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

Refer to NMFS No: WCRO-2020-03082

May 12, 2021

Alicia E. Kirchner
Chief, Planning Division
U.S. Army Corps of Engineers
1325 J Street
Sacramento, CA 95814-2922

Re: Endangered Species Act Section 7(a)(2) Biological Opinion, Magnuson-Stevens Fishery Conservation and Management Act Essential Fish Habitat Response for the American River Watershed Common Features General Reevaluation Report Reinitiation 2020

Dear Ms. Kirchner:

Thank you for your letter of September 9, 2020, requesting reinitiation 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 American River Watershed Common Features General Reevaluation Report. This consultation was conducted in accordance with the 2019 revised regulations that implement section 7 of the ESA (50 CFR 402, 84 FR 45016).

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

The enclosed biological opinion (BO) analyzes the effects of the American River Watershed Common Features General Reevaluation Report. This BO is based on the final biological assessment for the project, and on the best available scientific and commercial information. The BO concludes that the analyzed project is not likely to jeopardize the continued existence of the federally listed as endangered, Sacramento River winter-run Chinook salmon (*Oncorhynchus tshawytscha*) evolutionarily significant unit (ESU), the threatened Central Valley spring-run Chinook salmon ESU (*O. tshawytscha*), the threatened southern distinct population segment (DPS) of the North American green sturgeon (*Acipenser medirostris*), and the threatened California Central Valley steelhead (*O. mykiss*) DPS, and is not likely to destroy or adversely modify their designated critical habitats. NMFS has included an incidental take statement with reasonable and prudent measures and nondiscretionary terms and conditions that are necessary and appropriate to avoid, minimize, or monitor incidental take of listed species associated with the project.

This letter also transmits NMFS's review of potential effects of the American River Watershed Common Features General Reevaluation Report on EFH for Pacific Coast salmon, designated under the MSA. 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. The analysis concludes that the project would adversely affect the EFH of Pacific Coast salmon in the Action Area. The EFH consultation concludes with conservation recommendations.

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

Sincerely,

A. Catherine Marcinkevage

Cathy Marcinkevage
Assistant Regional Administrator for the
California Central Valley Office

Enclosure

cc: 151422-WCR 2020-SA00019

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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

American River Watershed Common Features General Reevaluation Report

NMFS Consultation Number: WCRO-2020-03082

Action Agency: United Stated Army Corps of Engineers

Affected Species and NMFS' Determinations:

ESA-Listed Species	Status	Is Action Likely to Adversely Affect Species?	Is Action Likely To Jeopardize the Species?	Is Action Likely to Adversely Affect Critical Habitat?	Is Action Likely To Destroy or Adversely Modify Critical Habitat?
Central Valley spring-run Chinook Salmon ESU (*Oncorhynchus tshawytscha*)	Threatened	Yes	No	Yes	No
California Central Valley steelhead DPS (*O. mykiss*)	Threatened	Yes	No	Yes	No
Southern DPS of North American green sturgeon (*Acipenser medirostris*)	Threatened	Yes	No	Yes	No
Sacramento River winter-run Chinook salmon ESU (*O. tshawytscha*)	Endangered	Yes	No	Yes	No

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

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

Issued By: A. Catherine Marcinkevage

Cathy Marcinkevage
Assistant Regional Administrator for the California Central Valley Office

Date: May 12, 2021

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1. Introduction

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

1.1. Background

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

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

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

1.2. Consultation History

Authorization for the overall American River Common Features (ARCF) Project is provided by Section 101 of the Water Resources Development Act (WRDA) of 1996 (PL 104-303), and modified by WRDA 1999, Section 366 (PL 106-53). The authorization was reassessed under a reevaluation study known as the ARCF General Reevaluation Report (GRR) (Corps 2015). On September 9th, 2015, the National Marine Fisheries Service (NMFS) issued a BO (NMFS 2015) and on September 11, 2015, the U.S. Fish and Wildlife Service (USFWS) issued a BO (File No. 08ESMF00-2014-F-0518; referred herein as 2015 USFWS BO; USFWS 2015) on the ARCF GRR in accordance with Section 7(a)(2) of the Endangered Species Act of 1973, as amended (FESA) (16 U.S.C. 1531 *et seq*.).

The history of the section 7 consultation on the ARCF Project started during the development of the ARCF GRR in 2015. The BOs were issued by NMFS and USFWS as described above. Full consultation history of all aspects prior to this reinitiation can be found in the consultation history of the September 9, 2015 NMFS BO (referenced in this document as 2015 NMFS BO). Several aspects of the 2015 BO have already been implemented or are beginning to be constructed as follows:

- Sacramento River East Levee cutoff walls in several areas (2020-2021)
- Tree removal at several locations (2018-2021)
- Partial areas of seepage berm installed on the Sacramento River (2019)

- Beach Stone Lakes Mitigation Site south of Freeport, north of Morrison Creek on the east side of the Sacramento River (2020 and ongoing)

- Arcade Creek (2017-2020)

- Purchase of 20 mitigation credits at Fremont Landing Conservation Bank (2019)

NMFS has provided technical assistance during the development of the site designs and the BA between October 2019 and ongoing through March 2021. Project technical assistance and design team involvement have been occurring regularly since December of 2018.

- On September 30, 2020, the Corps and NMFS agreed on the use of the proposed improvements to the existing Sacramento Weir stilling basin as a mitigation project.

- On February 25, 2020, NMFS received a draft Biological Assessment (BA) from the United States Army Corps of Engineers (Corps) for review and comments.

- March 2, 2020, NMFS sent comments on the draft BA to the Corps.

- April 16, 2020, NMFS received new draft BA from Corps.

- From April 2020 through August 2020, numerous technical meetings, discussions, and revisions occurred to reduce impacts, clarify project description, and adjust mitigation.

- September 9, 2020, NMFS received new BA from Corps requesting reinitiation of consultation.

- September 15, 2020, NMFS requested clarification on the BA from Corps regarding the proposed action, effects, and additional information on their method of analysis.

- October 28, 2020, NMFS received updated information and responses from Corps, and consultation was initiated.

- February 1, 2021, NMFS received changes to the proposed action from Corps and agreed upon an extension of the BO due date to April 3, 2021.

1.3. Proposed Federal Action

Under the ESA, "action" means all activities or programs of any kind authorized, funded, or carried out, in whole or in part, by Federal agencies (50 CFR 402.02).

Under MSA, Federal action means any action authorized, funded, or undertaken, or proposed to be authorized, funded, or undertaken by a Federal Agency (50 CFR 600.910).]

