water depth, velocity, and direction of flow are replaced by consistent moderate to high velocities. Gravel sources from the banks of the river and floodplain have also been substantially reduced by levee and bank protection measures. Levee and bank protection measures restrict the meandering of the river, which would normally release gravel into the river through natural erosion and deposition processes.

Chinook salmon spawn in clean, loose gravel, in swift, relatively shallow riffles, or along the margins of deeper river reaches where suitable water temperatures, depths, and velocities favor redd construction and oxygenation of incubating eggs. Construction of dams and resultant controlled flows and extensive gravel mining affect spawning habitat. Chinook salmon require clean, loose gravel from 0.75 to 4.0 inches in diameter for successful spawning (NMFS 1997). Juvenile Chinook salmon prefer slow and slack water velocities for rearing and the channelization of the river has removed most of this habitat type. Dams in the Upper Sacramento River and its tributaries have eliminated the major source of suitable gravel recruitment to many reaches of the river downstream of Keswick Dam.

The threat of altered sediments to sDPS green sturgeon due to impoundments is high. Upstream dams and impoundments reduces sediment delivery to bays and estuaries. This impacts sDPS green sturgeon feeding habitat quality and quantity through changes in sediment deposition and composition and subsequent changes in prey resources or through changes in turbidity that could impact habitat use and predation by sight-predators.

2.4.10. Water Quality

Current land use in the Sacramento river basin and Delta has seen a large increase in urbanization, industrial activity, and agriculture in the last century. In a basin-wide study, areas with relatively high concentrations of agricultural activity as well as areas that had previously experienced mining activity showed increased concentrations of dissolved solids and nitrite plus nitrate (Domagalski et al. 2000). Varying concentrations of mercury and methylmercury have been found throughout the Sacramento river basin (Domagalski et al. 2000). Concentrations of these contaminants were greatest downstream of previous mining sites (primarily Cache Creek). Both studies showed lower concentrations of contaminants in the American River as compared to other sites sampled in the basin.

Multiple studies document high levels of contaminants in the Delta such as polychlorinated biphenyls (PCBs), organochlorine pesticides, polycyclic aromatic hydrocarbons (PAHs), selenium, and mercury, among others (Stewart et al. 2004, Leatherbarrow et al. 2005, Brooks et al. 2012). This suggests that fish are exposed to these contaminants. The inability to characterize concentrations and loading dynamics makes it difficult to quantify transport and total contaminant loading in the system (Johnson et al. 2010). Additionally, numerous discharges of treated wastewater from sanitation wastewater treatment plants (e.g., Cities of Tracy, Stockton, Manteca, Lathrop, Modesto, Turlock, Riverbank, Oakdale, Ripon, Mountain House, and the town of Discovery Bay) and the untreated discharge of numerous agricultural wasteways are emptied into the waters of the San Joaquin River and the channels of the South Delta. This leads to cumulative additions in thermal effluent loads as well as cumulative loads of potential contaminants (i.e., selenium, boron, endocrine disruptors, pesticides, biostimulatory compounds, etc.).

Metals, PCBs, and hydrocarbons (typically oil and grease) are common urban contaminants that are introduced to aquatic systems via nonpoint-source stormwater drainage, industrial discharges, and municipal wastewater discharges. Many of these contaminants readily adhere to sediment particles and tend to settle out of solution relatively close to the primary source of contaminants. PCBs are persistent, adsorb to soil and organic matter, and accumulate in the food web. Lead and other metals will adhere to particulates and can bioaccumulate to levels sufficient to cause adverse biological effects. Mercury is also present in the Sacramento River and could be sequestered in riverbed sediments. Hydrocarbons biodegrade over time in an aqueous environment and do not tend to bioaccumulate or persist in aquatic systems.

Chinook salmon contain higher levels of some contaminants than other salmon species, however levels can vary considerably among populations. Mongillo et al. (2016) reported data for salmon populations along the west coast of North America, from Alaska to California, and found marine distribution was a large factor affecting persistent pollutant accumulation. They found higher concentrations of persistent pollutants in Chinook salmon populations that feed near land-based sources of contaminants. There is some information available for contaminant levels of Chinook salmon in inland waters (i.e., Krahn et al. 2007, O'Neill and West 2009, Veldhoen et al. 2010, Mongillo et al. 2016).

Harmful algal blooms also occur in the Delta and, although toxic exposure of estuarine fish has been documented, the extent of their impacts to the aquatic food web is unknown (Lehman et al. 2010). More recently, concerns have been raised about ammonia levels in the Delta (Davis et al. 2018). The largest source of dissolved ammonium is the Sacramento Regional Wastewater Treatment Plant. Upgrades to the facility were completed in the spring of 2023, so that the facility will now remove 99 percent of ammonia and 89 percent of nitrogen from the wastewater. Within a few years, the upgrades will help to show how important ammonium ratios are in limiting diatom production in the Bay-Delta. The Central Valley Regional Water Quality Control Board is working with researchers at San Francisco State University and University of California, Davis, to evaluate the impact of ammonia in the Delta (Connon et al. 2011). All the waters within the Delta are listed as impaired by at least one factor, either due to the presence of unacceptable levels of pollutants or lack of maintaining conditions such as adequate dissolved oxygen levels (EPA 2011a).

Pesticides are found in the water and bottom sediments throughout the Delta. The more persistent chlorinated hydrocarbon pesticides are consistently found at higher levels than the less persistent organophosphate compounds. Sediments in the western Delta have high pesticide content. Pesticides, such as polychlorinated biphenyls (PCBs), organochlorine pesticides, polycyclic aromatic hydrocarbons (PAHs), selenium, and mercury, among others, have concentrated in aquatic life, and have been documented at high levels in the Delta; but long-term effects and the effects of intermittent exposure are not known (Stewart et al. 2004, Leatherbarrow et al. 2005, Brooks et al. 2012). There are now concerns about the aquatic toxicity of pyrethroid-based pesticides (bifenthrin, cyfluthrin, cypermethrin, and permethrin), which have replaced organophosphorus pesticides such as diazinon and chlorpyrifos. Little is known about the potential for interactive toxicity from complex pesticide mixtures and/or pesticides interacting with other chemical, physical, or biological stressors (EPA 2011b). Pesticide use for the treatment and elimination of invasive aquatic vegetation may have important consequences for water quality parameters including amount of light that reaches the water column, temperature, salinity, turbidity, and food availability, which may also influence the migratory paths that sDPS green sturgeon salmonids utilize in the Delta (NMFS 2018).

Adult salmonid exposure to contaminants within the Delta is limited and not likely to affect reproduction. However, survival and growth of juvenile salmonids will potentially be affected. In contrast, sDPS green sturgeon may remain in or return to the Delta at all life stages such that survival, growth, and reproduction are all important characteristics to consider for sDPS green sturgeon.

2.4.11. Diversions and Entrainment

There are over 3,700 water diversions on the Sacramento and San Joaquin Rivers, their tributaries, and in the Delta; most of these are unscreened (Mussen et al. 2013), posing a widespread threat to early life stages of fish. A study of 12 unscreened, small to moderate sized diversions (less than 150 cfs) in the Sacramento River, found diversion entrainment was low for listed salmonids and sturgeon, though the study points out that the diversions used were all situated relatively deep in the river channel (Vogel 2013). The study also suggested that the factors affecting fish entrainment at unscreened diversions are complex and poorly understood because of the many site-specific variables that influence the exposure and vulnerability of fish to entrainment (Vogel 2013). In a previous mark-recapture study addressing mortality caused by unscreened diversions, low mortality was observed in hatchery-produced juvenile Chinook salmon released upstream of four different diversions throughout the Sacramento River (less than or equal to 0.1 percent of individuals released, Hanson 2001).

The Central Valley Project Improvement Act’s (CVPIA) Anadromous Fish Screen Program was established in 1994 to minimize the impacts of diversions on anadromous fish and provide technical guidance and cost-share funding for fish screen projects. The Anadromous Fish Screen Program also supports activities and studies to assess the potential benefits of fish screening, determine the highest priority diversions for screening, improve the effectiveness and efficiency of fish screens, encourage the dissemination of information related to fish screening, and reduce the overall costs of fish screens (State Water Resources Control Board 2017). Through the Anadromous Fish Screen Program, as of 2019, there were a total of 30 fish screens constructed at diversions on the Sacramento River, four fish screens in the San Joaquin and tributaries, and three fish screens at Delta diversions, which has resulted in reduced entrainment at those diversions. Currently, screen criteria for sDPS green sturgeon has not been developed (but see Verhille [2014]), and the benefits of projects intended to reduce salmonid impingement and entrainment at diversions to sDPS green sturgeon are not fully understood (NMFS 2018).

2.5. Effects of the Action

Under the ESA, “effects of the action” refers to the direct and indirect effects of an action on the species or critical habitat, together with the effects of other activities that are interrelated or interdependent with that action, that will be added to the environmental baseline. The environmental baseline includes the past and present impacts of all Federal, State, or private actions and other human activities in the action area, the anticipated impacts of all proposed Federal projects in the action area that have already undergone formal or early section 7 consultation, and the impact of State or private actions which are contemporaneous with the consultation in process. Indirect effects are those that are caused by the proposed action and are later in time, but still are reasonably certain to occur. Interrelated actions are those that are part of a larger action and depend on the larger action for their justification. Interdependent actions are those that have no independent utility apart from the action under consideration" (50 CFR 402.02 (2018)).

2.5.1. Construction and Pre-operation Maintenance: Effects to the Species

2.5.1.1 Acoustics

The proposed action has terrestrial and aquatic habitat construction elements that will result in acoustic related impacts (noise) in the areas associated with those activities. Acoustic related impacts will occur contemporaneously with construction activities, and will be associated primarily with the use of heavy construction equipment on the levees, such as excavators or drilling equipment to modify the levees and construction areas for improved soil stability, pile drivers to install sheet pile walls and steel pilings, and noise from increased vessel traffic due to the movement of commercial barges throughout the work areas transporting large construction equipment and materials. In addition, tunneling by tunnel boring machines (TBMs) has the potential to create low frequency sound and vibrations (infrasound) that will be transmitted to the overlying surface horizons, including the waterways of the Delta where the bore alignment crosses underneath them. When construction activities are halted, noise generation ceases. This is considered an effect of the construction process related to the Project.

2.5.1.1.1 Terrestrial Adjacent Noise

All the terrestrial construction elements and associated construction equipment required to complete the construction component of the proposed action will create noise in the terrestrial environment, and potentially in the surrounding waterways as well, particularly when heavy earth moving equipment is used. The scraping and moving of earth will create noise, as energy is being transferred from the hard blades or buckets of the equipment to the soil horizons. The energy imparted by the earth moving actions to the soil is partially transferred through the soil to surrounding areas as acoustic energy, including the adjacent aquatic environment, with a portion of the total energy being lost through heat or other mechanisms of transmission loss. This transfer of sound energy is referred to as coupled transmission. It is expected that noise transferred through the soil to adjacent waterways in this manner will attenuate in strength relatively quickly and is therefore unlikely to be of sufficient energy to cause mortality or injury to exposed fish, but more likely to result in harassment causing behavioral avoidance responses instead. It is anticipated that the resulting noise levels will initially "drive" fish away from any affected area, however they may return or stay in the area as they acclimate to the new acoustic environment (habituation). Noise coupled with increased human activity (*i.e.*, motion, noise, shadows, etc.) on the adjacent levees, however, may be sufficient to "drive" fish away from the work area for longer periods of time. Therefore, it is expected that any fish within the areas adjacent to levees where construction activities are underway will avoid the shoreline and the shallow water adjacent to the levee toe and move into deeper, open water to avoid the noise during construction activities. Furthermore, additional "background noise" within the aquatic environment may mask important ecological reception of sounds critical for survival, such as predator detection. Elevated noise within the aquatic environment has the potential to expose fish to elevated predation pressures from a combined lack of access to hiding areas along the shoreline, and the masking of approaching predators within their immediate surroundings.

The listed salmon, steelhead, and sturgeon species may be present in the action area during construction activities that result in terrestrial adjacent noise. Many of the listed species that are present are expected to pass through the Sacramento River channel migration corridor within the action area relatively quickly, minimizing exposure to terrestrial noise. However, some may exhibit behavioral responses that result in delayed migration or increased predation risk. Therefore, terrestrial adjacent noise is expected to impact a small number of fish during each of the years of in-water construction.

2.5.1.1.2 Pile Driving

Within the aquatic environment, the BA has described the driving of thousands of individual sheet pile sections into multiple locations in the Action Area to construct cofferdams, as well as driving hundreds of support pilings to create foundations for infrastructure associated with the proposed Project. Two types of pile driving hammers are proposed for the Project: vibratory and impact. A vibratory hammer will be used to initially drive sheet piles to the approximate final depth required and an impact hammer will be used to achieve final depth as required in the design specifications. Certain segments of the sheet pile walls will tie into adjacent levees and will likely also require the use of an impact hammer to achieve the necessary final depth and load bearing requirements for these sections, to prevent water seepage. Installation of steel piles will also require an impact hammer to drive the piles to necessary depths to support concrete floor foundations for the Project's various structural features. Installation of sheet pile cofferdams for multiple construction sites will require several weeks to complete. Once installed, the cofferdams will isolate construction areas, for dewatering to facilitate construction in the dry.

Pile driving consists of driving steel piles into the riverbed with a mechanical hammer. The force of the hammer hitting a pile forms a sound wave that travels down the pile and causes the pile to resonate radially and longitudinally. Acoustic energy is formed as the walls of the steel pile expand and contract, forming a compression wave that moves through the pile. The outward movement of the pile wall sends a pressure wave propagating outward from the pile and through the riverbed and water column in all directions. Inconsistent mediums such as soil and water cause acoustic energy to respond differently. Acoustic energy in water will result in a higher rate of transmission loss. In water, factors such as water depth, water turbulence, air bubbles, and substrate consistency are important considerations when estimating the distance a compression wave will travel. A compression wave traveling through shallow water and substrates with variable consistencies (*i.e.*, variable particle size class distribution) will attenuate more rapidly than compression waves traveling through a constant medium such as deep water or bedrock. As a compression wave moves away from the source, the wave length increases and intersects with the air/water interface. Once the compression wave contacts the air, it attenuates rapidly and does not return to the water column.

The degree an individual fish exposed to underwater sound will be affected (from a startle response to immediate mortality) depends on a number of variables such as the species of fish, size of the fish, presence of a swim bladder, sound pressure intensity and frequency, shape of the sound wave (rise time), depth of the water around the pile and the bottom substrate composition and texture. An important characteristic of the underwater sound that causes injury is frequency.

During pile installation, most energy is contained within the frequency range of 100–1,000 Hertz which results in reverberation of the swim bladder. The most susceptible tissues that are injured during exposure to underwater sound produced from pile driving are the soft-tissue organs surrounding the swim bladder, such as the liver and kidney (Hastings and Popper 2005). Both salmonids and sturgeon possess physostomous swim bladders and are therefore more susceptible to injury from acoustic impacts than fish without swim bladders. In addition, sturgeon, which are primarily benthically oriented fish, have large swim bladders which make them more susceptible to acoustic impacts than fish with smaller swim bladders. When fish are exposed to multiple strikes of a pile driver, the repetitive oscillations and the resultant pressure waves will cause the swim bladder to act like a drum. Although any single pulse (depending on its magnitude) may not result in acute injury to the internal organs, the repetitive nature of the sound produced during pile driving is likely to result in injury due to the repetitive flexure of the organ membrane, particularly if the membrane experiences resonance.