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

According to the Corps 2020 BA, Congress directed the Corps to investigate the feasibility of reducing flood risk to the city of Sacramento and surrounding areas. The Corps completed feasibility studies in 1991 and 1996, recommending a concrete gravity flood detention dam on the north fork of the American River at the Auburn site along with levee improvements downstream of Folsom Dam. Other plans evaluated in the report were Folsom Dam improvements and a stepped release plan for Folsom Dam releases. These additional plans also included levee improvements downstream of Folsom Dam. The ARCF Project was authorized in the WRDA of 1996 and a decision on Auburn Dam was deferred to a later date. Major construction components of ARCF in the 1996 and 2016 WRDA authorization included construction of seepage remediation along about 22 miles of American River levees and construction of levee strengthening and raising of 12 miles of Sacramento River levee in Natomas.

The purpose of the ARCF project is to reduce the flood risk for the City of Sacramento and surrounding areas. The BA identified following problems within the Sacramento levee system:

- Seepage and underseepage;
- Levee erosion;
- Levee stability;
- Levee overtopping;
- Access for maintenance and flood fighting;
- Vegetation and encroachments;
- Releases from Folsom Dam;
- Floodplain management; and
- Additional upstream storage from existing reservoirs.

In order to evaluate the effects to listed species, the Corps looked at the largest foreseeable footprint as a worst-case scenario. The Corps anticipates a reduced footprint once more detailed design development and the construction phase of the contracts occurs, likely resulting in reduced adverse effects to listed species.

The project is designed to support the surrounding levees for the release of 160,000 cubic feet per second (cfs) from Folsom Dam. The Corps has deemed that the levees along the American River are unable to withstand these maximum flows for extended periods of time without increased risk of erosion and potential failure. The exact locations where erosion will occur and to what extent erosion will occur during any given event is unknown.

The Corps' project involves the construction of fix-in-place levee remediation measures to address seepage, stability, erosion, and height concerns identified for the Sacramento River and American River levees, Natomas East Main Drainage Canal (NEMDC), and Arcade Creek. Most height concerns along the Sacramento River will be addressed by a widening of the Sacramento Weir and Bypass to divert more flows into the Yolo Bypass, thereby lowering water surface elevations downstream. Due to the urban nature and proximity of existing development within the American River North and South basins, the Corps is planning fix-in-place remediation. Table 1 below, summarizes the levee problems discussed above and the proposed measure/remediation for each waterway.

The Sacramento Area Flood Control Agency (SAFCA), one of the ARCF Project's sponsors, will complete some portions of the Federal project. SAFCA received Corps permission pursuant to 33 USC §408 (Section 408) for alteration of the Federal levees along the NEMDC and Arcade Creek. Those activities have been completed under the 2015 consultation (see consultation history) by SAFCA and will be discussed as it pertains to operations and maintenance.

In addition to the proposed levee improvements measures, the following measures and policies would be addressed during construction:

- The Corps will apply a semi-quantitative risk assessment methodology to evaluate the placement of on-site mitigation riparian tree and shrub species.

- The ARCF Project's non-Federal sponsors, CVFPB and SAFCA, will bring the levees into compliance with the Corps' standards using a System Wide Implementation Framework (SWIF) process. A SWIF is a long-term plan developed by the levee sponsor(s) and accepted by the Corps to implement system-wide improvements to a levee system (or multiple levee systems within a watershed) to address system-wide issues, including correction of unacceptable levee inspection items, in a prioritized way to optimize flood risk reduction. The standard levee footprint consists of a 20-foot crown width, 3:1 waterside slope and 2:1 landside slope. There may be locations where a 3:1 waterside slope design is not possible, and in those cases the slope would be buttressed with revetment, which would solve slope stability and erosion concerns (Corps BA, 2020).

Table 1. Remediation by Waterway.

Waterway	Seepage Measures	Stability Measures	Erosion Protection Measures	Overtopping Measures
American River[1]	---	---	Bank Protection (31,000 linear feet), Launchable Rock Trench (45,000 linear feet)	---
Sacramento River	Cutoff Wall (50,300 linear feet)	Cutoff Wall (50,300 linear feet)	Bank Protection (43,000 linear feet)	Sacramento Bypass and Weir Widening, Levee Raise (1,500 feet)
NEMDC	Cutoff Wall (6,000 linear feet)	Cutoff Wall	---	Floodwall (15,600 linear feet)
Arcade Creek	Cutoff Wall (22,000 linear feet)	Cutoff Wall	---	Floodwall (22,000 linear feet)

[1]American River seepage, stability, and overtopping measures were addressed in a previous construction project.

1.3.1. American River

The Corps has concluded that levees along the American River require improvements to address erosion. The proposed measures for these levees consist of waterside armoring to prevent erosion to the riverbank and levee, which could potentially undermine the levee foundation. Two primary measures described on the American River levees in the ARCF GRR: (1) a maximum of 31,000 linear feet (LF) of bank protection, and (2) a maximum of 65 acres/45,000 LF of launchable rock trench (Figure 1). Several alternative designs are described below, but may vary in footprint and overall impacts. These numbers are maximized because there is some overlap identified to account for the uncertainty of site-specific conditions.

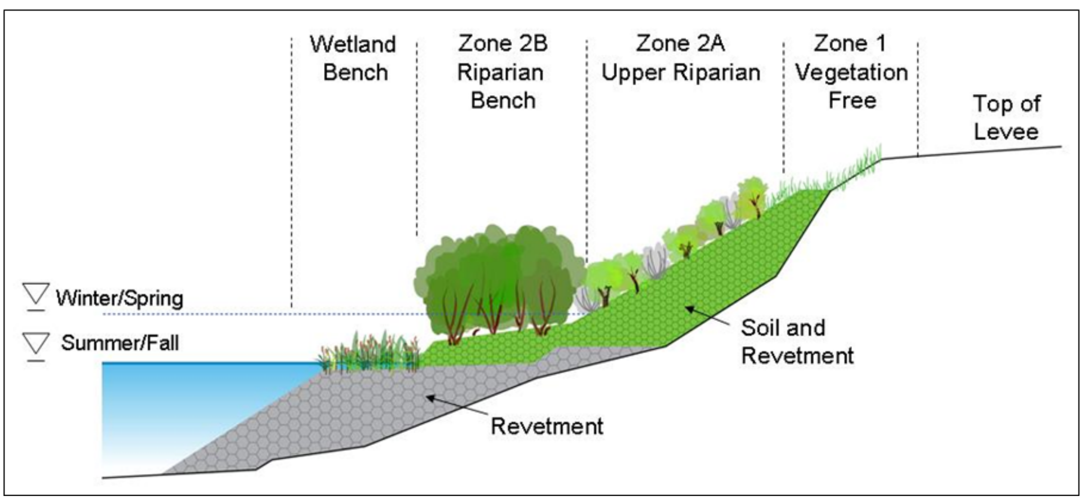
Bank Protection

This measure consists of placing rock revetment on the river's bank to prevent erosion. It entails installing revetment along the stream bank based on site-specific analysis (Figure 1). When necessary, the eroded portion of the bank will be filled and compacted prior to the rock placement. The sites will be prepared by clearing and stripping loose material and understory growth prior to construction. In most cases, large vegetation will be permitted to remain at these sites. Temporary access ramps will be constructed, if needed, using imported borrow material that would be trucked on site.