Noise created by pile driving can physically injure animals or change animal behavior in the affected environment. Injurious effects can occur in two ways (Popper *et al*. 2014). First, immediate adverse effects can occur if a single noise event exceeds the threshold for direct physical injury. Second, effects can result from prolonged exposure to repetitive or sustained noise levels for extended periods of time. Behavioral effects can be adverse if such effects interfere with an animal's behavior such as migrating, feeding, resting, or reproducing.

NMFS (2021) uses the sound exposure level (SEL) metric, expressed as the square of the time integrated sound-pressure-level measured in decibels over the duration of the sound exposure (decibels are referenced to one micropascal (µPa) of pressure; one pascal is equivalent to one Newton of force per square meter), to correlate physical injury to fish from underwater sound pressure produced during the installation of piles (Hastings and Popper 2005). This metric allows summation of energy over multiple strikes. Using SEL, the exposure of fish to a total amount of energy (*i.e.,* dose) can be used to determine a physical injury response.

For fishes, generally, the accumulation period can be reset to zero after a 12-hour period of no pile driving, especially in a river or tidally influenced waterway where many fish species are moving. The SEL metric additionally incorporates ‘effective quiet’, which means if the received SEL from an individual pile strike is below a certain level (*e.g.*, 150 dB SEL), then the accumulated energy from multiple strikes would not contribute to injury, regardless of how many pile strikes occur. ‘Effective quiet’ establishes a limit on the maximum distance from the pile where injury is expected. Beyond this distance no physical injury is expected, regardless of the number of pile strikes.

Installation of sheet piles and steel piles with either a vibratory pile driving hammer or impact hammer is expected to result in adverse effects to listed salmonids and sDPS green sturgeon due to levels of underwater sound that will be produced. Elevated noise levels from pile driving activities may cause temporary behavioral changes and/or loss or reduction of hearing in affected fish. Rearing juvenile and migrating post-spawn adult sDPS green sturgeon are expected to avoid the elevated noise of pile driving operations by swimming around the areas with the highest noise levels or holding outside of the high noise areas until pile driving ceases. There is a potential for these fish to suffer a temporary loss of hearing sensitivity at the expected noise levels generated by pile drivers. Loss of hearing sensitivities in juvenile sturgeon could expose them to higher risks of predation. Fish with impacted hearing capacities will have a lower ability to detect predators and may be unable to maintain position in the water column due to inner ear equilibrium factors. Noise from pile driving may also cause startling and/or avoidance of habitat by fish in the immediate vicinity of in-water and near-shore construction activities. Startling of fish can cause harm by temporarily disrupting normal behaviors essential to growth and survival such as feeding, sheltering, and migrating. Disruption of these behaviors may occur for specific periods during daylight pile driving operations. Cessation of pile driving activities each night is expected to provide a respite, allowing fish to migrate through the affected area and partially offsetting the extent of impacts to listed species in the area. NMFS assumes that normal behavior patterns will cause individual migrating salmonids and sDPS green sturgeon to leave the affected areas within one day, and therefore underwater sound energy will not be summed across multiple days.

NMFS characterizes sound sources as either impulsive or non-impulsive as described below:

- <u>Impulsive sound sources</u>: produce sounds that are typically transient, brief (less than one second), broadband, and consist of high peak sound pressure with rapid rise time and rapid decay. Impulsive sounds can occur in repetition (*e.g.*, seismic air guns, impact pile driving) or as a single event (*e.g.*, explosives).

- <u>Non-impulsive sound sources:</u> can be continuous or intermittent, and produce sounds that can be broadband, narrowband or tonal, and brief or prolonged. Non-impulsive sources do not have the high peak sound pressure with rapid rise time typical of impulsive sounds. Examples of non-impulsive sources include drilling, vibratory pile driving, and certain active sonars.

In 2008, NMFS' West Coast Region established the following interim dual thresholds for the onset of physical injury from impact pile driving activities (*i.e.*, impulsive sound sources) through the Fisheries Hydroacoustic Working Group (FHWG 2008).

	Onset of Physical Injury (Received Level)
Fish Size	Impulsive Sound Sources
Fishes ≥ 2 g	Single strike instantaneous peak: 206 dB Cumulative SEL: 187 dB
Fishes < 2 g	Single strike instantaneous peak: 206 dB Cumulative SEL: 183 dB

Installation of piles using a vibratory hammer is unlikely to result in physical injury to listed fish species but could nevertheless result in behavioral effects to individual fish exposed to active pile driving operations. NMFS considers impacts from this level of exposure will be insignificant due to the mobility of these species and the similarity, accessibility, and availability of nearby habitat in this open-water environment. If an individual fish chooses to remain within the behavioral response zone, it could be exposed to increasing levels of sound energy during pile driving operations for a sustained period. Since pile installations will occur intermittently during daylight hours only, these species will be able to resume normal activities during quiet periods between pile installations and at night.

Based on the findings presented in section 5.4.1 in the BA (ICF 2025), incorporated here by reference and supported by our own independent analysis, construction of the cofferdams and training walls associated with construction of the new intakes indicated that impact hammer pile driving will result in a single strike peak SEL of 206 dB at a radius of up to 8.5 meters (28 feet) away from the pile being driven, and a cumulative SEL of 187 dB at a radius of up to 179 meters (588 feet) at Intake B and 117 meters (383 feet) at Intake C, representing the distance from the pile driving activity where physical injury could occur following exposure to multiple pile strikes over the course of a day. NMFS expects injurious noise effects are unlikely to occur due to the mobility of these species and the typical behavioral response of moving away from injurious sounds. The duration of impact pile driving to complete construction of the cofferdams would be 21 days at each intake. Up to four additional days of pile driving will also be required during the final year of construction at each intake to install steel pipe piles to support the floating log boom. For detailed descriptions of the assumptions on which this analysis was based, and graphical representations of the extent of acoustic impacts associated with impact hammer pile driving at each of the intakes, NMFS incorporates by reference Tables 5.4-2 and 5.4-3, as well as Figures 5.4-4, 5.4-5, 5.4-6, and 5.4-7 from the BA.

Impact pile driving would also be required at two bridge crossings associated with the proposed action (*i.e.*, Burns Cutoff and Snodgrass Slough). The area of effect associated with single strike peak SEL of 206 dB from impact pile driving at these locations, accounting for attenuation of sound by river bends, extends to a distance from the pile driving activity of 24 meters (82 feet) at Burns Cutoff and 7 meters (24 feet) at Snodgrass Slough. The cumulative SEL of 187 dB from impact hammer pile driving at each bridge crossing extends to 371 meters (1,217 feet) and 273 meters (896 feet) from the source of the pile being driven at Burns Cutoff and Snodgrass Slough, respectively. As with the construction of the intakes, NMFS expects injurious noise effects from impact pile driving at the bridge crossings is unlikely to occur due to the mobility of NMFS listed species and the typical behavioral response of moving away from injurious sounds. The duration of impact pile driving at the bridge crossings would range from five to nine days at each location. For detailed descriptions of the assumptions on which this analysis was based, and graphical representations of the extent of acoustic impacts associated with impact hammer pile driving at each of the bridge crossings, NMFS incorporates by reference Table 5.4-4 and Figures 5.4-8, and 5.4-9 from the BA.

The listed salmon, steelhead, and sturgeon species may be present in the action area during construction activities that result with in-water noise. Underwater noise intensity levels of that cause direct injury or mortality of fish could occur over a period of approximately 25 days during the proposed in-water work period (June 1–October 31) over a 6-year period at each intake location. In addition to the work window, avoidance and minimization measures (AMMs) and best management practices (BMPs) would be implemented to monitor and decrease noise levels from impact pile driving. Underwater noise levels would return to baseline levels following cessation of pile driving and other construction activities and would not be expected to result in long-term impacts on species and critical habitat. Many of the listed species present in the action area during the work window are expected to avoid, either spatially or temporally (e.g., migrate at night), sound-related impacts, or alternatively pass through the Sacramento River channel migration corridor relatively quickly, minimizing exposure time. However, these behavioral changes in response to underwater noise may disrupt migration and increase predation risk. Therefore, in-water noise is expected to affect low numbers of each species present in the action area during the years of construction.

2.5.1.1.3 Boat/ Barge Operations

Boat operations during construction will result in temporary acoustic effects to listed fish species. Barge/tugboat operations will be conducted to transport construction equipment and materials to each intake, for a total of 94 and 68 trips to intakes B and C, respectively. There would be no more than two trips upstream and two trips downstream per day, with work staggered by at least one year for each intake. In addition, each barge round trip would be associated with one day of dredging to excavate and prepare the subgrade at the intake for riprap placement for a total of 19 to 28 days of dredging at each intake. It is unlikely that concurrent barge operations and conventional dredging practices on this scale will create sufficient acoustic effects to cause physical injury to fish or elicit anything other than a behavioral avoidance response. Temporary hearing loss could occur if fish remained in the vicinity of an operating dredge for an extended period, but it is unlikely that this would occur in an open water environment. The listed salmon, steelhead, and sturgeon species may be present in the action area during boat/barge operations and exposed to underwater noise. However, the listed species are expected to pass through the Sacramento River channel migration corridor within the action area relatively quickly, actively avoiding any noise-related impacts. Some listed species may exhibit behavioral changes, resulting in delayed migration or increased predation risk. Therefore, boat/barge operations are expected to impact low numbers of each fish species during each of the years of construction.

2.5.1.1.4 Tunnel Boring Related Noise

Finally, the use of several TBMs to cut tunnels under the Delta sediment horizons will create vibrations and low frequency noise (*i.e.*, infrasound) due to the noise of the machines themselves and the action of the rotating cutterheads grinding through the native soils. Tunnel boring along the DCP alignment would pass beneath 14 different waterbodies a total of 17 times. Tunnel boring is expected to progress at approximately 40 feet per day, with work continuing up to 20 hours per day, 5 days per week, and up to 10 hours on Saturdays, thereby passing under each waterbody for several days, depending on the width of the waterbody along the tunnel alignments. Acoustic modeling of potential effects was undertaken for the tunnel boring intersection with the San Joaquin River, which is the shallowest tunnel boring location passing beneath a waterbody (approximately 21 meters (68 feet) of cover between the crown of the tunnel and the bottom of the river channel). The overall SEL at the bottom of the channel was estimated at 104 dB, which is well below the 150-dB threshold for 'effective quiet' described above. Given this, tunnel boring is not expected to result in sound-related injury to listed species present within action area. However, behavioral changes in response to underwater noise/disturbance from tunnel boring may occur, delaying migration and increasing predation risk. Therefore, tunnel boring noise is expected to impact low numbers of each fish species during each of the years of construction.

2.5.1.1.5 Summary of Risk

As described, increase in aquatic and terrestrial- adjacent noise levels during construction activities for the north Delta diversion intakes and other activities have the potential to temporarily affect individual fish. Sound-related injury resulting from pile driving activities is expected to impact a small number of listed species that may be present in the action area during the in-water work window. However, it is expected that most fish will actively avoid areas with increased noise levels, which in turn is likely to result in behavioral changes that delay migration and increase predation risk. These potential impacts are anticipated to have a localized and temporary effect on individual fish within the action area. The proposed conservation measures, AMMs and construction BMPs included as part of the proposed action are expected to reduce the severity and potential for acoustic-related impacts on the listed fish species.

2.5.1.2 Water Quality

2.5.1.2.1 Sediment Disturbance

The proposed project involves construction and pre-operation maintenance activities in or adjacent to the Sacramento River that would result in the generation and release of suspended sediments to the water column, temporarily increasing water-column turbidity above ambient levels and altering habitat conditions for listed anadromous fish. The re-suspension and deposition of instream sediments is a potential impact of various construction activities. Turbidity-producing activities include bed and bank disturbance during cofferdam and log-boom installation, dredging for riprap placement adjacent to the new intake locations and the placement of bed and rock riprap armoring, and pre-operation maintenance dredging, vegetation removal, and screen cleaning. Propeller wash associated with boat traffic at construction sites may also produce localized turbidity pulses, depending on location.

Temporary increases in turbidity, when compared to the ambient background turbidity levels, are anticipated to occur during various phases of construction in the action area. Elevated turbidity and suspended sediment levels have the potential to negatively affect freshwater life stages of salmonids by clogging or abrading gill surfaces, reducing primary productivity and photosynthesis activity (Cordone and Kelley 1961), and adversely affecting dissolved oxygen levels within the gravel (Zimmerman and Lapointe 2005; Lisle and Eads 1991). Fish behavioral and physiological stress responses include gill flaring, coughing, avoidance, and increased blood sugar levels (Berg and Northcorte 1985; Servizi and Martens 1992). Temporary increases in turbidity and suspended sediment levels from construction may also negatively impact individual salmonids through reduced availability of food, reduced feeding efficiency. Green sturgeon are less likely to be negatively impacted by temporary increases in turbidity and suspended sediment due to differences in feeding ecology compared to salmonids. Green sturgeon are benthic feeders and primarily rely on non-visual methods to hunt for prey within the benthic sediment (NMFS 2018). Salmonids, on the other hand primarily use vision to hunt for small prey items in the water column.

Increases in turbidity and suspended sediment resulting from the proposed project are expected to be localized and temporary. Turbidity plumes from construction activities are not expected to span the entire river channel, allowing most fish to actively avoid impacted areas. In addition, AMMs and BMPs will be implemented to monitor and minimize sediment disturbance during construction activities. The temporary increases in turbidity and suspended sediment are not expected to be severe enough to cause injury or death of listed salmonids or sturgeon. Instead, we expect temporary behavioral effects that include migration delays and movement of fish to adjacent areas, leading to reduced survival (through higher likelihood of predation) and growth (through reduced feeding) for the small number of juvenile fish that are expected to be present in the action area during construction activities.

Re-suspended sediment due to construction and pre-operation maintenance activities could include contaminants (i.e., metals, hydrocarbons such as oil and grease, organochlorine pesticides, polychlorinated biphenyls), that may be released and dispersed when sediments are disturbed. Fish could be exposed to elevated levels of contaminants if present near construction activities that disturb contaminated sediments. The greatest potential for such exposure would be during dredging and excavation for riprap placement. Other potential exposure routes include pile driving for cofferdam and log-boom installation, or from propeller wash by construction boat traffic. Disturbance of contaminated sediments could also affect the food web for listed anadromous fish because toxins in re-suspended sediment can enter the food web via bioaccumulation in macroinvertebrate organisms.

The listed salmon, steelhead, and sturgeon species may be present in the action area during construction activities that result in sediment disturbance. However, their presence is expected to be in low numbers, given adherence to the proposed in-water work window. Exposure to increased sediment is not expected to result in injury or death to listed species, but may cause in behavioral changes, such as avoidance of the action area when work is occurring. These behavioral changes could affect the survival of juvenile fishes due to reduced feeding and increased predation risk. Those listed species that are present during in-water work are expected to pass through the Sacramento River channel migration corridor within the action area relatively quickly, minimizing overall exposure time. Therefore, sediment disturbance is expected to result in low numbers of fish impacted during each of the years of construction.

Summary of Risk

As described, increased turbidity and suspended sediment levels during construction and pre-operation maintenance activities for the north Delta diversion intakes have the potential to affect water quality in the action area. These impacts would be temporary and localized, affecting migration behavior and increasing predation risk for individual fish that are present during the in-water work window. The conservation measures and construction best management practices described in the BA are expected to result in the minimization of the severity and potential water quality impacts on the listed fish species.

2.5.1.2.2 Construction Contaminants

Construction of the proposed action could result in accidental spills of contaminants, including oil, fuel, hydraulic fluids, concrete, paint, and other construction-related materials, resulting in localized water quality degradation. If this occurs, it could result in effects to fish through direct injury or mortality (e.g., damage to gill tissue causing asphyxiation), or delayed effect on growth and survival (e.g., increased stress or reduced feeding), depending on the nature and extent of the spill and the contaminants involved.