The placement of rock onto the bank will be conducted from a land-based staging area using long reach excavators and loader. The loader brings rock from a permitted source and stockpiles it near the levee in the construction area. The excavator then moves the rock from the stockpile to the waterside of the levee.

The revetment will be placed on the existing bank at a slope varying from 2V (vertical):1H (horizontal) to 3V:1H depending on site-specific conditions. Where hydraulic stage impacts have been deemed acceptable and space allows, a planting berm consisting of either a soil-fill trench or a soil-rock mix, supported by a launchable rock toe, will be constructed to support onsite mitigation. Planting berms would be scaled on a site-by-site basis based on site-specific constraints and design performance targets.

Figure 1. Example of Bank Protection with Planting Bench.

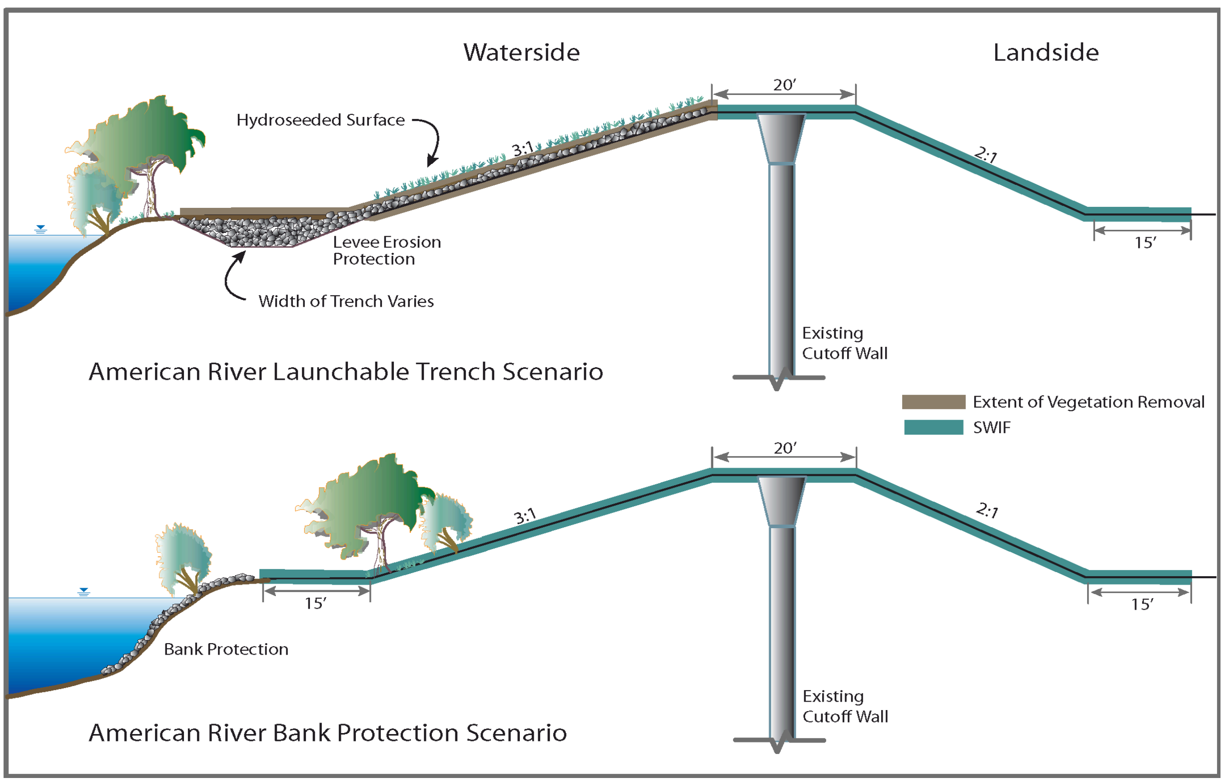


Launchable Rock Trench

For the purposes of this project description, it is assumed that up to 65 acres of the lower American River will incorporate the launchable rock trench measure for remediation. The construction of the launchable rock-filled trench would be designed to deploy once erosion has removed the bank material beneath it (Figure 2). All launchable rock trenches will be constructed outside of the natural river channel, and be well above the ordinary high water mark (OHWM). The vegetation will be removed from the footprint of the trench and the levee slope prior to excavation of the trench. The trench configuration will be a range of side slopes between 1:1 and 3:1 and will be excavated at the toe of the existing levee. All soil removed during trench excavation will be stockpiled for potential reuse or disposed of offsite.

After excavation, the trench will be filled with revetment that will be imported from an offsite commercial location. After rock placement, the trench will be covered with a minimum of 3 feet of soil for a planting berm. Rock placed on the levee slope may be covered with soil and as with all disturbed areas will be reseeded with native grasses and small shrubs.

Figure 2. Launchable Rock Trench and Bank Protection.



Additional Potential Designs

Additional bank protection measures may be considered and found to be appropriate during the implementation of site-specific designs as described in the *Stakeholder Engagement Process* section in the 2020 Corps BA. Design and analysis of any additional measures would be carried out during the site-specific planning and design phase. Examples of additional measures include, but are not limited to, toe protection, flow modification, cut bank, and alternative design and materials for reduction of riprap. These and other measures, which may be developed in the future, would be designed in coordination with NMFS and USFWS to minimize adverse effects to listed species and their habitat resulting from the Proposed Action.

One current design for a segment on the American River includes cutting the bank back to create a more gentle slope less prone to erosion. This cut bank design, combined with launchable buried rock tiebacks oriented perpendicular to the river and spaced in intervals between 30-100 feet is a design that was adopted as a set of measures to protect both the levee and the bank while providing a natural bank line that will support a naturally functioning riparian community between the rock tiebacks. This combination of measures is to eliminate or slow the retreat or loss of the bank, create more shallow water, shaded riverine aquatic habitat below the (OHWM), and retain the contiguous riparian corridor with onsite plantings between and within the soil-filled riprap tiebacks.

1.3.2. Arden Pond Mitigation Site

Also being constructed alongside the earlier erosion projects is one offsite mitigation area at Arden Pond (American River, River Mile [RM] 12). Arden Pond is approximately 29.5 acres in size (Figure 3). Work at Arden Pond includes grading and fill to reconnect the area with the river by constructing a side channel shoal system and adjacent emergent vegetation. A full description can be found in the *Arden Pond Supplemental Information for NMFS Consultation* document (ESA January 2021), which is summarized below for analysis purposes.