The greatest potential for adverse impacts to water quality is associated with an accidental spill from construction activities occurring in or near the river channel. Construction for the north

Delta diversion intakes involve extensive in-water work, albeit with much of the work occurring inside a cofferdam. There is some potential for spills during drilled shaft work, cofferdam support installation, excavation of cofferdam, and tremie pours of concrete (although additional concrete would be poured into the concrete base, thereby minimizing the potential for concrete mixing with water within the cofferdam prior to dewatering), but once cofferdams are installed and dewatered, any spills within the cofferdam would prevent or minimize movement of spill materials entering the main river water. Discharge of water from construction sites could also affect water quality for fish. The proposed AMMs and BMPs are expected to minimize the potential for contaminants entering waterbodies, and if they are accidentally released, cleanup plans will be in place to minimize effects on listed species.

The listed salmon, steelhead, and sturgeon species may be present in the action area during construction activities that result in the potential for exposure to construction contaminants. Spills would be accidental and therefore would be infrequent and not expected to occur, especially with proposed AMMs in place.

Summary of Risk

The potential for accidental release of contaminants through spills or sediment disturbance could degrade water quality and impact fish. However, these potential impacts are anticipated to have a localized and temporary effect on individual fish within the action area. Deployment of conservation measures and construction BMPs described in the BA are expected to minimize the potential for water quality impacts from construction contaminants on the listed fish species.

2.5.1.3 Physical Injury or Mortality

In-water construction for the proposed action has the potential to result in physical injury or mortality to listed fish species. Construction activities that could result in physical injury or mortality include: pile driving, barge/tugboat operations, enclosing construction areas and associated fish rescues, riprap placement, and construction-related water diversion from surface waters. Any surface water diversion necessary for construction activities would be screened to avoid fish entrainment. Work will be conducted during the proposed in-water work window (June 1-October 31) reducing the potential for listed species presence in the action area. Prior to dewatering and in-channel work behind a cofferdam, fish rescue will be implemented as described in Appendix 3A of the BA (ICF 2025). Fish that are handled are expected to experience low levels of stress or physical injury or mortality. However, fish rescue and handling is anticipated to be conducted by a qualified biologist which is expected to result in reduced injury and reduced likelihood of mortality for fish in the dewatered areas. Additionally, fish handling and rescue is anticipated to occur one time for each intake location, upon completion of the cofferdam at each intake location.

Barge and tugboat operations associated with construction activities have the potential to result in direct physical injury or mortality of anadromous fish from propeller entrainment or strikes. However, given that fish typically exhibit an avoidance behavioral response with boats, there is low potential for physical injury or mortality from barge and tugboat operations.

The listed salmon, steelhead, and sturgeon species may be present in the action area in low numbers during construction activities resulting in physical injury or mortality. However, adherence to the in-water work window and implementation of AMMs and BMPs reduces the potential for fish to be exposed to project activities. Listed species that are present in the action area are expected to exhibit avoidance behavior or pass through the Sacramento River channel migration relatively quickly. Therefore, the potential for physical injury or mortality is expected to result in low numbers of fish impacted during construction. The herding, capture, and relocation of small numbers of each species is expected to result in low numbers of injury or mortality.

Summary of Risk
The construction activities that have the potential to cause physical injury or mortality are anticipated to be localized within the action area. The conservation measures and construction BMPs included as part of the proposed action are expected to result in the avoidance and/or minimization of potential physical injury or mortality of listed anadromous fish. The herding, capture, and relocation of small numbers of each species is expected to result in low numbers of injury or mortality.

2.5.2. Construction and Pre-operation Maintenance: Effects to Critical Habitat

The proposed project would result in both temporary and permanent impacts to designated critical habitat for the listed salmonids and sDPS green sturgeon PBFs in the Sacramento River channel portion of the Action Area (refer to Section 2.3 of this Biological Opinion). The overall footprint of the construction activities is approximately 1.5 acres of temporary effects[5] in terrestrial areas, and approximately 5.6 acres of permanent effects on tidal perennial habitat. The proposed project footprint of the water intakes in channel-margin habitat in the Sacramento River is approximately 494 linear feet of temporary impact, and approximately 3,124 linear feet of permanent impact. For Intake B (upstream of Hood; refer to Figure 2), rock riprap will replace approximately 1.8 acres of riparian habitat. For Intake C, (downstream of Hood), rock riprap will replace approximately 1.6 acres of riparian habitat.

The nonfederal project applicant, DWR proposes to offset permanents impacts on critical habitat through restoration within designated critical habitat of tidal perennial habitat and channel; margin habitat at an approved restoration site and/ or the purchase of conservation credits at an approved conservation bank (refer to Appendix 3B within the BA; ICF 2025). The critical habitat PBFs for the listed species is described in Section 2.4, Environmental Baseline of this Biological Opinion. In summary, the proposed project will permanently remove 3,124 linear feet of riverine/tidal riparian habitat and replace it with in-water structures and riprap, such as the diversion intakes and associated fish screen. These activities affect the PBFs of freshwater rearing habitat, freshwater migratory corridor, and estuarine areas.

2.5.2.1 Riparian Vegetation Permanent Removal

While scientific literature regarding salmonids and riparian habitat is plentiful, there is a paucity of literature specifically evaluating the interaction of green sturgeon and riparian vegetation, outside of spawning grounds. However, the ecological functions of riparian vegetation for

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[5] Temporary effects are the habitat extent acreage that can be returned to original basic use following completion of construction; permanent effects are the habitat acreage that cannot be returned to original basic use following completion of construction.

riverine and estuarine ecosystems remain the same for a variety of fish species. Therefore, the effects to critical habitat, and the mechanisms of potential impacts, to the listed salmon, steelhead, and green sturgeon are similar and are described as follows.

Riparian and in-channel vegetation provide important habitat to listed salmonids and sDPS green sturgeon, such as large woody materials, temperature and velocity micro-refugia, and macroinvertebrate prey items for juvenile fish. The following analyses describe the mechanisms of how vegetation is an essential aspect of habitat for fish, and how the removal of riparian vegetation can impact anadromous fish.

2.5.2.1.1 Food web for juvenile fish

Riparian and in-channel vegetation are components of the food web that juvenile salmonids rely on during freshwater rearing. Riparian vegetation is an especially important contributor of organic materials to the stream, including large woody materials, and provides a significant input of external energy (termed allochthonous sources) to the food web of a stream. Macroinvertebrates, such as aquatic and terrestrial insects, crustaceans, mollusks, and worms, depend and feed on the allochthonous sources, such as leaves or other organic materials provided by riparian vegetation (Cummins 1973; Allan et al. 2021). Macroinvertebrates are the primary food source for juvenile salmonids (Moyle 2002), which means that riparian vegetation significantly influences the food web upon which salmonids depend on (Allan et al. 2003; Rundio and Lindley 2008; Grunblatt et al. 2019). For example, terrestrial invertebrates that fall into the water supplement the macroinvertebrate community already in the area and those that drift down with flows (Rundio and Lindley 2008). Additionally, juvenile salmonids must compete for food sources with several nonnative fish, such as juvenile bass (*Moronidae spp.*), that eat macroinvertebrates as well (Olson 1996; Sullivan et al. 2012). Therefore, riparian vegetation also contributes to a prey base that would allow juvenile salmonids to better compete with juvenile nonnative fish species.

The quality and quantity of macroinvertebrates is highly influenced by river flows and hydrology over time, in addition to water quality. Because of this connection to water quality and flows, macroinvertebrates, and particularly benthic ones (or bottom-dwelling), are commonly used as a biological indicator for water quality, and the general "health" of a stream or waterbody (refer to section 2.4 Environmental Baseline; Karr 1999; Norris and Thoms 1999; Rehn 2009). Aquatic macroinvertebrates spend all or more of their lives in water, are easy to collect, and differ in their tolerances of water velocities and water quality variables, such as salinity, water temperatures, and contaminants. Since macroinvertebrates are the first biological linkage between water and fish, monitoring for them can provide information on the relationship between river flows and water quality, and the health of fish populations.

2.5.2.1.2 Habitat heterogeneity and refugia

Riparian vegetation and organic materials within a waterway are essential to providing a diversity of micro-habitats for both adult and juvenile salmonids, and sDPS green sturgeon. These micro-habitats can range in utility from providing pockets of macroinvertebrate prey (for juvenile fish), shelter from predators, overhead cover or shade, and thermal or velocity refugia (Crook and Robertson 1999; Windell et al. 2017). Instream organic materials and overhanging vegetation provide shelter for juvenile salmonids from predators, such as nonnative piscivorous fish, aquatic mammals, and aquatic piscivorous birds. Larger instream organic materials, such as woody materials, are particularly well understood for its benefits in providing cover and shelter for juvenile salmonids (Kauffman et al. 1997; Roni and Quinn 2001; Whiteway et al. 2010; Windell et al. 2017). For example, a study by Sabal et al. (2021) suggests areas with shade, and no instream shelters, such as organic vegetative or woody materials, create potential predator ambush habitat. The potential predator ambush habitat is created when juvenile salmonids cannot visually determine if a predator is waiting in a shaded open area. On the other hand, areas with instream vegetative materials that provide hiding locations for juvenile salmonids, allow them to safely visually assess an area for predators.

Riparian vegetation that provides overhead cover and shade are also important thermal refugia for salmonids (Torgensen et al. 1999). Shade and micro-thermal refugia are especially essential during the spring and summer months when air and water temperatures increase. Riparian vegetation that provides overhead cover and shade allows both adult and juvenile salmonids and sturgeon some temporary respite from summer ambient air temperatures, and likely creates micro-thermal refugia of slightly decreased water temperatures that fish could hold in for short periods of time to decrease their body temperatures.

Riparian vegetation and instream organic material can also dissipate energy of flowing water and create micro-pockets of velocity shelters that could be utilized by both adult and juvenile salmonids and sturgeon. These micro-velocity refuges would be most essential during the warmer spring months when adult and juvenile salmonids and sturgeon have increased metabolic demand, especially if water temperatures consistently exceed 69.8° F (21° C) (Poletto et al. 2017). Micro-velocity refuges allow anadromous fish to rest, temporarily decreasing their metabolic demand. For juveniles, these refuges are especially important in warmer waters when piscivorous predators become more active and voracious (McInturf et al. 2022). Temporary decreases in metabolic demand could allow for energy conservation applied in response to other stressors, and greater investments in growth, both with potentially positive effects on juvenile fish survival. For example, if a juvenile salmonid needs to expend a lot of energy to escape a predator, then the presence of micro-velocity refuges would allow a juvenile salmonid to recover. This may make the juvenile less susceptible to predators, particularly if energy saved is used to grow larger than the prey size targeted by other predators. Juvenile growth is important for outmigration and estuarine survival, and may be a key influence on a salmonid cohort's success (Kareiva et al. 2000).

2.5.2.2 In-Water Structures and Predation

In-water structures may temporarily and/or permanently result in increased predation risk for juvenile salmonids. Temporary in-water structures used during construction would have the potential to provide habitat for predatory species. The cofferdams to be used during construction at the north Delta intakes would include flutes (i.e., vertical grooves), which may make them suitable as predatory fish habitat. In-water structures, particularly cofferdams at the north Delta intakes, may result in negative effects on small fish, such as downstream-migrating juvenile salmonids. Juvenile salmonids in the construction action area near the intakes could be subject to greater risk of predation if predatory fish move in and use the temporary structures for cover.

The permanent in-water structures of the diversion intakes and associated fish screens may increase predation risk of juvenile salmonids and have the potential to create another predation hotspot. Increased predation of juvenile salmonids at the north Delta intakes could occur if predatory fish aggregate along the intakes' cylindrical tee screens or associated in-water structures (i.e., the floating log boom and its support pilings, including accumulated debris) at greater density than existing conditions.

Predator-prey interactions can be broken down into several fundamental steps between the prey and the predator. These steps include the rates of encounters between the predator and the prey, the rate the predator decides to pursue and attack the prey when detected, the rate the predator successfully captures the prey, and, ultimately, the rate the prey is consumed by the predator. Each one of these steps is influenced by biological and physical factors in the surrounding environment such as prey abundance, spatial and temporal overlap of prey with the predator, habitat complexity, turbidity, and behavioral, physiological, and morphological adaptations that facilitate (predator success) or inhibit (prey avoidance) the predation process (Grossman et al. 2013, Grossman 2016). Although predation is frequently the proximate cause of mortality, the ultimate cause of mortality is often related to alterations in the physical or biological parameters of the habitat the prey occupy that enhance rates of predation. Because fish are adaptable, the response to habitat changes and quality are not always straightforward and linear and thus may not always be completely predictable, particularly on a shorter time scale.

In general, though, habitat that is complex and offers a multitude of different niches provides for a more diverse biological community (Grossman et al. 2013, Grossman 2016). In a stable, undisturbed, properly functioning habitat, multiple species can occupy the same general area with each species occupying a particular ecological niche, thereby minimizing direct competition between species and having a balanced predator-prey interaction. This is particularly true in habitats where predators and prey have co-evolved with each other. This relationship does not exist or is compromised when habitat is altered or nonnative species invade a new habitat, causing a loss of equilibrium among the species inhabiting it.

Man-made structures that do not offer any natural habitat attributes, such as riparian vegetation or large woody materials, have the potential to become predator "hot spots" (Sabal et al. 2016, Michel et al. 2020). While predators of juvenile salmonids currently occupy the action area, the proposed action facilities have the potential to become a predator hotspot. The addition of these structures will increase the amount of predators in the area while reducing the amount of natural riparian habitat juvenile salmonids use to hide from predators. However, special studies and location-specific data are needed to quantify the rate of predation that would occur in the action area from the proposed action. The impact the proposed action has on predation of juvenile salmonids around the new intake screens is uncertain at this time.

Overall, the weight of available information suggests that predation effects of the north Delta intakes on juvenile salmonids could be limited, but there is some uncertainty and would depend more on the operations and long-term maintenance of the facilities (refer to section 2.5.3 in this opinion). Fisheries studies will be undertaken to provide information on predatory fish and predation rate at the north Delta intakes once they are operational, to inform the refinement of future operations and adaptive management (refer to section 2.5.3 in this opinion, and Appendix 5B in ICF 2025).

2.5.2.3 Summary of Risk

The proposed project includes offsetting permanents impacts on critical habitat through restoration of tidal perennial habitat and channel; margin habitat at an approved restoration site and/ or the purchase of conservation credits at an approved conservation bank (refer to Appendix 3B within the BA; ICF 2025). Implementation of the Compensatory Mitigation Plan for Special-Status Species and Aquatic Resources as described in the BA would offset the permanent loss of critical habitat overall. However, there is still a temporal and spatial impact that would occur to the listed species in the Action Area, which is within the primary upstream and downstream migratory route for all listed anadromous fish in the Sacramento River watershed.

Through the mechanisms described above, riparian and in-channel vegetation habitat influence the growth and survival of juvenile anadromous fish. The riparian vegetation community provides large woody materials and other organic materials to the river. Riparian vegetation and instream organic materials affect the quality and quantity of juvenile rearing and migration habitat, including the macroinvertebrate community that are the primary food source for juvenile salmonids and foraging sDPS green sturgeon. Adult salmonids and sDPS green sturgeon are expected to be minimally affected by reduced shade and cover, however, we do not expect them to linger in the action areas as long juveniles might. The specific location of habitat loss in the juvenile salmonid and sDPS green sturgeon migration corridor is expected to adversely impact juvenile fish survival in particular.

There is some uncertainty on how listed salmonids and sDPS green sturgeon would interact with the in-channel structures and facilities under the proposed project. Monitoring of juvenile and adult Chinook salmon, CCV steelhead, and sDPS green sturgeon near the completed structures is expected to be useful to inform how the proposed action affects juvenile anadromous fish downstream migration, and adult upstream migration. The negative exchange of riparian vegetation for concrete, riprap, fish screens, and diversion intake structure is expected to result in reduced fitness and growth, and reduced survival of a small portion of the population of juvenile and adult salmon, steelhead, and green sturgeon as they migrate past the action area.

2.5.3. Compounding Effects

The construction schedule for in-water and in-channel work within the Sacramento River migratory and rearing corridor is estimated to occur for six years (refer to section 1.3 of this opinion). If there are unforeseen delays in construction, then it is possible that in-channel construction could take up to a total of seven years for the intakes. This timeframe encompasses at least two generations of SR winter-run Chinook salmon, CV spring-run Chinook salmon, and CV steelhead. Individual sDPS green sturgeon could also rear or migrate near or past the construction action area more than once in their lifetime.

Effects from the proposed action activities of construction could have compounding effects on individuals of the listed species each year, multiple times throughout their life cycle. These compounding effects include widespread ongoing noise and degraded water quality, resulting in behavioral changes that increase predation risk. Reduced and temporarily disturbed riparian habitat due to construction activities within the Sacramento River channel results in an overall reduction in prey availability, shelter from predators, and thermal and velocity refugia. This in turn may impact a small portion of the species at the population level by increasing stress and reducing the overall fitness of individuals migrating through or rearing in the Delta. Furthermore, nutritional deficiencies and reduced fitness of individuals may result in an abbreviated residence time in the waters of the Delta, stunted growth rates, and diminished resiliency for survival in the ocean. Additional results may include the potential for increased susceptibility to disease, contaminants, predation, entrainment (upstream and/or downstream of action area), and other project-related effects that are likely to be compounded by exposure to multiple stressors during their residence in and migration through the action area.

2.5.4. Framework-Level Component Analysis

As described in the Analytical Approach section, this opinion is considered a "mixed programmatic" action and includes certain action components analyzed as programmatic actions. Programmatic actions include framework programmatic actions that establish a framework for the development of future actions that are authorized, funded, or carried out at a later time, and any take of a listed species would not occur unless and until those future actions are authorized, funded, or carried out and subject to further ESA section 7 consultation.

The level of detail available at the framework programmatic level is often insufficient to identify with particularity where, when, and how the program will affect listed species. Without such detail, NMFS cannot reliably identify the amount or extent of take associated with the specific program and write sufficiently specific and meaningful terms and conditions intended to minimize the impact of the taking for the benefit of the listed species. Under a framework programmatic approach, as specific projects are developed in the future, they are subject to project-specific stepped-down, or tiered, consultations where incidental take is addressed. Once framework-level action components are further developed with sufficient detail to determine the amount or extent of incidental take, they will require additional ESA section 7 consultation before implementation; this subsequent consultation will include an incidental take statement for those components. The implementation of specific actions would occur after the future ESA consultations are complete.

Framework programmatic actions are often described in broader terms and receive a qualitative analysis of their potential effects on listed species and critical habitat. In some cases, programmatic actions are designed to a level of detail where the action and its effects are reasonably certain to occur and can be analyzed more quantitatively. Regardless of whether an action is analyzed qualitatively or quantitatively, NMFS applies the same approach regarding the potential species exposure, response, and risk to individuals and populations described in this opinion's Analytical Approach section.

The following framework programmatic actions are considered in this opinion:

- Operations and maintenance (post-construction)
- Fisheries tidal habitat mitigation
- Long-term aquatic studies (including fisheries monitoring)

2.5.4.1 Operations and Maintenance

The effects of the proposed action components of the future operations and maintenance of the DCP are described in the BA, Appendix 5C.7, 5C.8, 5C.10, 5C.11, and 5C.12, and are incorporated here by reference. A qualitative summary of the DCP related stressors in association with the 2024 LTO opinion and the State's ITP conditions of approval is described in the BA, Appendix 7A.1, and is incorporated here by reference.

Additionally, in Reclamation's BA for the 2024 LTO opinion (Reclamation 2023-2024), relevant guiding principles for the proposed operations of DCP included the following. NMFS expects these principles to apply to the proposed action in this opinion:

- Operate the projects consistent with existing and/or future regulatory requirements in the Delta;
- Implement pulse flow criteria to provide migrating anadromous fish an opportunity to migrate past the diversion locations with minimum exposure to diversions and further minimize effects to through-Delta survival;
- Use best available science to establish flow levels necessary to provide migratory and rearing habitat to minimize effects on juvenile anadromous fish survival and facilitate their movement down the river toward the Delta and San Francisco Bay;
- Monitor and mitigate the effects of diversions on migrating anadromous species and their habitat through identification of opportunities to develop additional habitat (i.e., tidal and channel margin restoration) to improve the productivity of those fish populations;
- Protect habitat conditions supporting listed pelagic and anadromous species, and mitigate potential flow-related effects of DCP with habitat restoration developed in coordination with NMFS, USFWS, and CDFW to improve the productivity of those fish populations;
- Implement project operations and maintenance consistent with the proposed project description as an integrated component of the SWP;
- Update and align elements of project description with conditions (e.g., regulatory, climate, and status of species) in the future consultation on DCP operations and maintenance in advance of operations of the north Delta diversions;
- Use an adaptive management program (AMP) that would integrate with the AMP to test operational modifications to remedy or lessen unanticipated effects.

Exposure and Risk
Adult and juvenile SR winter-run Chinook salmon, CV spring-run Chinook salmon, CCV steelhead, and sDPS green sturgeon will be exposed to the operational effects of the DCP. Fish would generally be present during winter and spring months as they migrate upstream and downstream through the operational footprint, although there are some general exceptions described in greater detail in the Status of the Species section of this opinion. Affected attributes of designated critical habitat are freshwater rearing sites and migration corridors, riparian habitat, access for juvenile migration, and estuarine rearing and migration.

Juvenile and adult listed fish species will be exposed to operational effects primarily during the winter and spring months and, to a lesser extent, during the summer and fall. Sub-adult sDPS green sturgeon could be exposed during all months. Exposure to operational effects using diversion criteria such as minimum bypass flows, pulse flow criteria and protections, and other guiding principles will be used to develop more details in a future operations plan. In general, exposure to operational effects would range between medium and high due to the large number of individuals of each species that migrate through the operational footprint.

The suite of potential effects of the DCP to listed species is from operational effects. Sublethal and lethal effects on juvenile rearing and out-migration are associated with exposure to new or existing diversion facilities and fish screen structures and reduced out-migration flows for juveniles in the Sacramento River and the Delta. Other adverse effects to individuals include impacts to juvenile rearing and out-migration conditions associated with reduced flows and out-migration cues and conditions that reduce survival. It is anticipated the DCP will be operated with operational criteria, including factors such as pulse protection criteria and bypass flows, wherein diversions are restricted based on large-scale downstream movement of juvenile salmonids to minimize the potential for negative effects. Compensatory mitigation, as described in Section 1.3 of this opinion, would be undertaken for hydrodynamic effects, including the potential for reduced riverine flow leading to the potential for lowering the river and possible impacts to critical habitat features.

A suite of potential effects to individuals and PBFs of designated critical habitat are proposed to be minimized or avoided through established guiding principles, BMPs, adaptive management strategies, and monitoring and compensatory mitigation strategies. At this time, without specific operations plans and detailed modeling of integrated operations with the CVP and SWP, we determine there would be a low to medium level of impact to individuals listed fish and their designated critical habitat. However, it is not possible to discern the full scope of those impacts, which will be closely evaluated in subsequent phases of development, authorization, and ESA section 7 consultation.

Summary of Risk
The proposed action includes the future operations and maintenance of the facilities that will be constructed, as described in Section 1.3 of this opinion. There is still uncertainty regarding the details of future operations and maintenance of the DCP. However, the DCP is expected to operate in compliance with various regulatory permits and boundaries. Therefore, NMFS expects that the impacts from the operations and maintenance of the DCP facilities on the listed species will be limited by temporal and spatial components of operating criteria informed by key biological considerations for each listed anadromous species. Biological considerations will be further informed by future site-specific studies on potential effects of the facilities and their operations and maintenance. We anticipate information gained from these studies, combined with latest information on the status of the listed species, will be appropriately used to guide management and operational considerations to further minimize impacts to SR winter-run Chinook salmon, CV spring-run Chinook salmon, CCV steelhead and sDPS green sturgeon.

2.5.4.2 Fisheries Tidal Habitat Mitigation

The proposed action includes habitat mitigation to offset impacts from the permanent removal of habitat within the Sacramento River, as described in section 1.3 of this opinion, and the section 3.6 and Appendix 3B of the BA. This element of the proposed action is considered at the programmatic framework level, because project-specific consultation will determine the amount and extent of take associated with these restoration projects.

All ESA-listed salmonids and sDPS green sturgeon must pass through the Delta during their migration to the Pacific Ocean. Although rearing and migration through the Delta represents a short period of these fish’s overall life cycle, a large proportion of juvenile SR winter-run

Chinook salmon, CV spring-run Chinook salmon, CCV steelhead, and sDPS green sturgeon are expected to be exposed to the tidal habitat restoration in the Delta.

Habitat restoration is expected to benefit juvenile SR winter-run Chinook salmon, CV spring-run Chinook salmon, CCV steelhead, and sDPS green sturgeon through increased food availability and quality and refuge habitat from predators. These benefits can be manifested by higher growth rates in fish using these habitats and increased survival through the Delta.

The following life stages of the listed salmonids and sDPS green sturgeon are expected to be present in the Delta during this period and have the potential to be exposed to impacts from in-water construction: immigrating adult CCV steelhead, juvenile sDPS green sturgeon, and some emigrating adult sDPS green sturgeon. Few, if any, juvenile SR winter-run Chinook salmon, CV spring-run Chinook salmon, or CCV steelhead are expected to be present during the in-water construction work window.

Anticipated effects during construction include temporary loss of aquatic and riparian habitat leading to increased predation, increased water temperature, and reduced food availability; degraded water quality from contaminant discharge by heavy equipment, soils, and increased discharges of suspended solids and turbidity leading to direct toxicological impacts on fish health/performance, indirect impairment of aquatic ecosystem productivity, loss of aquatic vegetation providing physical shelter, and reduced foraging ability caused by decreased visibility; impediments and delay in migration caused by elevated noise levels from machinery; and direct injury or mortality from in-water equipment strikes or isolation/stranding within dewatered cofferdams. The risk from these potential effects would be minimized through the application of AMMs. In general, the objectives of tidal habitat restoration are consistent with objectives of the proposed action.

2.5.4.3 Long-term Aquatic Studies (including Fisheries Monitoring)

The proposed action includes fisheries monitoring and studies, as described in Appendix 5B of the BA. Many ongoing monitoring programs that inform operational actions and effects are currently under existing and separate ESA section 7 consultations and section 10(a)(1)(A) permits and in the Environmental Baseline section of this opinion. Potential future changes to monitoring programs associated with the operation of the proposed action will be addressed in separate ESA section 7 consultations that are tiered to the consultation.

The framework programmatic consultation approach for monitoring includes the following principles, which would be incorporated into any future changes to monitoring programs addressed in a subsequent consultation:

- Ensure monitoring will be beneficial to the proposed action for:
    - Minimizing effects to listed species and habitat.
    - Understanding if various operational objectives are met (e.g., effectiveness and validation monitoring).
- Confirm data collected meet data quality objectives and open data practices.
- Establish a multi-agency collaborative approach, including a management structure for decision-making.
- Ensure scientific rigor of new or modified monitoring and achieving objectives of new or modified monitoring.

- Develop and test mechanisms for learning and adopting new technologies, while maintaining comparability and continuity to historical information on fish and the environment.
- Establish mechanisms for close coordination with any existing or future AMP.
- Provide for robust synthesis of monitoring data to incorporate results and lessons learned.

Given the framework-level programmatic nature of this action component, where further commitment and collaborative planning are necessary to identify effects and quantify a level of benefits and incidental take, it is still possible to estimate a general level of impact qualitatively.

Monitoring effects to listed species commonly include sublethal and lethal effects associated with the capture, collecting, and handling of individuals, although some monitoring activities involve passive techniques that do not result in any adverse effects. Information about when, where, and how the monitoring will occur is important to determining the extent, frequency, and duration of adverse effects, if any, to listed species and critical habitat. If there are changes to the monitoring programs, subsequent approvals would likely be required through separate tiered or stepped-down consultations if it is determined that those activities may affect listed species or designated critical habitat. In general, the objectives of the monitoring program are consistent with objectives of 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 broad scale 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 phenomena that are properly part of the environmental baseline *vs.* cumulative effects. Therefore, all relevant future broad scale environmental conditions in the action area are described earlier in the discussion of environmental baseline (Section 2.4).

2.6.1. Unscreened Water Diversions

Water diversions for irrigated agriculture, municipal and industrial use, and managed wetlands are found throughout the California Central Valley. Thousands of small and medium-size water diversions exist along the Sacramento River, San Joaquin River, their tributaries, and the Delta, and many of them remain unscreened. Depending on the size, location, and season of operation, these unscreened diversions entrain and kill many life stages of aquatic species, including juvenile listed anadromous species (Mussen et al. 2013, Mussen et al. 2014). In 1997, 98.5 percent of the 3,356 diversions included in a Central Valley database were either unscreened or screened insufficiently to prevent fish entrainment (Herren and Kawasaki 2001). More recent data show over 95 percent of more than over 3,700 water diversions on the Sacramento and San Joaquin rivers, their tributaries, and the Delta, remain unscreened (CalFish 2019). The impacts from unscreened water diversions have somewhat improved due to the anadromous fish screen program, part of CVPIA, as well as DWR's fish screening program (Meier 2013). While private irrigation diversions in the Delta are mostly unscreened, the total amount of water diverted onto Delta farms has remained stable for decades (Culberson et al. 2008). A study of a dozen unscreened diversions in the Sacramento River, all relatively deep in the channel, reported low entrainment for listed salmonids and steelhead (Vogel 2013).

2.6.2. Agricultural Practices

Agricultural practices may negatively affect riparian and wetland habitats through upland modifications that lead to increased siltation or reductions in water flow in stream channels flowing into the action area, including the Sacramento River, Stanislaus River, San Joaquin River, and Delta. Grazing activities from dairy and cattle operations can degrade or reduce suitable critical habitat for listed fish species by increasing erosion and sedimentation. These practices introduce nitrogen, ammonia, and other nutrients into the watershed, which then flow into receiving waters (Lehman et al. 2014). Ammonia introduction from agricultural activities can be additive with much larger sources, such as wastewater treatment discharges.
Salmonids and sturgeon exposure to contaminants are inherent in the Delta, ranging in the degree of effects. Stormwater and irrigation discharges related to agricultural activities contain numerous pesticides, herbicides, and other contaminants that may disrupt various physiological mechanisms and negatively affect reproductive success and survival rates of listed anadromous fish (Dubrovsky et al. 1998, Scott and Sloman 2004, Whitehead et al. 2004, Scholz et al. 2012). Agricultural operations outside the action area can result in discharges that flow into the action area and contribute to cumulative effects of contaminant exposure. The State of California issues waste discharge requirements to dischargers, including irrigators, dairy operations, and cattle operations, that require the implementation of BMPs designed to protect surface water quality, with benefits for listed fish species. Agricultural operations have monitoring and reporting requirements associated with those waste discharge requirements that ensure compliance with BMPs.