The proposed Arden Pond Mitigation Site is located at approximately RM 12 as illustrated in Figure 3**.** While there is the potential for listed species to occur seasonally in Arden Pond in its current state, it does not provide suitable habitat for rearing juvenile salmonids. Conversely, juvenile salmonids that enter Arden Pond have a high risk of mortality due to predation, warm water temperatures, and low water quality. The proposed Arden Pond Mitigation Site is being designed to continue to provide recreational opportunities for the public, while increasing suitable habitat for salmonids.

Separating the recreational pond from the restoration area would reduce depths in the area to meet habitat requirements for juvenile salmonids and support emergent vegetation to improve habitat by providing shade, cover, and food. Revegetation using emergent species (tules) would occur within portions of the new shoal perimeter of the placed fill. A swale would extend from the inlet channel mouth to the upstream end of the outlet channel. The final grading plan would include several islands within the mitigation site that would be designed to support riparian trees and shaded riverine aquatic (SRA) habitat. SRA and riparian vegetation would be created along the berm shoreline. Instream woody material (IWM) would also be added in various places for salmonid rearing habitat.

There has not been a bathymetric data collection effort conducted within the pond area; however, it is estimated that the depth of the pond is around 8 feet when flows in the LAR are at 2,000 cfs. The primary components of the mitigation site, as illustrated in Figure 3, include:

1. A Bass Pond (up to 11.3 acres) within the existing footprint of Arden Pond for recreational fishing activities;
2. A shallow side channel habitat within the existing footprint of Arden Pond as rearing and migration habitat for juvenile salmon with two design features:
    a. 6.1 acres of shallow flow areas with depths between 2 and 3 feet at 3,900 cfs during the winter/springs months
    b. 12.1 acres of riparian vegetation plantings along the shallow flow areas of the pond to create shaded riverine habitat;
3. A 2.8-acre earth-filled berm, with a section of permeable materials, to separate the two ponds to prevent predation of juvenile salmonids by bass while still providing flow circulation of fresh water into the area of the pond inhabited by bass; and
4. Two inundated floodplain mitigation sites (a 7.1-acre "West" and 2.3-acre "East" Mitigations Sites) to be excavated to the 2,660 cfs water surface elevation with gradual slopes and planting benches excavated above this elevation. The material excavated from these sites would be used for fill in Arden Pond.

Construction of the Arden Pond Mitigation Site would involve placement of approximately 330,000 cubic yards (CY) of soil into the restoration area, which is to come from the cut bank excavation of Site 2-3, excavated material from the bass pond, and excavated materials from the West and East Mitigation Sites (see description below). Approximately 140,000 CY would be placed in the 18-acre mitigation area to create 1- to 3-foot deep shoals at elevations of 1 to 3 feet below the 3,900 cfs flow water surface elevation up to the existing vegetated shoreline edges and the new berm.

The Bass Pond will be connected to the mitigation site via constructed open channel. The intent of the connection is to allow water levels in the Bass Pond to rise and fall with water levels in the neighboring mitigation site and to provide similar water quality conditions in the remaining Bass Pond to the existing pond. The connection will provide volitional passage for juvenile salmonids when active. The connection will likely be dry during drought and late summer months similar to the existing pond connection. The connection will be constructed with boulders, cobbles, and gravels as a natural channel Bass Pond

The existing Bass Pond would be excavated to a total depth of 6 feet with the material used for the construction of the berms and channel. Construction would decrease the area of the Bass Pond to approximately 11.3 acres within the existing mitigation site footprint. A non-permeable earth-filled berm (3 acres) would separate the pond from the side channel to prevent predation of juvenile salmon in the channel by bass in the pond. The pond will be dewatered to an elevation below the existing pond bottom elevation in the bass pond. (Existing pond elevation is at approximately 27 feet, pond to be dewatered to elevation of approximately 25 feet). Excavators will track out and excavate material and place material in haul equipment, which will haul over and dump into the fill location. The pond is thought to have a relatively coarse sand bottom over hard deposits. Tracked haul equipment or temporary matting may be required to support vehicles. Excavation will not occur in areas with standing water. Material is estimated to range from 24,000 to 50,000 CY.

West and East Mitigation Sites

The East and West Mitigation Sites would be excavated from the existing American River bank near the downstream extent of Arden Pond. The East and West Mitigation Site segments would include the enhancement and creation of aquatic habitat along an approximately 880-linear foot segment (430 linear feet at the West and 450 linear feet at the East Mitigation Site) along the riverbank. The majority of the excavation will occur above the typical summer water surface elevations. If excavation is required below the water surface level, it would take place in late summer when water levels are at their lowest. Excavation and grading activities within the site would be completed prior to breaching to the river to complete the connection. A turbidity curtain would be placed along the shoreline from the west edge of the West mitigation site to the eastern boundary of the East Mitigation at the start of construction and remain in place until construction activities were complete.

The East Mitigation Site would require excavation of about 30,000 CY of material and the West Mitigation Site would require excavation of about 125,000 CY of material. Excavated material from these sites would be used for fill at Arden Pond. The existing elevation at these sites is currently above the 2-year water surface elevation and does not generally support woody vegetation. The Proposed Action would excavate material from the existing banks at these sites down to the 2,660 cfs water surface elevation. The sites would include shallow islands, flat slopes of 5H:1V, or flatter with IWM, and benches, which would be planted with native riparian vegetation. The flat slopes, vegetation, and lower surfaces would provide rearing habitat and aquatic habitat suitable for juvenile salmonid rearing at a range of flows. The sites together would provide an additional approximate increase of 7 acres of habitat (5.16 acres on the West and 1.95 acres on the East Mitigation Site) below the 18,500 cfs water surface elevation.

Construction Methods and Phasing

Construction would occur in six phases starting in the winter of 2021/2022. Trees would be removed between November 2021 and February 2022, before the nesting season. After these activities and prior to July 1, 2022, mobilization would include the application of temporary best management practices (BMPs) for the control of off-site stormwater runoff and sedimentation, building temporary access roads, preparing staging areas, rerouting pedestrian and bicycle trails, and installing signage for traffic and alternate transportation routes that would be affected by construction activities (e.g., bicycle routes). Vegetation clearing could be needed to allow for site access and to accommodate construction activities.

A turbidity curtain, or other minimization measures approved by the State Water Resources Control Board (SWRCB), the California Department of Fish and Wildlife (CDFW), NMFS, and USFWS, would be installed prior to any in-water work conducted on the waterside of the levee.

The work limits and staging areas would be fenced with orange construction fencing to protect sensitive habitat and to identify disturbance area limits. In addition, a 6-foot-tall temporary chain-link security fencing would be installed around staging areas and along the access routes within the sites.

Prior to commencing earthwork activities within the Arden Pond or East and West Mitigation Sites, measures to eliminate water within the construction footprint would be implemented first. These measures would not occur at the East and West Mitigation Sites until the beginning of the in-water work window on July 1. The inlet channel to Arden Pond would be blocked starting June 1 using a temporary dam structure (e.g., a water filled bladder dam or sand or gravel filled sacks). The outlet channel would be notched with an excavator to gradually lower the pond level to an elevation of about 25 feet NAVD88 (North American Vertical Datum of 1988). The excavator will slowly notch the channel to maintain a controlled rate of lowering pond levels. The controlled rate will be determined at further levels of design to meet geotechnical, fisheries, and water quality requirements. Biological monitors will be on-site to observe for fish presence prior to use of excavator to remove and sidecast material from the channel lowering the channel outlet. After the pond level has been decreased to a water surface elevation 25, fish rescue within the pond would occur (See Conversation Measures Section below). Sediment capture material will be placed in the channel.

If required, pumps may be installed within Arden Pond to lower the pond level below the elevation of the American River channel at the outlet. The pump system and fish screen would conform to the anadromous salmonid passage facility design criteria issued by NMFS in July 2011. Water would be pumped directly into the American River, and turbidity testing would occur during the pond lowering to ensure values are within SWRCB water quality permit conditions.

Conservation Measures Specific to Arden Pond Mitigation Sites

In addition to the conservation measures already proposed, the following measures will be included specific to Arden Pond:

1. In-water construction activities shall be conducted within in-water work windows to avoid and minimize effects to critical salmonid life stages (juvenile rearing, and juvenile and adult passage), typically from July 1 through October 31. The exception being, that in-watering work related to what is necessary for dewatering activities would begin starting June 1. Any requested in-water work outside this window will be coordinated with NMFS.

2. Erosion protection material used within restoration areas would consist of a cobblestone rock mix ranging between 0.5 to 4 inches in diameter, which is consistent with the rock sizing recommended by the USFWS and NMFS to meet salmonid spawning protection requirements.

3. Because installation of the cofferdam and dewatering in the Arden Pond site during construction could result in fish stranding, both during initial temporary dam installation

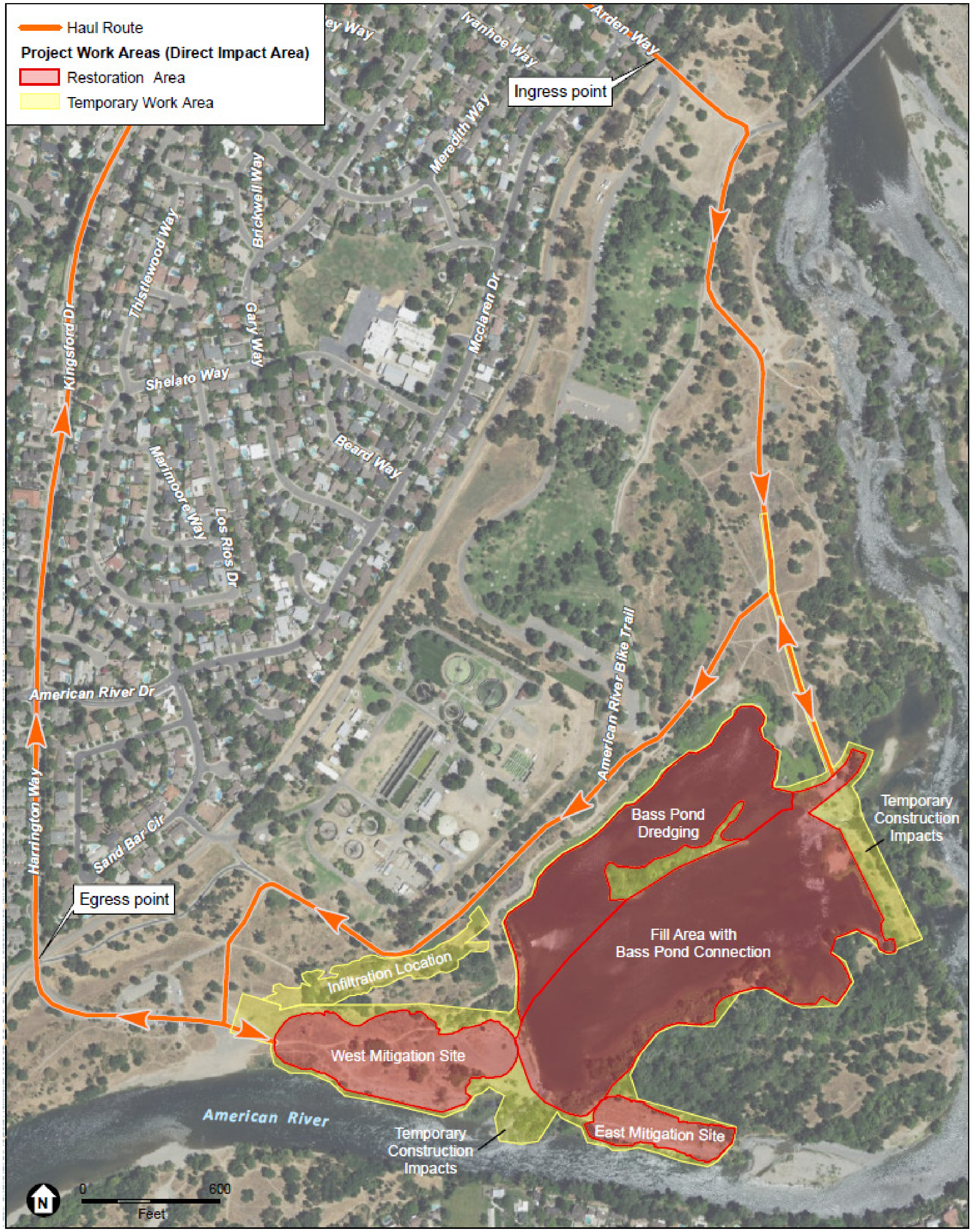
and following potential temporary dam overtopping events. The Corps will implement fish rescues acceptable to NMFS and shall implement dewatering in a manner that is not harmful to fish or other aquatic or semi-aquatic wildlife. Dewatering efforts would utilize the least impactful techniques, such as draining the pond via gravity first and then if necessary, using a pump system to complete dewatering activities. If a pump is required, the suction end of the intake pipe shall be fitted with fish screens intended to prevent entrainment or impingement of small fish[1] . The Corps will ensure that dewatering shall be implemented with a fish rescue team composed of several qualified fisheries biologist and/or technicians, each with experience in fish capture and handling to maximize efficiency of rescues while avoiding potential stranding or desiccation of fish. The fish rescue effort will be implemented during the dewatering of the pond area behind the temporary dams and involve capture and return of those fish to suitable habitat within adjacent waterways, or to another NMFS approved location. The area will first be seined, to the extent feasible, followed by electrofishing to remove fish that are behind the dam. The contractor will monitor the progress of dewatering and allow for the fish rescue to occur prior to completely closing the dam and again when water depths reach the approximate elevation of the American River. NMFS will be notified at least 48 hours prior to the start of fish rescue efforts. Information on the species, number, and sizes of fish collected will be recorded during the fish rescue and provided in a letter report to be submitted within 30 days after the fish rescue to NMFS. Implementation of fish rescues would minimize lethal impacts to listed fish species (when present) associated with fish stranding during dewatering activities related to the construction activities.