2.6.3. Wastewater Treatment Plants

Two wastewater treatment plants (one located on the Sacramento River near Freeport and the other on the San Joaquin River near the City of Stockton) have received special attention because of their discharge of ammonia. The EPA published revised national recommended ambient water quality criteria for the protection of aquatic life from the toxic effects of ammonia in 2013. However, few studies have been conducted to assess the effects of ammonia on Chinook salmon, steelhead, or sturgeon. Studies of ammonia effects on various fish species have shown numerous effects, including membrane transport deficiencies, increases in energy consumption, immune system impairments, gill lamellae fusions deformities, liver hydropic degenerations, glomerular nephritis, and nervous and muscular system effects leading to mortality (Eddy 2005, Connon et al. 2011).

Werner et al. (2008), Werner et al. (2009), and Werner et al. (2010) analyzed the acute effects of Sacramento Regional Wastewater Treatment Plant effluent on Delta smelt, rainbow trout, and fathead minnow. The studies found that at ammonia/um concentrations reported downstream of the discharge, on average below 1 milligram per liter ammonia/um, lethal toxicity effects are not expected. In general, this lack of toxicity was attributed to the fact that the lethal concentration at which 50 percent of individuals exposed die (i.e., LC50 values) was much higher than ammonia concentrations reported in environmental sampling. However, the studies did not assess sublethal toxicity. Sublethal ammonia toxicity at concentrations similar to what had been reported downstream of Sacramento Regional Wastewater Treatment Plant (less than 1 milligrams per liter) has been demonstrated in fish. In a study of coho salmon and rainbow trout exposed to ammonia, (Wicks et al. 2002) showed a decrease in swimming performance due to metabolic challenges and depolarization of white muscle and found that ammonia was significantly more toxic for active fish. Furthermore, fish exposed to sublethal concentrations of ammonia/um have exhibited increased respiratory activity and heart rate, loss of equilibrium, and hyper-excitability (Eddy 2005). None of these studies assessed the chronic effects of ammonia/um exposure that may occur at lower concentrations on the behavior, reproduction, or long-term survival of ESA-listed or surrogate species. However, Werner et al. (2009) concluded that “ammonia/um concentrations detected in the Sacramento River below the Sacramento Regional Wastewater Treatment Plant are of concern with respect to chronic toxicity to Delta smelt and other sensitive species.”

The Sacramento Regional Wastewater Treatment Plant (SRWTP), in order to comply with Order no. R5-2013-0124, began implementing compliance measures to reduce ammonia discharges. Construction of treatment facilities for three major projects required for ammonia and nitrate reduction was initiated in March 2015 (Sacramento Regional County Sanitation District 2015). The order was modified in October 2013 by the Central Valley Regional Water Quality Control Board to impose new effluent limitations, requiring effluent limits for ammonia of 2.0 milligrams per liter per day from April to October, and 3.3 milligrams per liter per day from November to March (Central Valley Regional Water Quality Control Board 2016). However, the board concluded that compliance with these effluent limitations was not feasible and put the plant in non-compliance with the ammonia final effluent limitations. In September 2020, the SRWTP requested a Time Schedule Order to extend the compliance schedule to allow additional time to complete upgrades to the Facility. Time Schedule Order R5-2020-0904 was issued on December 4, 2020, which provided a schedule to achieve compliance with final effluent limitations for ammonia by June 1, 2022 (Central Valley Regional Water Quality Control Board 2019, State of California Department of Finance 2023). As of spring 2023, the SRWTP completed extensive upgrades, and the treatment process now removes 99 percent of ammonia.

2.6.4. Increased Urbanization

California’s current population is approximately 39.1 million people. The California Department of Finance projects that California’s population will increase to 40.2 million in 2044, and then decrease to 39.6 million by 2060 (State of California Department of Finance 2023). The increase between now and 2044 will likely be accompanied by increases in urbanization and housing developments. The Delta, East Bay, and Sacramento regions include portions of Alameda, Sacramento, San Joaquin, Solano, Stanislaus, Yolo, and Yuba counties. Population growth rate was highest in Yuba County (0.76 percent, State of California Department of Finance 2023). Increases in urbanization and housing developments can impact habitat by altering watershed characteristics and changing both water use and stormwater runoff patterns. Increased growth will place additional burdens on resource allocations, including natural gas, electricity, and water, as well as on infrastructure such as wastewater sanitation plants, roads, highways, and public utilities. Some of these actions, particularly those situated away from waterbodies, will not require federal permits and thus will not undergo review through ESA section 7 consultations.

Negative effects on listed fish species and their critical habitats may result from urbanization-induced point and non-point source chemical contaminant discharges within the action area. These contaminants, which include, but are not limited to, ammonia and free ammonium ion, numerous pesticides and herbicides, and oil and gasoline product discharges, may disrupt various physiological mechanisms and may negatively affect reproductive success and survival rates of listed anadromous fish (Dubrovsky et al. 1998, Scott and Sloman 2004, Whitehead et al. 2004, Scholz et al. 2012).

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 critical habitat for the conservation of the species.

The aggregate of the jeopardy and adverse modification analyses also includes an evaluation of proposed framework level programmatic activities to assess how they would function within the context of the proposed action, including how they would influence the nature of effects to listed species and their critical habitat. The evaluation of framework programmatic actions considers if the framework action descriptions include conservation measures, guiding principles, best management activities and/or adaptive management provisions that would avoid, minimize or mitigate for the consequences of future project activities on listed species and their designated critical habitat. Under a framework programmatic approach, as specific projects are developed in the future, they are subject to project-specific, or tiered, consultations. Once framework-level action components are further developed and provide sufficient detail to analyze effects on species and critical habitat, they will require additional ESA section 7 consultation before implementation. Those subsequent consultations will include a jeopardy and adverse modification analysis to determine if these future actions would appreciably reduce the likelihood of both the survival and recovery of a listed species or appreciably diminish the value of critical habitat for the conservation of the species. These consultations would also include an incidental take statement for those action components.

2.7.1. SR Winter-run Chinook Salmon

2.7.1.1 Summary of the Environmental Baseline, Cumulative Effects, and Status of the Species

The SR winter-run Chinook salmon in the ESU is currently at a high risk of extinction due to the presence of only one population with a high level of hatchery influence (NMFS 2023). The ESU also continues to face threats from disease; predation; habitat loss, alteration, and degradation; and is particularly susceptible to environmental variation and drought (NMFS 2024c). The existing population spawns in the Sacramento River immediately downstream from Shasta and Keswick reservoirs, and recent droughts in 2014 to 2016 and again in 2020 and 2021 affected early life stage survival that affected adult abundance. The status of SR winter-run Chinook salmon is described in detail in the Status of the Species section of the opinion; in the Environmental Baseline section, where the status is discussed in terms of the past and present impacts of all federal, state, or private actions and other human activities in the action area, and the impact of state or private actions which are contemporaneous with the consultation in process; and in the Cumulative Effects section, that discusses the 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.

In this opinion, the effects of past and current CVP and SWP operations and existing structures are also part of the environmental baseline. Effects of those actions have been analyzed through past and current consultations and contributed to the current condition of the species and critical habitat in the action area. SR winter-run Chinook salmon are exposed to numerous cumulative effects such as unscreened water diversions, agricultural practices that impact water quality and riparian habitat, water contamination from municipal and agricultural sources, effects of urbanization, and other activities.

Abundance and productivity have shown modest improvement in the most recent years, adult escapement in 2024 was low and the full effects of the 2020–2022 drought have yet to be realized due to the 3-year life cycle of most SR winter-run Chinook salmon. Meanwhile, the spatial structure of the ESU remains limited to the single population found in the mainstem Sacramento River, and the genetic and life history diversity of the ESU may have been negatively affected by elevated water temperatures, reduced early life stage survival, and the increased hatchery production implemented to address drought conditions. The ESU also continues to face threats from disease, predation, and habitat loss, alteration, and degradation, and is particularly susceptible to climate change and drought (NMFS 2024c).

The 2023 Viability Assessment for Pacific Salmon and Steelhead Listed Under the Endangered Species Act: Southwest (NMFS 2023) concluded that the LSNFH improved the ESU demographically and genetically through increasing abundance, especially during periods of extremely poor in-river survival, but that the long-term impacts on relying on hatchery fish pose a concern to the long-term viability of the population and the ESU. The lack of population redundancy in the SR winter-run Chinook salmon ESU is the primary factor contributing to its high extinction rate, and viability will ultimately be improved by re-establishing SR winter-run Chinook salmon to properly functioning historical habitats. Efforts to reintroduce fish to Battle Creek have been ongoing since 2014, when the Battle Creek SR winter-run Chinook salmon jump-start project began; evidence of successful spawning has been observed since 2020. Reintroduction efforts on the McCloud River, upstream from Shasta Reservoir, have also been ongoing since 2022 and recently concluded a third year of egg transfers, juvenile survival studies, and equipment testing. Unfortunately, funding for this effort in the McCloud River is tenuous.

2.7.1.2 Summary of the Proposed Action Effect to the Species (Construction and Pre-Operation Maintenance)

SR winter-run Chinook salmon are primarily exposed to project-related effects in the mainstem Sacramento River where construction of the north Delta intakes would occur. Most of the effects to species, as described in section 2.5.1, are localized around the immediate in-channel construction activities. Anticipated effects to species include impacts from construction related noise and reductions in water quality from increased turbidity and sediment disturbance. These activities are expected to cause avoidance of the action area and other behavioral responses, affecting migration and increasing predation risk. With adherence to the in-water work window and implementation of AMMs and BMPs, we expect a small number of juveniles to be affected by these activities during each of the construction years. Additionally, we expect that a small number of juvenile and adult fish to be injured/killed from interactions with construction equipment (e.g., boat/barge propellers, diversions during dewatering, pile driving, etc.) and from capture and handling during rescue efforts. Rescues will be conducted by qualified biologists in order to minimize the numbers of injury and mortality, though low numbers of fish are expected to be injured or killed.

The timeframe for construction within the Sacramento River channel will result in compounding effects. The construction timeframe encompasses at least two generations of SR winter-run Chinook salmon. This in turn may impact the viability of a small portion of the population by increasing stress and reducing the overall fitness of individuals migrating through or rearing in the Delta.

2.7.1.3 Environmental Variation Considerations

As previously described in this opinion, SR winter-run Chinook salmon egg and fry stages are vulnerable to warmer water temperatures during the summer, and therefore particularly at risk from warming conditions due to environmental variations. The only remaining population of SR winter-run Chinook salmon relies on the cold-water pool in Shasta Reservoir, which is used to buffer the effects of warm temperatures in most years. The exception occurs during drought years, particularly back-to-back drought years, which are predicted to occur more often due to ongoing effects of environmental variation.

2.7.1.4 Risk to the Species

The SR winter-run Chinook salmon ESU currently comprises one population that resides in one diversity group in California: the Basalt and Porous Lava Diversity Group. The population currently faces a high risk of extinction that is driven by habitat loss, alteration, and degradation, water operations at Shasta Dam, high levels of hatchery influence, threats from disease, predation, environmental variation and drought (NMFS 2024c). There are ongoing efforts to reintroduce SR winter-run Chinook salmon to Battle Creek and to the McCloud River, but to date, there are no established populations in these areas and funding for the McCloud River effort is currently insufficient to effectively re-establish a viable population.

The proposed action does not impede the implementation of other key elements of the recovery plan, such as improving water conservation across California, incorporating ecosystem restoration in flood control planning, and improving salmon harvest monitoring and management. Implementation of the proposed action is likely not creating conditions that would preclude recovery of SR winter-run Chinook salmon in the future. Ultimately, the most effective way to improve the viability of SR winter-run Chinook salmon is by reestablishing them in their historical habitats upstream of Shasta Reservoir and Battle Creek.

After considering its current rangewide status, the environmental baseline within the action area, the effects of the proposed action, the effects of other activities, and cumulative effects, NMFS concludes that the proposed action is not likely to appreciably reduce the likelihood of both the survival and recovery of the SR winter-run Chinook salmon ESU.

2.7.2. Critical Habitat of SR Winter-run Chinook Salmon

2.7.2.1 Summary of the Status of Designated Critical Habitat for SR Winter-run Chinook Salmon

The PBFs essential for the conservation of listed SR winter-run Chinook salmon within the action area include: (1) migration access from the Pacific Ocean to appropriate spawning areas in the Upper Sacramento River, (2) adequate river flows, (3) habitat areas and adequate prey that are not contaminated, (4) riparian habitat that provides for successful juvenile development and survival, and (5) migration access downstream so that juveniles can migrate to the Pacific Ocean.

Many of the essential PBFs of SR winter-run Chinook salmon are degraded and provide limited high-quality habitat. Water diversions, shoreline armoring, and land development impair the PBFs that support juvenile rearing and out-migration by degrading and limiting access to the floodplain. The lasting impacts of habitat destruction from historical gold mining activities, as well as ongoing activities downstream of the action area within the San Francisco Bay and the southern Delta (including dredging, water exports, vessel traffic, and food web disruption from invasive species), continue to further limit habitat quality.

2.7.2.2 Summary of the Proposed Action Effects on Designated Critical Habitat

Proposed action components that affect the functioning of essential PBFs include:

- The permanent removal of riparian habitat (approximately 5.6 acres) within the primary migration corridor for adult and juvenile salmon.
- The permanent replacement of riparian habitat with riprap and in-water structures such water diversion intakes with a fish screen.

The PBFs of designated critical habitat affected by these proposed activities are habitat areas and adequate prey that are not contaminated, and riparian habitat that provides successful juvenile development and survival.

2.7.2.3 Risk to Critical Habitat at the Designation Level

The essential PBFs of this critical habitat have been highly degraded by past and ongoing actions. Ongoing private, state, and federal actions and future non-federal actions are likely to continue to impair the function of PBFs and slow or limit the development of beneficial aspects of these features. The proposed action will generally mitigate or offset project effects. Therefore, the proposed action is not likely to appreciably diminish the value of the critical habitat for the conservation of SR winter-run Chinook salmon.

2.7.3. Framework-Level Component Summary: SR Winter-run Chinook Salmon and Critical Habitat

Operations and Maintenance
Adverse effects to individuals and PBFs of designated critical habitat are proposed to be minimized or avoided through established Guiding Principles (U.S. Bureau of Reclamation 2023-2024), BMPs, adaptive management strategies, and monitoring and compensatory mitigation strategies. Project components include bypass and pulse flow criteria, monitoring and mitigation actions to address the adverse effects of diversions, including habitat restoration, and use of the best available science to develop and implement operations plans. In addition, the project is expected to operate in compliance with the Biological Criteria and Conditions of Approval of CDFW's 2025 ITP for DCP, which would further limit anticipated adverse effects associated with operations and maintenance of the project.

Fisheries Tidal Habitat Mitigation
Construction for tidal habitat restoration will result in near-term, temporary impacts to aquatic and riparian habitat leading to minimal impacts to listed species. However the risks to individuals will be largely avoided, minimized and mitigated through long-established BMPs described in the BA. Furthermore, the long-term impacts of fisheries tidal habitat mitigation are expected to be beneficial for the listed species and their critical habitat.

Long-term Aquatic Studies (including Fisheries Monitoring)
Many ongoing monitoring programs to inform operational actions and effects are currently under existing and separate ESA section 7 consultations and section 10(a)(1)(A) permits. These consultations and permits were considered in the Environmental Baseline section of this opinion. Proposed monitoring programs associated with the operation of the DCP (framework level component) will be addressed in a subsequent ESA section 7 consultations that will be tiered to this consultation. Subsequent changes to existing monitoring programs are expected to be coordinated and included in future consultations of the LTO of the CVP and SWP to allow for a more uniform analysis and improved accounting of incidental take exemptions associated with the operation of the DCP.