Mitigation/Compensation for ARCF Actions from Arden Pond

Restoration efforts proposed at Arden Pond have been designed to provide compensatory mitigation for the ARCF GRR Proposed Action. The 29.5 acres of pond within Arden Pond will be regraded and a portion filled to create the side channel. Creation of additional juvenile habitat within the Arden Pond channel and East and West Mitigation sites would result in the temporary disturbance of (roughly 6.48 acres of SRA habitat and 9.8 acres of riparian habitat) low quality juvenile salmonid rearing and riparian habitat. However, the project will create an estimated 12.1 acres of higher quality riparian habitat along the shores and islands of the proposed channel and an additional 13.21 acres of inundated rearing habitat between the channel (6.1 acres) and the East and West mitigation Sites (7.11 acres).

1 http://www.dfg.ca.gov/fish/ResQurces/Projects/Engin/Engin ScreenCriteria.asp

Figure 3. Arden Pond Mitigation Site plan view



SOURCE: USDA, 2018; NHC, 2021; ESA 2021 ARCF 2016 American River Contract 2

The Corps also proposes to degrade the island, just upstream of the Howe Ave boat launch, for the purpose of Hydraulic Mitigation. This concept involves removing the mid-channel island and using the material to fill in the bank. The bank fill area extends from the existing bank at approximately elevation 30 feet out into the channel to the 3,900 cfs water surface elevation (approximately 18 feet). The proposed design cuts down half of the island to 16 feet and then cuts down to existing ground at a gradual slope. The area at 16 feet elevation provides shallow fish rearing habitat, as it is in the 95 percent (%) exceedance flow and will not grow vegetation. The area at and around 18 feet is expected to grow vegetation, as this elevation is where natural recruitment is seen elsewhere on the river. The area is not in close proximity to known active steelhead spawning areas. An option with the island fully cut down to existing elevation was modeled and considered as well.

1.3.3. Sacramento River

Seepage, Stability, and Overtopping

The Corps reports that levees along the Sacramento River need improvements to address seepage, stability, and erosion. About 43,000 LF of bank protection and 50,300 LF of cutoff wall or slope stability work is planned for the Sacramento River. In addition, these levees may need a total of one mile of intermittent height improvements in order to ensure that additional river flows that exceed current design levels could be accommodated without risk of levee failure.

Where the existing levee does not meet the levee design requirements, as discussed above, slope flattening, crown widening, and/or a minimal amount of levee raise is required. This improvement measure addresses problems with slope stability, geometry, height and levee crest access and maintenance. To begin levee embankment grading, loose material and vegetation understory will be cleared, grubbed, stripped, and where necessary, portions of the existing embankment will be excavated to allow for bench cuts and keyways to tie in additional embankment fill. Excavated and borrow material (from nearby borrow sites) will be stockpiled at staging areas. Haul trucks and front end loaders will bring borrow materials to the site, which will then be spread evenly and compacted according to levee design plans.

The levee will be raised about 1 to 2 feet resulting in the levee footprint extending out a maximum of 5 feet on the landside from the existing levee. The levee crown patrol road will be re-established at the completion of construction.

Cutoff Walls

To address seepage concerns, a cutoff wall will be constructed through the levee crown. The cutoff wall will be installed by one of three methods: (1) conventional open trench cutoff walls, (2) deep soil mixing (DSM) cutoff walls, and (3) jet grout cutoff walls. The method of cutoff wall selected for each reach will depend on the depth of the cutoff wall needed to address the seepage. The open trench method can be used to install a cutoff wall to a depth of about 85 feet. For cutoff walls of greater depth, the DSM method will be utilized. Jet grout cutoff walls may be used when underground utilities prevent the installation of other types of cutoff walls.

Prior to any cutoff wall construction method, the construction site and any staging areas will be cleared, grubbed, and stripped. The levee crown will be degraded up to half the levee height to create a large enough working platform (about 30 feet) and to reduce the risk of hydraulically fracturing the levee embankment from the insertion of slurry fluids. This method of slurry wall installation will also reduce the risk of slurry mixture following seepage paths and leaking into the river or into landside properties.

Open Trench Cutoff Wall

Under the open trench method, a trench about 3 feet wide will be excavated at the top of levee centerline and into the subsurface materials up to 85 feet deep with a long boom excavator. As the trench is excavated, it is filled with low-density temporary bentonite water slurry to prevent cave in. The soil from the excavated trench is mixed nearby with hydrated bentonite, and in some applications cement. The soil bentonite mixture is backfilled into the trench, displacing the temporary slurry. Once the slurry was hardened, it will be capped and the levee embankment will be reconstructed with impervious or semi-impervious soil.

DSM Cutoff Wall

The DSM method involves a crane supported set of two to four mixing augers used to drill through the levee crown and subsurface to a maximum depth of about 140 feet. As the augers are inserted and withdrawn, a cement bentonite grout will be injected through the augers and mixed with the native soils. An overlapping series of mixed columns will be drilled to create a continuous seepage cutoff barrier. A degrade of up to one-half the levee height will be needed for construction of the DSM wall. For both methods, once the slurry has hardened it will be capped and the levee embankment will be reconstructed with impervious or semi-impervious soil.

Jet Grout Construction

Jet grout construction involves injecting grout into the soil at very high pressures and will be used in areas where there are utilities that cannot be removed, such as the regional sewer line and the Pacific Gas and Electric (PG&E) natural gas line near the Pioneer Bridge. The grout is a mixture of cement and water that would be mixed in a batch plant located in the staging area and transported through high- pressure hoses to the location of construction. The jet grout process involves drilling a hole straight down into the levee to a depth of up to approximately 130 feet, then injecting grout into the hole through a high-pressure nozzle. As the grout is injected from the bottom to the top of the hole, the high pressure excavates the soil around the nozzle to a radius of 3 to 4 feet, mixing the soil within the levee with grout. The grout injection may be accompanied with air and water to assist the excavation of soil. The nozzle is rotated and lifted at a slow, smooth, constant speed to achieve thorough mixing and consistent quality. The grout then solidifies to create a column of low permeability. Multiple columns constructed together create a wall through the levee that prevents seepage. Soil that is displaced from the injection site would be piped into drying beds or containment cells located in the staging area for later disposal.