2.7.4. CV Spring-run Chinook Salmon

2.7.4.1 Summary of the Environmental Baseline, Cumulative Effects, and Status of the Species

The status of CV spring-run Chinook salmon is described in detail in the Status of the Species section of the opinion; in the Environmental Baseline section, where the status is discussed in terms of the past and present impacts of all federal, state, or private actions and other human activities in the action area, and the impact of state or private actions which are contemporaneous with the consultation in process; and in the Cumulative Effects section, that discusses the 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. The ESU is currently represented by numerous small populations across all four diversity groups in the Central Valley.

In this opinion, the effects of past and current CVP and SWP operations and existing structures are also part of the environmental baseline. Effects of those actions have been analyzed through past and current consultations and contributed to the current condition of the species and critical habitat in the action area. CV spring-run Chinook salmon are exposed to numerous cumulative effects such as unscreened water diversions, agricultural practices that impact water quality and riparian habitat, water contamination from municipal and agricultural sources, effects of urbanization, and other activities.

The SWFSC's midcycle viability assessment (SWFSC 2023) concluded that the viability of CV spring-run Chinook salmon (through 2021) has declined since the prior viability assessment in 2016, and that the ESU's extinction risk may have increased. This ESU continues to face significant, unyielding threats that are likely to be exacerbated by the impacts of future climate change. Given that the viability of the ESU has decreased, and the threats to the species' persistence remain high and are not improving, significant habitat and flow improvement actions are urgently needed to prevent the species from experiencing a change is status from threatened to endangered or possibly extinct.

2.7.4.2 Summary of the Proposed Action Effect to the Species

CV spring-run Chinook salmon are primarily exposed to project-related effects in the mainstem Sacramento River where construction of the north Delta intakes would occur. Most of the effects to species, as described in section 2.5.1, are localized around the immediate in-channel construction activities. Anticipated effects to species include impacts from construction related noise and reductions in water quality from increased turbidity and sediment disturbance. These activities are expected to cause avoidance of the action area and other behavioral responses, affecting migration and increasing predation risk. With adherence to the in-water work window and implementation of AMMs and BMPs, we expect a small number of juveniles to be affected by these activities during each of the construction years. Additionally, we expect that a small number of juvenile and adult fish to be injured/killed from interactions with construction equipment (e.g., boat/barge propellers, diversions during dewatering, pile driving, etc.) and from capture and handling during rescue efforts. Rescues will be conducted by qualified biologists in order to minimize the numbers of injury and mortality, though low numbers of fish are expected to be injured or killed.

The timeframe for construction within the Sacramento River channel will result in compounding effects. The construction timeframe encompasses at least two generations of CV spring-run Chinook salmon. This in turn may impact the viability of a small portion of the population by increasing stress and reducing the overall fitness of individuals migrating through or rearing in the Delta.

2.7.4.3 Environmental Variation Considerations

Environmental variation is expected to further degrade the suitability of habitats in the Central Valley through increased temperatures, increased frequency of drought, increased frequency of flood flows, and overall drier conditions. Adult CV spring-run Chinook salmon key on snowmelt runoff to access their higher elevation holding and spawning habitat. Thus, the shift from later runoff from snowmelt to earlier runoff from rain could disrupt cues for upstream migration. Adults would arrive in spawning areas earlier and be more likely to hold in unsuitable conditions. Also, juveniles emigrate during spring periods that often coincide with similar runoff events.

2.7.4.4 Risk to the Species

The CV spring-run Chinook salmon listed ESU boundary is currently delineated as all naturally spawned CV spring-run Chinook salmon originating from the Sacramento River and its tributaries downstream of large rim dams. The listed ESU boundary does not include the San Joaquin River or its tributaries, as CV spring-run Chinook salmon were considered extirpated from the basin at the time of listing. However, the San Joaquin River now includes a reintroduced non-essential experimental population (NEP) in the San Joaquin River Restoration (SJRRP) Area (NMFS 2024b); and CV spring-run Chinook salmon have recently been observed in the Mokelumne, Stanislaus, Tuolumne, and Merced rivers in increasing number of returning fish (Gutierrez et al. 2024). The majority of spring-run Chinook salmon populations are in the Sacramento River basin.

The proposed action also does not impede the implementation of other key elements of the recovery plan, such as incorporating ecosystem restoration in flood control planning, and improving salmon harvest monitoring and management. Implementation of the proposed action is therefore not expected to create conditions that would preclude recovery of CV spring-run Chinook salmon in the future. The viability of the CV spring-run Chinook salmon can be improved by reestablishing them in their historical habitats upstream of major dams.

After considering its current rangewide status, the environmental baseline within the action area, the effects of the proposed action, the effects of other activities, and cumulative effects, NMFS concludes that the proposed action is not likely to appreciably reduce the likelihood of both the survival and recovery of the CV spring-run Chinook salmon ESU.

2.7.5. Critical Habitat of CV Spring-run Chinook Salmon

2.7.5.1 Summary of the Status of Designated Critical Habitat for CV Spring-run Chinook Salmon

As described in the Status of the Species and Critical Habitat sections, the geographical range of designated critical habitat for CV spring-run Chinook salmon within the action area includes the Sacramento River in the northern Delta. Within the range of the CV spring-run Chinook salmon ESU, the PBFs of the designated critical habitat that are considered vital for CV spring-run Chinook salmon within the action area include: freshwater rearing sites, water quantity and floodplain connectivity, water quality and forage, natural cover, freshwater migration corridors, and estuarine areas.

As generally described in the Status of the Species and Critical Habitat sections, the status of critical habitat in each of these PBFs is highly degraded. In general, stressors to CV spring-run Chinook salmon critical habitat PBFs include water diversions and water management, dams and other structures that block passage, loss of floodplain connectivity, loss of natural riverine function, bank protection, dredging, sediment disposal, gravel mining, invasive aquatic organisms, and agricultural, urban, and industrial land use (McEwan 2001). Freshwater rearing and migration habitats have been degraded, which delays upstream migration, reduces the availability of quality rearing habitat, and creates improved feeding opportunities for predators such as pikeminnow and striped bass. Additional negative effects to rearing and migration habitats within the Sacramento River include loss of natural river function and floodplain connectivity through flow regulation, levee construction, direct loss of floodplain and riparian habitat, and effects to water quality associated with agricultural, urban, and industrial land use.

Based on the host of stressors to spawning, rearing, migratory, and estuarine habitats in the Central Valley, the current condition of CV spring-run Chinook salmon critical habitat is degraded.

2.7.5.2 Summary of the Proposed Action Effects on Designated Critical Habitat

Proposed action components that affect the functioning of essential PBFs include:

- Permanent removal of riparian habitat (approximately 5.6 acres) within the primary migration corridor for adult and juvenile salmon.
- Permanent replacement of riparian habitat with riprap and in-water structures such water diversion intakes with a fish screen.

The PBFs of designated critical habitat affected by these proposed activities are: freshwater rearing sites, water quantity and floodplain connectivity, water quality and forage, natural cover, freshwater migration corridors, and estuarine areas.

2.7.5.3 Risk to Critical Habitat at the Designation Level

The essential PBFs of this critical habitat have been highly degraded by past and ongoing actions. Ongoing private, state, and federal actions and future non-federal actions are likely to continue to impair the function of PBFs and slow or limit the development of these features. The proposed action is expected to generally mitigate or offset project effects. Therefore, the proposed action is not likely to appreciably diminish the value of the critical habitat for the conservation of CV spring-run Chinook salmon.

2.7.6. Framework-Level Component Summary: CV Spring-run Chinook Salmon and Critical Habitat

Operations and Maintenance
Adverse effects to individuals and PBFs of designated critical habitat are proposed to be minimized or avoided through established Guiding Principles (U.S. Bureau of Reclamation 2023-2024), BMPs, adaptive management strategies, and monitoring and compensatory mitigation strategies. Project components include bypass and pulse flow criteria, monitoring and mitigation actions to address the adverse effects of diversions, including habitat restoration, and use of the best available science to develop and implement operations plans. In addition, the project is expected to operate in compliance with the Biological Criteria and Conditions of Approval of CDFW's 2025 ITP for DCP, which would further limit anticipated adverse effects associated with operations and maintenance of the project.

Fisheries Tidal Habitat Mitigation
Construction for tidal habitat restoration will result in near-term, temporary impacts to aquatic and riparian habitat leading to minimal impacts to listed species. However the risks to

individuals will be largely avoided, minimized and mitigated through long-established BMPs described in the BA. Furthermore, the long-term impacts of fisheries tidal habitat mitigation are expected to be beneficial for the listed species and their critical habitat.

Long-term Aquatic Studies (including Fisheries Monitoring)
Many ongoing monitoring programs to inform operational actions and effects are currently under existing and separate ESA section 7 consultations and section 10(a)(1)(A) permits. These consultations and permits were considered in the Environmental Baseline section of this opinion. Proposed monitoring programs associated with the operation of the DCP (framework level component) will be addressed in a subsequent ESA section 7 consultations that will be tiered to this consultation. Subsequent changes to existing monitoring programs are expected to be coordinated and included in future consultations of the LTO of the CVP and SWP to allow for a more uniform analysis and improved accounting of incidental take exemptions associated with the operation of the DCP.

2.7.7. CCV Steelhead

2.7.7.1 Summary of the Environmental Baseline, Cumulative Effects, and Status of the Species

The status of CCV steelhead is described in detail in the Status of the Species section of this opinion; in the Environmental Baseline section, where the status is discussed in terms of the past and present impacts of all federal, state, or private actions and other human activities in the action area, and the impact of state or private actions which are contemporaneous with the consultation in process; and in the Cumulative Effects section, that discusses the 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.

In this opinion, the effects of past and current CVP and SWP operations and existing structures are also part of the environmental baseline. Effects of those actions have been analyzed through past and current consultations and contributed to the current condition of the species and critical habitat in the action area. CCV steelhead are exposed to numerous cumulative effects such as water management and water diversion practices, unscreened water diversions, agricultural practices that impact water quality and riparian habitat, water contamination from municipal and agricultural sources, effects of urbanization, and other activities.

The DPS is currently represented by numerous small populations across all four diversity groups in the Central Valley. The construction and presence of dams block access to most of their historical habitat. There are approximately six Core 1, sixteen Core 2, and four Core 3 populations and several candidate watersheds for reintroduction. Based upon the limited information available, the overall viability of the CCV steelhead DPS appears to be unchanged since the NMFS (2016c) 5-year review. However, the majority (11 of 16) of populations for which there are data are at a high risk of extinction based on abundance and/or hatchery influence, with no population considered to be at a low risk of extinction. The lack of improved natural production estimates, and low abundances coupled with a large hatchery influence are causes for continued concern (NMFS 2023). No reintroduction efforts for CCV steelhead are in the current planning stage in the Central Valley.

2.7.7.2 Summary of the Proposed Action Effect to the Species

CCV steelhead are primarily exposed to project-related effects in the mainstem Sacramento River where construction of the north Delta intakes would occur. Most of the effects to species, as described in section 2.5.1, are localized around the immediate in-channel construction activities. Anticipated effects to species include impacts from construction related noise and reductions in water quality from increased turbidity and sediment disturbance. These activities are expected to cause avoidance of the action area and other behavioral responses, affecting migration and increasing predation risk. With adherence to the in-water work window and implementation of AMMs and BMPs, we expect a small number of juveniles to be affected by these activities during each of the construction years. Additionally, we expect that a small number of juvenile and adult fish to be injured/killed, from interactions with construction equipment (e.g., boat/barge propellers, diversions during dewatering, pile driving, etc.) and from capture and handling during rescue efforts. Rescues will be conducted by qualified biologists in order to minimize the numbers of injury and mortality, though low numbers of fish are expected to be injured or killed.

The timeframe for construction within the Sacramento River channel will result in compounding effects. The construction timeframe encompasses at least two generations of CV steelhead. This in turn may impact the viability of a small portion of the population by increasing stress and reducing the overall fitness of individuals migrating through or rearing in the Delta.

2.7.7.3 Environmental Variation Considerations

Environmental variation is expected to further degrade the suitability of habitats in the Central Valley through increased temperatures, increased frequency of drought, increased frequency of flood flows, and overall drier conditions. Adult CCV steelhead key on snowmelt runoff to access their higher elevation holding and spawning habitat. Thus, the shift from later runoff from snowmelt to earlier runoff from rain will likely disrupt cues for upstream migration. Adults would arrive in spawning areas earlier and be more likely to hold in unsuitable conditions. Also, juveniles emigrate during spring periods that often coincide with similar runoff events.

2.7.7.4 Risk to the Species

CCV steelhead are composed of multiple populations across four diversity groups. Based upon the limited information available, the overall viability of the CCV steelhead DPS appears to be unchanged since the NMFS (2016c) 5-year review. However, the majority (11 of 16) of populations for which there are data are at a high risk of extinction based on abundance and/or hatchery influence, with no population 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.

The proposed action does not impede the implementation of other key elements of the recovery plan, incorporating ecosystem restoration in flood control planning, and improving salmon harvest monitoring and management. Implementation of the proposed action is therefore not likely to create conditions that would preclude recovery of CCV steelhead in the future. Ultimately, the most effective way to improve the viability of the CCV steelhead is reestablishing them in their historical habitats upstream of major dams.

Considering its current rangewide status, the environmental baseline within the action area, the effects of the proposed action, the effects of other activities, and cumulative effects, NMFS concludes that the proposed action is not likely to appreciably reduce the likelihood of both the survival and recovery of the CCV steelhead.

2.7.8. Critical Habitat of CCV Steelhead

2.7.8.1 Summary of the Status of Designated Critical Habitat for CVV Steelhead

As described in the Status of the Species and Critical Habitat section, the geographic extent of designated critical habitat for CCV steelhead within the action area includes the Sacramento River in the northern Delta, and the waterways of the Delta. CCV steelhead critical habitat within the action area has PBFs that include: freshwater rearing sites, freshwater migration corridors, and estuarine habitat. The PBFs for CCV steelhead designated critical habitat were described in 70 FR 52488.

In general, stressors to CCV steelhead critical habitat PBFs of rearing sites, and migration corridors include; water diversions and water management, dams and other structures, loss of floodplain connectivity, loss of natural riverine function and bank protection, dredging, sediment disposal, gravel mining, invasive aquatic organisms, and agricultural, urban, and industrial land use (McEwan 2001). Passage impediments in the Sacramento and San Joaquin river basins have contributed to substantial reductions in suitable habitat available to CCV steelhead by isolating them from much of their historical spawning habitat. The function of PBFs of available critical habitat is currently highly degraded. Rearing and migration PBFs have also been degraded within the Sacramento and San Joaquin river basins by loss of natural river function and floodplain connectivity through flow regulation, water withdrawals, levee construction, direct loss of floodplain and riparian habitat, and effects to water quality associated with agricultural, urban, and industrial land use. Lasting impacts of habitat destruction from gravel mining and historical gold mining activities as well as ongoing activities in the Central Valley bays and Delta (including dredging, agricultural barriers, water exports, vessel traffic, and food web disruption from invasive species) continue to further limit habitat quality.

Based on the host of stressors to spawning, rearing, migratory, and estuarine habitats in the Central Valley, it is apparent that the current condition of CCV steelhead critical habitat is degraded.

2.7.8.2 Summary of the Proposed Action Effects on Designated Critical Habitat

Proposed action components that affect the functioning of essential PBFs include:

- The permanent removal of riparian habitat (approximately 5.6 acres) within the primary migration corridor for adult and juvenile salmon.
- The permanent replacement of riparian habitat with riprap and in-water structures such water diversion intakes with a fish screen.

The PBFs of designated critical habitat affected by these proposed activities are: freshwater rearing sites, freshwater migration corridors, and estuarine habitat.

2.7.8.3 Risk to Critical Habitat at the Designation Level

The essential PBFs of this critical habitat have been highly degraded by past and ongoing actions. Ongoing private, state, and federal actions and future non-federal actions are likely to continue to impair the function of PBFs and slow or limit the development of these features. The proposed action will generally mitigate or offset project effects. Therefore, the proposed action is not likely to appreciably diminish the value of the critical habitat for the conservation of CCV steelhead.

2.7.9. Framework-Level Component Summary: CCV Steelhead and Critical Habitat

Operations and Maintenance
Adverse effects to individuals and PBFs of designated critical habitat are proposed to be minimized or avoided through established Guiding Principles (U.S. Bureau of Reclamation 2023-2024), BMPs, adaptive management strategies, and monitoring and compensatory mitigation strategies. Project components include bypass and pulse flow criteria, monitoring and mitigation actions to address the adverse effects of diversions, including habitat restoration, and use of the best available science to develop and implement operations plans. In addition, the project is expected to operate in compliance with the Biological Criteria and Conditions of Approval of CDFW's 2025 ITP for DCP, which would further limit anticipated adverse effects associated with operations and maintenance of the project.

Fisheries Tidal Habitat Mitigation
Construction for tidal habitat restoration will result in near-term, temporary impacts to aquatic and riparian habitat leading to minimal impacts to listed species. However the risks to individuals will be largely avoided, minimized and mitigated through long-established BMPs described in the BA. Furthermore, the long-term impacts of fisheries tidal habitat mitigation are expected to be beneficial for the listed species and their critical habitat.

Long-term Aquatic Studies (including Fisheries Monitoring)
Many ongoing monitoring programs to inform operational actions and effects are currently under existing and separate ESA section 7 consultations and section 10(a)(1)(A) permits. These consultations and permits were considered in the Environmental Baseline section of this opinion. Proposed monitoring programs associated with the operation of the DCP (framework level component) will be addressed in a subsequent ESA section 7 consultations that will be tiered to this consultation. Subsequent changes to existing monitoring programs are expected to be coordinated and included in future consultations of the LTO of the CVP and SWP to allow for a more uniform analysis and improved accounting of incidental take exemptions associated with the operation of the DCP.

2.7.10. sDPS of North American Green Sturgeon

2.7.10.1 Summary of the Environmental Baseline, Cumulative Effects, and Status of the Species

The status of sDPS of North American green sturgeon is described in detail in the Status of the Species section of this opinion; in the Environmental Baseline section, where the status is discussed in terms of the past and present impacts of all federal, state, or private actions and other human activities in the action area, and the impact of state or private actions which are contemporaneous with the consultation in process; and in the Cumulative Effects section, that discusses the 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.

In this opinion, the effects of past and current CVP and SWP operations and existing structures are also part of the environmental baseline. Effects of those actions have been analyzed through past and current consultations and contributed to the current condition of the species and critical habitat in the action area. sDPS green sturgeon are exposed to numerous cumulative effects such as water management and water diversion practices, unscreened water diversions, agricultural practices that impact water quality and riparian habitat, water contamination from municipal and agricultural sources, effects of urbanization, and other activities.

The sDPS of green sturgeon is at substantial risk of future population declines (NMFS 2021). The principal threat to green sturgeon in the sDPS is the reduction in available spawning habitat due to dams and barriers on Central Valley rivers, which alter and reduce the replenishment of spawning substrates for the species. The potential threats faced by sDPS green sturgeon include enhanced vulnerability due to the reduction of spawning habitat into one concentrated area on the Sacramento River, lack of empirical population data, vulnerability of long-term cold water supply for egg incubation and larval survival, loss of juvenile sDPS green sturgeon due to entrainment at the CVP and SWP 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.

2.7.10.2 Summary of the Proposed Action Effect to the Species

sDPS green sturgeon are primarily exposed to project-related effects in the mainstem Sacramento River where construction of the north Delta intakes would occur. Most of the effects to species, as described in section 2.5.1, are localized around the immediate in-channel construction activities. Anticipated effects to species include impacts from construction related noise and reductions in water quality from increased turbidity and sediment disturbance. These activities are expected to cause avoidance of the action area and other behavioral responses, affecting migration and increasing predation risk. With adherence to the in-water work window and implementation of AMMs and BMPs, we expect a small number of juveniles to be affected by these activities during each of the construction years. Additionally, we expect that a small number of juvenile and adult fish to be injured/killed from interactions with construction equipment (e.g., boat/barge propellers, diversions during dewatering, pile driving, etc.) and from capture and handling during rescue efforts. Rescues will be conducted by qualified biologists in order to minimize the numbers of injury and mortality, though low numbers of fish are expected to be injured or killed.

The timeframe for construction within the Sacramento River channel will result in compounding effects. Individual sDPS green sturgeon could rear or migrate near or past the construction action area more than once in their lifetime. This in turn may impact the viability of a small portion of the population by increasing stress and reducing the overall fitness of individuals migrating through or rearing in the Delta.

2.7.10.3 Environmental Variation Considerations

In the Sacramento River, the upstream extent of the spawning range for sDPS green sturgeon lies somewhere downstream of ACID Dam (river mile 298), as that dam and associated fish ladder presumably impede passage for sDPS green sturgeon further up the Sacramento River. It is uncertain if sDPS green sturgeon spawning occurs in cooler water reaches of the Upper Sacramento River near ACID Dam, but this habitat (~4 river miles to Keswick Dam) could allow spawning to shift upstream in response to environmental variation change effects.

2.7.10.4 Risk to the Species

sDPS green sturgeon are known to range through the San Francisco Bay estuary, the Delta, and the Sacramento, Feather, and Yuba Rivers. In summary, available information indicates the spatial structure of sDPS green sturgeon is composed of a single, independent population, which principally spawns in the mainstem Sacramento River and also breeds opportunistically in the Feather River and Yuba River. Concentration of adults in a very few select spawning locations makes the species highly vulnerable to poaching and catastrophic events. The apparent extirpation from potential upstream spawning reaches of the San Joaquin River narrows the habitat usage by the species, leaving little buffer to impacts to the species.

NMFS expects the effects of the proposed action on abundance are likely insignificant. Overall, the proposed action is not expected to exert any additional selective pressures on sDPS green sturgeon that would affect the diversity parameter. Given the higher tolerances of water temperatures and turbidity of sDPS green sturgeon when compared to salmonids, the effects of the proposed action on individual fish are anticipated to be insignificant.

The proposed action also does not impede implementation of other key elements of the recovery plan, such as improving passage and water quality conditions in the Yuba and Feather Rivers and reducing non-point source contaminants in the Delta. Implementation of the proposed action is, therefore, not creating conditions that would preclude recovery of sDPS green sturgeon.

After considering its current rangewide status, the environmental baseline within the action area, the effects of the proposed action, the effects of other activities, and cumulative effects, NMFS concludes that the proposed action is not likely to appreciably reduce the likelihood of both the survival and recovery of the sDPS green sturgeon.

2.7.11. Critical Habitat of sDPS of North American Green Sturgeon

2.7.11.1 Summary of the Status of Designated Critical Habitat for sDPS Green Sturgeon

The PBFs essential for the conservation of listed sDPS green sturgeon within the action area include (1) food resources, (2) substrate type or size, (3) water flow, (4) water quality, (5) migratory corridor, (5) water depth, and (6) sediment quality.

Many of the PBFs of sDPS green sturgeon designated critical habitat are currently degraded or impaired and provide limited high-quality habitat. Features that lessen the quality of migratory corridors and rearing habitat for juveniles include unscreened or inadequately screened diversions, altered flows in the Delta, and the presence of contaminants in sediment. Although the current conditions of sDPS green sturgeon critical habitat are significantly degraded, the spawning habitat, migratory corridors, and rearing habitat that remain in both the Sacramento/San Joaquin River watersheds and the Delta are considered to have high intrinsic value for the conservation of the species.

2.7.11.2 Summary of the Proposed Action Effects on Designated Critical Habitat

Proposed action components that affect the functioning of essential PBFs include:

- The permanent removal of riparian habitat (approximately 5.6 acres) within the primary migration corridor for adult and juvenile sDPS green sturgeon.
- The permanent replacement of riparian habitat with riprap and in-water structures such water diversion intakes with a fish screen.

The PBFs of designated critical habitat affected by these proposed activities are: food resources, substrate type or size, water quality, migratory corridor, water depth, and sediment quality.

2.7.11.3 Risk to Critical Habitat at the Designation Level

The essential PBFs of this critical habitat have been highly degraded by past and ongoing actions. Ongoing private, state, and federal actions and future non-federal actions are likely to continue to impair the function of PBFs and slow or limit the development of these features. The proposed action will generally mitigate or offset project effects. Therefore, the proposed action is not likely to appreciably diminish the value of the critical habitat for the conservation of sDPS of green sturgeon.

2.7.12. Framework-Level Component Summary: sDPS Green Sturgeon and Critical Habitat

Operations and Maintenance

Adverse effects to individuals and PBFs of designated critical habitat are proposed to be minimized or avoided through established Guiding Principles (U.S. Bureau of Reclamation 2023-2024), BMPs, adaptive management strategies, and monitoring and compensatory mitigation strategies. Project components include bypass and pulse flow criteria, monitoring and mitigation actions to address the adverse effects of diversions, including habitat restoration, and use of the best available science to develop and implement operations plans. In addition, the project is expected to operate in compliance with the Biological Criteria and Conditions of Approval of CDFW's 2025 ITP for DCP, which would further limit anticipated adverse effects associated with operations and maintenance of the project.

Fisheries Tidal Habitat Mitigation

Construction for tidal habitat restoration will result in near-term, temporary impacts to aquatic and riparian habitat leading to minimal impacts to listed species. However the risks to individuals will be largely avoided, minimized and mitigated through long-established BMPs described in the BA. Furthermore, the long-term impacts of fisheries tidal habitat mitigation are expected to be beneficial for the listed species and their critical habitat.

Long-term Aquatic Studies (including Fisheries Monitoring)

Many ongoing monitoring programs to inform operational actions and effects are currently under existing and separate ESA section 7 consultations and section 10(a)(1)(A) permits. These consultations and permits were considered in the Environmental Baseline section of this opinion. Proposed monitoring programs associated with the operation of the DCP (framework level component) will be addressed in a subsequent ESA section 7 consultations that will be tiered to this consultation. Subsequent changes to existing monitoring programs are expected to be coordinated and included in future consultations of the LTO of the CVP and SWP to allow for a more uniform analysis and improved accounting of incidental take exemptions associated with the operation of the DCP.

2.8. Conclusion

After reviewing, analyzing, and adding together 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 of North American green sturgeon, or destroy or adversely modify their designated critical habitat.

2.9. Incidental Take Statement

Section 9 of the ESA and federal regulations pursuant to section 4(d) of the ESA prohibit the take of endangered and threatened species, respectively, without a special exemption. "Take" is defined as to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture or collect, or to attempt to engage in any such conduct. "Harm" is further defined by regulation to include significant habitat modification or degradation that actually kills or injures fish or wildlife by significantly impairing essential behavioral patterns, including breeding, spawning, rearing, migrating, feeding, or sheltering (50 CFR 222.102). "Harass" is further defined by 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.

An incidental take statement is not required for a framework-level programmatic action component, i.e., an action "that approves a framework for the development of future action(s) that are authorized, funded, or carried out at a later time, and any take of a listed species would not occur unless and until those future action(s) are authorized, funded, or carried out and subject to further ESA section 7 consultation" (50 CFR 402.02; 50 CFR 402.14).

For a mixed programmatic action, an incidental take statement is required only for those programmatic actions that are reasonably certain to cause take and are not subject to further ESA section 7 consultation (50 CFR 402.14). A mixed programmatic action is defined as, "for the purposes of an incidental take statement, a federal action that approves action(s) that will not be subject to further ESA section 7 consultation, and also approves a framework for the development of future action(s) that are authorized, funded, or carried out at a later time and any take of a listed species would not occur unless and until those future action(s) are authorized, funded, or carried out and subject to further ESA section 7 consultation" (50 CFR 402).

If an action agency designs a mixed programmatic action that approves a framework for the development of future action(s) that are authorized, funded, or carried out at a later time and provides adequate information to inform the development of a biological opinion related to future actions implemented under the program that are not subject to further ESA section 7 consultation, NMFS will include an incidental take statement related to such programmatic action if it determines that the action is reasonably certain to cause incidental take of listed species.

The proposed action is a mixed programmatic action that includes: (1) a framework for the development of future actions (i.e., operations and maintenance of the future DCP, habitat mitigation, fisheries studies), and (2) actions that are not subject to further approvals (i.e., construction of the DCP facilities). This incidental take statement is applicable to all construction and pre-operation maintenance activities for the DCP, as described in the BA (ICF 2025). This incidental take statement does not include framework programmatic action components of the proposed action where information was not sufficient to determine specific levels of incidental take of listed species. An incidental take statement for those actions is expected to be included in a subsequent tiered project-level ESA section 7 consultation.

2.9.1. Amount or Extent of Take

NMFS often cannot, using the best available information, quantify and track the amount or number of individuals that are expected to be incidentally taken per species because of the variability and uncertainty associated with the population sizes of the species, annual variation in the timing of migration, and variability regarding individual habitat use of the action area. However, it is possible to express the extent of incidental take in terms of ecological surrogates for those elements of the proposed action that are expected to result in incidental take.

These ecological surrogates are measurable, and the Corps and DWR can monitor the ecological surrogates to determine whether the level of anticipated incidental take described in this incidental take statement is exceeded.

In the biological opinion, NMFS determined that incidental take is reasonably certain to occur as follows: increases in turbidity, pile driving, barge and boat traffic noise, and permanent loss of habitat.

2.9.1.1 Incidental take associated various construction noise sources

NMFS anticipates incidental take will be limited to take in the form of harm, injury and death to individual listed fish, due to elevated underwater noise from construction, including pile driving.

The anticipated low numbers of adult and/or juvenile SR winter-run Chinook salmon, CV spring-run Chinook salmon, CCV steelhead, and sDPS green sturgeon that are passing through or otherwise present in the action area during construction activities will be exposed to elevated levels of noise generated by pile driving, dredging, and boat or barge traffic, resulting in reduced fitness and reduced survival. The level of underwater noise generated during construction can be accurately and consistently measured and provides a quantifiable metric for the extent of acoustic effects. The measurement of underwater noise generated during construction, and the vibratory and impact pile driving described in the proposed action, will therefore serve as a quantifiably measurable surrogate for incidental take of listed fish species. The most appropriate thresholds for incidental take in the form of harm (resulting in fish displacement or behavior modification), injury, and death associated with elevated underwater noise from construction and pile driving is an ecological surrogate expressed as the amount of habitat temporarily disturbed by elevated underwater noise within a certain distance from the construction site or the source of the acoustic signal, in this case the pile being driven. Elevated underwater noise disturbances are also expected to elevate fish stress levels, contributing to decreased overall fitness and survival of exposed individuals through compounding sub-lethal effects.

NMFS uses an ecological surrogate for acoustic noise characterized as an estimated distance to a specific threshold of sound that is expected to result in adverse effects to fish, either through behavioral responses to the disturbance (150 dB), the onset of physical injury (183/187 dB), or mortality (206 dB). The corresponding area of effect at each construction site is then calculated based on the distance to a given threshold as determined by the equipment being used, the nature, frequency, and duration of the construction activities being performed, and any unique site-specific environmental conditions that might affect the way sound disperses at that location, such as channel geometry, water depth, or soil composition (Table 6). Underwater acoustic noise below the 150 dB threshold is considered ‘effective quiet’ for assessing effects to listed fish. The estimated distances and corresponding areas of effect for each of the construction sites in or adjacent to the aquatic environment in the action area are represented in the table below.