Jet grouting activities near Pioneer Bridge may occur on a 24 hour a day schedule to expedite work, which will generate noise and require night lighting.

Municipal Drainage Systems

Several municipal drainage systems, both legacy and operational, have pipes that run through the levee. These facilities require removal and replacement to install the cutoff walls. Temporary waterside access below the OHWM of the river is required to remove or replace these structures. A small portion of concrete apron will be poured as part of an outfall pipe replacement (also called Sump 70), and will likely extend below the OHWM. This concrete apron is to protect the shoreline below from erosion that may occur from water exiting the outfall pipe. While other outfall pipes will need to be replaced as part of this project, this is currently the only one anticipated to require work below the OHWM. Temporary access will consist of dewatering the area with the use of a cofferdam approximately five feet high (1.75 feet above the typical water level) and approximately 120 feet in length. The cofferdam would be installed, and work completed between July 1 and October 31, which is outside of sensitive fish species migration windows. A portion of the existing revetment would be removed. Work to replace individual drainage facilities is estimated to take up to 15 days. There may be up to five areas where in-water work may be needed to remove or replace these pump systems throughout all Sacramento River east levee contracts.

Stability Berms and Blankets

Stability berms and blankets address shallow foundation and/or levee embankment through-seepage. A stability berm or blanket is a prism of compacted soil that acts as a buttress to increase stability factors of safety and, in some cases, includes an inclined filter/drain zone placed on the landside slope of a levee to capture seepage that would otherwise exit on and potentially erode the unprotected levee slope. Typical stability berms are 10-15 feet high (depending on the height of the levee) and 10-25 feet wide, and are considered in limited areas that do not have substantial right of way issues. Alternatively, the stability berm can be constructed within the existing levee in areas with constrained access along the landside levee toe. The inset stability berm would be constructed by excavating the landside levee slope, constructing the filter/drain zone, then rebuilding the levee slope to approximately the original grade with compact fill.

Toe Drains

The primary purpose of a toe drain is to capture through-levee seepage before it exists on the levee slope, potentially causing erosion and instability, and to filter the discharge in such a way as to reduce velocity and fine soil carrying capacity. A toe drain would typically be used when through-seepage or through-seepage-driven landslide slope stability is problematic. Toe drains could be used in several limited reaches where the levee does not have an existing shallow cutoff wall and there is a concern regarding potential seepage breakout on the levee slope or the levee toe. Toe drains would be constructed by excavating into the levee prism and constructing a filtered drain within the downstream toe of the levee embankment.

Bank Protection

Proposed bank protection along the Sacramento River will address erosion concerns. The Sacramento River levees have a medium to high risk of breach due to erosion (Corps 2020 BA). Bank protection will be addressed with rock revetment and planting berms when feasible. The bank protection measure for the Sacramento River consists of placing rock protection on the bank to prevent erosion. This measure entails filling the eroded portion of the bank, where necessary, and installing revetment along the waterside levee slope and streambank from streambed to a height determined by site-specific analysis. Large trees on the lower half of the waterside slope may be protected in place when possible to retain SRA habitat. The sites will be prepared by removing vegetation along the levee slopes at either end of the site for construction of a temporary access ramp, if needed. The ramp will then be constructed using imported commercial borrow material that will be trucked on site.

The placement of rock onto the levee slope will occur from atop the levee and/or from the waterside by means of barges. Rock placed within the channel, both above and below the water line at the time of placement, will be mixed with soil where feasible and placed by an excavator from a barge. Construction may require two barges: one barge would carry the crane and/or excavator, while the other barge will hold the stockpile of rock to be placed on the channel slopes. While most sites will not need rock on the levee embankment, when it is installed on the upper portions of the slopes, it will be placed by an excavator located on top of the levee. Rock placement from atop the levee will require one excavator and one loader for each potential placement site. The loader brings the rock from a permitted source and stockpiles it near the levee in the construction area. The excavator then moves the rock from the stockpile to the waterside of the levee.

The revetment will be placed via the methods discussed above on existing bank at a slope varying from 2V:1H to 3V:1H depending on site-specific conditions. After initial revetment placement has been completed, a small planting berm where feasible, consisting of either a soil-fill trench or a soil-rock mix, supported by a launchable rock toe, will be constructed to support onsite mitigation.

Additional Measures

Additional bank protection measures may be considered and found to be appropriate during the implementation of site-specific designs in coordination with NMFS. Design and analysis of any additional measures would be carried out during the site-specific planning and design phase. Examples of additional measures include, but are not limited to, toe protection, flow modification, cut bank, and alternative design and materials for reduction of riprap. These and other measures, which may be developed in the future, would be designed in coordination with NMFS and USFWS to minimize effects to listed species and their habitat from the proposed action. Adverse effects to listed fish species described below within the Section 2.5 Effects of the Action are anticipated to cover these site-specific design variations. Measures for erosion protection that the Corps is considering include rock toe launchable berms with soil-filled or soil-rock mix riparian planting benches and soil filled riprap upslope, sheet pile, articulated concrete blocks, tule benches with IWM anchored in place in rock terraces, and keyed-in bendway weirs.

Natomas East Main Drain Canal and Arcade Creek

The Corps anticipates that the east levee of the NEMDC will need 6,000 LF of improvements to address seepage and stability at locations where historic creeks had intersected the current levee alignment. A cutoff wall will be constructed at this location to address the seepage and stability problems. The cutoff wall will be constructed by one of the methods described in the Sacramento River section above. SAFCA is proposing to construct 2,500 LF of cutoff wall beginning just south of the confluence of Arcade Creek and extending south along the NEMDC. The Corps will construct the remaining 3,500 LF of cutoff wall.

The Corps also proposes that the Arcade Creek levees will need improvements to address seepage, slope stability, and overtopping when the event exceeds the current design. A centerline cutoff wall will be constructed to address seepage along 22,000 LF of the Arcade Creek levees. Levees from Rio Linda Boulevard to Marysville Boulevard will have a cutoff wall constructed at the waterside toe of the levee. Construction of the waterside toe cutoff wall will require constructing a workbench along the toe of the levee. Excavation for the bench will extend deep enough below existing grade to remove organic material and soft, unsuitable foundation soils. Bench excavation will also extend into the existing waterside slope of the levee as needed. Riprap will be placed on the waterside benches after construction of the waterside toe cutoff wall. Some portions of the Arcade Creek north levee will require more substantial excavation and reconstruction of the waterside slope to provide a low permeable seepage levee slope barrier. Bench fill material will be integrated with the slope reconstruction fill to provide an integral seepage barrier with the cutoff wall over the full height of the levee slope. A small section of levee will have a sheet pile cutoff wall at the centerline of the levee, rather than the waterside toe cutoff wall.