Table 6. Summary table of the estimated distances to threshold and areas of acoustic impacts from pile driving based on noise level (where dB = decibels).

Estimated distances to thresholds and areas of acoustic effects from pile driving

Noise Level (below)	Intake B Cofferdams (21 days)	Intake C Cofferdams (21 days)	Intake B Logbooms (4 days)	Intake C Logbooms (4 days)	Snodgrass Slough Bridge Crossing (5 days)	Burns Cutoff Bridge Crossing (9 days)
206-dB	9 m 0.1 acres	9 m 0.1 acres	25 m 0.5 acres	25 m 0.5 acres	7 m 0.1 acres	24 m 0.47 acres
187-dB	179 m 12.3 acres	117 m 6.7 acres	1,166 m 66.4 acres	302 m 27.2 acres	273 m 4.1 acres	371 m 12.4 acres
183-dB	331 m 25.1 acres	216 m 18.5 acres	1,166 m 66.4 acres	558 m 51.7 acres	504 m 7.3 acres	685 m 12.4 acres
150-dB	4,641 m 67.7 acres	4,641 m 134.1 acres	3,981 m 69.3 acres	3,981 m 117.9 acres	3,981 m 25.5 acres	3,981 m 12.4 acres

Based on the timing of the proposed in-water work in these areas, and as detailed in sections 3.2.2, 5.4.1, and Appendix 3A.1.15 of the BA and incorporated here by reference, NMFS anticipates that underwater noise levels from pile driving and other construction activities would adversely affect the listed species due to their temporal and spatial overlap with pile driving over a period of up to 25 to 35 days during the proposed in-water work windows (June 1–October 31) over a 2-year interval at each intake location.

If monitoring indicates that underwater sound levels greater than 206 dB peak, 187 dB or 183 dB cumulative SEL, or 150 dB RMS extend beyond the distances expected for the activities and locations presented in the table above, the amount of incidental take for those surrogates will have been exceeded, triggering the need to stop work and contact NMFS within 24 hours.

2.9.1.2 Incidental take associated with water quality (elevated in-river turbidity plumes and disturbance)

In-water construction and pre-operation maintenance activities are expected to mobilize sediment and increase water turbidity beyond natural levels. Increased turbidity is expected to cause harm to listed species present through elevated stress levels and disruption of normal habitat use. These temporary responses are expected to result in decreased growth, survival, and a reduction of overall fitness as described in the effects section of this opinion.

NMFS anticipates incidental take will be limited to take in the form of harm to a low number of SR winter-run Chinook salmon, CV spring-run Chinook salmon, CCV steelhead, and sDPS green sturgeon over a 2-year interval at each intake location, as a result of exposure to elevated concentrations of suspended sediment in the water column generating turbidity plumes in the action area. The most appropriate ecological surrogate providing a quantifiable metric to determine the extent of incidental take of listed fish caused by turbidity increases related to in-water construction and maintenance activity is a measurement of nephelometric turbidity units (NTUs) in the water column relative to pre-construction background conditions measured upstream of the construction area.

Incidental take would consist of fish disturbance and sub-lethal effects associated with elevated in-river turbidity plumes is an ecological surrogate of the extent and duration of turbidity increases in the aquatic environment relative to environmental background conditions during in-water construction and maintenance. In tidally influenced waters, such as the action area, the affected area may occur either upstream or downstream from the disturbance in accordance with the prevailing direction of flow at that time. Based on specific site conditions, and in accordance with the turbidity objectives and basin plan standards for construction as identified by the Central Valley Regional Water Quality Control Board in the *Basin Plan for the Sacramento River and San Joaquin River Basins* (CVRWQCB 2019), where natural turbidity is between 5 and 50 NTUs, turbidity levels may not be elevated by 20 percent above ambient conditions; where ambient conditions are between 50 and 100 NTUs, conditions may not be increased by more than 10 NTUs; and where natural turbidity is greater than 100 NTUs, increases will not exceed 10 percent. If turbidity is higher than these levels, take would be considered exceed.

2.9.1.3 Incidental take associated with the permanent loss of habitat

The proposed project would result in permanent impacts to approximately 5.6 acres of tidal perennial habitat, which includes 3.4 acres of riparian habitat. Habitat features would be permanently replaced by riprap or in-channel water diversion structures. This area of 5.6 acres will serve as the ecological surrogate.

NMFS expects the following species and life stages to be impacted by the permanent loss of habitat:

- adult and/or juvenile SR winter-run Chinook salmon
- adult and/or juvenile CV spring-run Chinook salmon
- adult and/or juvenile CCV steelhead
- adult and/or juvenile sDPS green sturgeon

Incidental take will occur in the form of harm to the listed species and life stages through permanent adverse habitat changes resulting from the removal of riparian vegetation and habitat. The most appropriate surrogate measurement of harm to the listed species is the total area (in terms of acreage) and amount of riparian habitat permanently removed from the action area. This is an appropriate surrogate because the amount of riparian habitat removal and degradation is expected to be coextensive with effect to fish and resulting in impacts.

The removed riparian vegetation would have otherwise supported the macroinvertebrate prey of juvenile salmon, steelhead, and benthic prey items for adult and juvenile sDPS green sturgeon. The removed riparian vegetation would have also provided limited amounts of shade and habitat cover relative to their occupation in the overall available habitat. The loss of shade, habitat cover, and allochthonous input (i.e., macroinvertebrates and organic materials), will result in a reduction in growth, fitness, and survival.

NMFS considers any increases to the area of permanent habitat loss would exceed the anticipated incidental take of ESA-listed anadromous fish as assessed in this opinion.

2.9.1.4 Incidental take associated with the compounding effects of construction

The proposed project includes a variety of ongoing construction activities within the Sacramento River channel for approximately six years. During each of those years, NMFS expects the following species and life stages to be impacted by compounding effects, as described in the effects section of this opinion:

- adult and/or juvenile SR winter-run Chinook salmon
- adult and/or juvenile CV spring-run Chinook salmon
- adult and/or juvenile CCV steelhead
- adult and/or juvenile sDPS green sturgeon

Incidental take will occur in the form of harm to the listed species and life stages through the compounding effects of acoustics, degraded water quality, physical injury and/or mortality, and permanent loss of habitat. The most appropriate surrogate measurement of harm to the listed species is the length of time that construction will occur within the Sacramento River channel within the action area. This is an appropriate surrogate because fish are expected to be exposed to the effects caused by construction and pre-operation maintenance for the entire length of time these activities occur within the river channel, and those effects are expected to result in take.

Due to the length of time of construction within the primary rearing and migratory route for the above listed species, multiple generations of fish for each species are expected to be impacted.

The multi-generational impacts of the proposed project will result in reduced growth, fitness, and survival to a small proportion of the populations.

While the construction activities are expected to occur for up to six years, we can reasonably assume unforeseen construction delays could result in an additional year of work. Therefore, NMFS considers that if construction within the Sacramento River channel extends more than seven years total, then it would exceed anticipated incidental take of ESA-listed anadromous fish as assessed in this opinion.

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 designated critical habitat.

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 by the Corps, or its applicant, to reduce underwater sound impacts and other disturbances related to pile driving and barge and boat traffic, as described in this biological opinion.
2) Measures shall be taken by the Corps, or its applicant, to minimize sediment events and turbidity plumes in the action area and related effects, as described in this biological opinion.
3) Measures shall be taken by the Corps, or its applicant, to reduce the extent of degradation and alteration to the habitats in the action area because of the permanent removal of riparian habitat and replacement with riprap and in-channel structures, related to the effects of this proposed project, as described in this biological opinion.
4) Measures shall be taken by the Corps, or its applicant, to prepare and provide NMFS with a plan and report describing how ESA-listed species in the action area would be protected and/or monitored and to document the observed effects of the proposed action on listed species and designated critical habitat. In the report, the Corps, or its applicant, shall demonstrate how the conservation measures were incorporated and implemented.

2.9.4. Terms and Conditions

In order to be exempt from the prohibitions of section 9 of the ESA, the federal action agency must comply (or must ensure that any applicant complies) with the following terms and conditions. The Corps, or any applicant, has a continuing duty to monitor the impacts of incidental take and must report the progress of the action and its impact on the species as specified in this ITS (50 CFR 402.14). If the entity to whom a term and condition is directed does not comply with the following terms and conditions, protective coverage for the proposed action would likely lapse.

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

    a. For each year of construction for the proposed project with in-river channel work, an annual report shall be submitted to NMFS that describes how incidental take was not exceeded due to sound from construction. The report should include a description of the monitoring efforts and associated data used to evaluate the level of underwater noise from the various construction and pre-operation maintenance related activities. The annual report should be submitted to NMFS by March 31 of each calendar year and should include information for the previous calendar year.

2. The following terms and conditions implement reasonable and prudent measure 2:
    a. For each year of construction and/or pre-operation maintenance for the proposed project with in-water work, an annual report shall be submitted to NMFS that describes how incidental take was not exceeded due to turbidity, suspended sediments, or accidental contaminants from such activities. The report should include a description of the monitoring efforts and associated data used to evaluate the level of water quality impacts from those activities. The annual report should be submitted to NMFS by March 31 of each calendar year and should include information for the previous calendar year.

3. The following terms and conditions implement reasonable and prudent measure 3:
    a. For each year of construction for the proposed project where riparian or tidal perennial habitat is permanently removed, an annual report shall be submitted to NMFS that describes how incidental take was not exceeded due to habitat removal from construction. The report should include a description of the monitoring efforts and associated data used to evaluate the level of permanent habitat loss from the various construction related activities. The annual report shall be submitted to NMFS by March 31 of each calendar year and should include information for the previous calendar year.
    b. Upon completion of riparian and tidal perennial habitat permanent removal, a plan shall be submitted to NMFS that outlines an estimated timeframe and details for how habitat for ESA-listed anadromous fish will be mitigated per Appendix 3B of the BA (ICF 2025). The plan shall be submitted within one calendar year of completion of permanent habitat removal.

4. The following terms and conditions implement reasonable and prudent measure 4:
    a. Prior to the start of construction activities, a plan shall be submitted to NMFS that outlines how ESA-listed species in the action area would be protected and/ or monitored during construction, and to document the observed effects of the proposed action on listed species and designated critical habitat. In the plan, the Corps, or its applicant, shall demonstrate how the conservation measures will be implemented. The plan shall be submitted to NMFS at least 90 days prior to the start of construction activities within the Sacramento River channel. The plan shall also include a communication protocol for how the Corps, or its applicant, will notify NMFS if incidental take has been exceeded, and/or if ESA-listed anadromous fish are observed in the action area during construction activities. This communication protocol shall include a process for how NMFS will be informed within 48 hours if incidental take, as measured by the ecological surrogates, has been exceeded.

b. Upon completion of in-river channel work for the proposed project, a report shall be submitted to NMFS that describes how ESA-listed species were monitored and protected during construction activities. The report shall be submitted within 90 days of completion of in-river channel work for the proposed project.

2.10. Conservation Recommendations

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

1) The Corps should continue supporting and promoting aquatic and riparian habitat restoration within the Sacramento-San Joaquin River Delta and other watersheds, especially those with listed anadromous fish species. Practices that avoid or minimize adverse effects to listed species should be encouraged.
2) The Corps should continue to work cooperatively with other State and Federal agencies, private landowners, governments, and local watershed groups to identify opportunities for cooperative analysis and funding to support salmonid and/or green sturgeon habitat restoration projects.
3) The Corps should use all their authorities, to the maximum extent feasible to implement high priority actions in the Central Valley Salmon and Steelhead Recovery Plan (NMFS 2014) and/or the Recovery Plan for the sDPS of North American Green Sturgeon (NMFS 2021).

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

2.11. Reinitiation of Consultation

This concludes formal consultation for the Delta Conveyance Project.

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

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

Section 305(b) of the MSA directs federal agencies to consult with NMFS on all actions or proposed actions that may adversely affect EFH. Under the MSA, this consultation is intended to promote the conservation of EFH as necessary to support sustainable fisheries and the managed species' contribution to a healthy ecosystem. For the purposes of the MSA, EFH means "those waters and substrate necessary to fish for spawning, breeding, feeding, or growth to maturity", and includes the 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. Essential Fish Habitat Affected by the Proposed Action

NMFS has evaluated the proposed action for the ESA consultation as a "mixed programmatic" action as defined by 50 CFR 402.02 because it includes some action components for which no additional authorization will be necessary and others that are considered at a framework-level. Once framework-level action components are further developed and sufficient detail is available to determine the amount and extent of incidental take, they will require additional ESA section 7 consultation, and EFH consultation, before implementation. Additionally, in future combined ESA/ EFH consultations, the action area may be re-assessed based on updated information and operational details. Therefore, this EFH consultation only includes the construction and pre-operation maintenance activities under the proposed action, and the associated action area for those activities (section 2.3.1 of this opinion), and does not include the activities assessed under the Framework Programmatic.

The proposed action under this EFH consultation occurs within EFH for various federally managed fish species within the Pacific Coast Groundfish Fishery Management Plan (FMP; PFMC 2025) and the Pacific Coast Salmon FMP (PFMC 2014, 2024). The action area of the proposed action occurs within the legal boundary of the Sacramento- San Joaquin Delta (Delta). The Delta is considered to be a tidally influenced and part of the San Francisco Bay-Delta estuary. This information is relevant in determining which, if any, habitat area of particular concern (HAPC) are within or near the vicinity of the proposed project. Given this information, the project occurs within and near the vicinity of estuary habitat that is designated as a HAPC for various federally managed fish species within the Pacific Coast Groundfish FMP, and for various federally managed fish species within the Pacific Coast Salmon FMP. Under the Pacific Coast Salmon FMP, the populations include SR winter-run Chinook salmon, CV spring-run Chinook salmon, and CV fall-run and late fall-run Chinook salmon.

HAPC are described in the regulations as subsets of EFH which are rare, particularly susceptible to human-induced degradation, especially ecologically important, or located in an environmentally stressed area. Designated HAPC are not afforded any additional regulatory protection under the MSA; however, federal projects with potential adverse impacts on HAPC will be more carefully scrutinized during the consultation process.

3.2. Adverse Effects on Essential Fish Habitat

NMFS determined the proposed action would adversely affect EFH as follows, and the HAPC described above, as follows:

- Temporary adverse effects include: acoustic effects and water quality effects.
- Permanent adverse effects include: loss of approximately 5.6 acres of tidal perennial habitat, which includes the loss of approximately 3,124 linear feet of the Sacramento River.

These temporary and permanent adverse effects to the habitat in the action area are described in more detail in section 2.5 of this Biological Opinion and are incorporated by reference here.

For the temporary effects of the proposed action on EFH, NMFS believes that the proposed action, including the construction best management practices, and by abiding by the RMPs and Terms and Conditions of this Biological Opinion, the action agency will address temporary effects on Pacific Coast Salmon and Pacific Coast Groundfish EFH and HAPC.

For the permanent effects of the proposed action on EFH, NMFS believes that the proposed actions described in the Compensatory Mitigation Plan for Special-Status Species and Aquatic Resources (Appendix 3B of the BA; ICF 2025), will address the permanent loss of Pacific Coast Salmon and Pacific Coast Groundfish EFH and HAPC.

Therefore, NMFS has no additional EFH conservation recommendations to provide at this time. This concludes the EFH consultation.

3.3. 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 the Corps, and their applicant DWR. Individual copies of this opinion were provided to them. The document will be available within 2 weeks at the NOAA Library Institutional Repository [https://repository.library.noaa.gov/welcome]. The format and naming adhere to conventional standards for style.

4.2. Integrity

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

4.3. Objectivity

Information Product Category: Natural Resource Plan

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

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

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

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

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