There is a ditch adjacent to the north levee at the landside toe, which provides a shortened seepage path, and could affect the stability of the levee. The ditch will be replaced with a conduit or box culvert and then backfilled. This will lengthen the seepage path and improve the stability of the levee. Additionally, pressure relief wells will be installed along the landside toe of the levee along the north levee west of Norwood Avenue.

The majority of the Arcade Creek levees have existing floodwalls; however, there remains a height issue in this reach. A 1- to 4-foot floodwall will allow the levees to pass flood events greater than the current design level. The floodwall will be placed on the waterside hinge point of the levee and will be designed to disturb a minimal amount of waterside slope and levee crown for construction. The waterside slope will be re-established to its existing slope and the levee crown will grade away from the wall and be surfaced with aggregate base.

1.3.4. Sacramento Weir and Fish Passage Facility

The proposed action will include a new fixed-crest passive weir structure north of the existing Sacramento Weir, setting back the Sacramento Bypass north levee approximately 1,500 feet, a new bridge over the weir on Old River Road, a fish passage structure, a levee embankment between the existing weir and new passive weir, realignment of County Road 124, and removal of the railroad embankment.

New Weir and Bridge

A new 1,496-foot-long passive weir will be constructed along the right bank (looking downstream) of the Sacramento River, north of the existing weir. The new weir and existing weir will be separated by a levee embankment. The proposed weir would be composed of 60-foot-wide weir bays, separated by 3- to 5-foot-wide piers. A concrete approach slab and weir crest would form the floor between the piers. The weir crest elevation would be at 26 feet.

The new primary weir structure will be constructed behind the existing levee and Old River Road; therefore, only 1 year of in-water work is anticipated for the levee degrade, rock slope placement, and fish exit pool construction.

The existing levee, which will be in front of the newly constructed weir, would be removed in the final year of construction, and the soil will be used to create a graded approach to the new weir. The elevation of the graded approach to the new weir would be excavated down to an elevation of 22 feet, which would require the removal of 82,567 CYs of material. Once grading of the approach is completed, part of the area will be seeded with native perennial herbaceous species to stabilize the approach and protect it from erosion. Based on the proposed elevation of the approach, the Corps anticipates that this area would likely be inundated on an annual to biennial basis, given the OHWM is 2 feet higher than the proposed approach.

Once the graded approach is completed, areas that cannot be seeded due to erosion risk will have rock slope protection placed. Rock placed above the 10-foot contour would be 20 inches thick, while rock placed below this elevation would be 30 inches thick. A total of 18,358 CYs of rock are anticipated to be necessary. Placement of the rock would be achieved using an excavator staged from a barge or on land, and/or by bottom dumping rock from a barge. It may also be necessary to install a vibratory driven sheet-pile cofferdam to dewater the work area for installation of the rock slope protection. Turbidity would be controlled via a cofferdam, installation of a turbidity curtain, or other means and methods approved by the Regional Water Quality Control Board and NMFS. Up to 6.2 acres of habitat may be permanently impacted by construction activities, rock placement, or concrete pouring.

Fish Passage Structure

In 2015, a fish passage feature was added into the proposed action for the purpose of increasing adult fish passage and reducing fish stranding in the expanded Sacramento Bypass. The new fish passage features are intended to mitigate adverse effects of the weir expansion. The fish passage elements for the proposed action were formulated through a series of meetings with the fish passage project design team (PDT). The PDT (consisting of the Corps, the California Department of Water Resources (DWR), SAFCA, NMFS, CDFW, and HDR Consulting) formed in December 2018, came to a decision on a technical fishway approved by all agencies. See the full 2020 Sacramento Weir BA for a full description of the fishway evaluation process.

Based on the 2015 NMFS BO, the working group established the following goals for fish passage:

- Provide upstream migration for adult salmonids and southern Distinct Population Segment (sDPS) of Green sturgeon (green sturgeon).
- Design and construct the new weir such that fish stranding will be minimized to the greatest extent possible. Minimizing fish stranding includes:
  - ➢ Minimizing both adult and juvenile fish stranding on the downstream (bypass) side of the new weir when floodwater stops overtopping.
  - ➢ Minimize stranding in depressions in the widened Sacramento Bypass following receding floodwaters.

Fish Passage Project Elements

The proposed action's fish passage design includes the following design elements:

- Hydraulic Control Structure and Fishway Exit Pool
- Fish Ladder
- Fish Passage Channel
- Stilling Basin Drain
- Transition of open channel fishway into Tule canal.

Similar to the new weir, the majority of the fish passage facility would be constructed behind the existing Sacramento River and Tule Canal levees. As such, the only components of the fish passage facility that would affect ESA-listed species and their habitats during construction include the fishway exit pool and the tie-in of Lower Elkhorn Basin Levee Setback (LEBLS) ditch to the Tule Canal.

Hydraulic Control Structure and Fishway Exit

The hydraulic control structure for the fish passage facility will include two concrete channels. One channel will discharge flow to the fish ladder and the other will provide water to the open channel fishway. Both channels will include a vertical lift gate for flow control to the fishways. The north channel, with a floor elevation of 8 feet, will be used for lower Sacramento River stages. The south channel, with a floor elevation of 14 feet, will be used for higher Sacramento River stages.

The vertical lift gates will be just downstream of the weir feature and roadway deck, integrated into sections of the control structure that are between the south road abutment wall and the new weir. The top of the fish passage channel and fish ladder gates (while in the closed position) are at elevations 17 feet and 27 feet, respectively. Concrete headwalls above these elevations extend to the top of the adjacent walls to cut off flow above the operating water surface elevations for the gates.

The top of wall elevations upstream of the vertical lift gates are 36.16 feet or greater such that the 100-year flood does not overtop the walls. The minimum top of wall elevation includes 3 feet of freeboard above the 100-year flood elevation in the Sacramento River. The walls upstream and downstream of the gates will include slots for temporary stop logs to allow the gate area to be dewatered for maintenance. The stop logs will be manufactured and stored on site near the hydraulic controls, which will be located on the embankment between the existing and new weir structures.

Fish Exit Pool

The primary purpose of the fish exit pool is to provide a low-velocity channel for fish to exit the fishway and continue their upstream migration in the Sacramento River, while simultaneously providing water flow to the fishways. The exit pool will also incorporate features for minimizing the entrainment of debris and sediment into the ladder. Such features are likely to include debris booms, trash racks, and/or other appropriate means and methods to be further defined through coordination with the PDT and DWR's operations and maintenance. To provide a fish exit channel of adequate depth, the fish pool area located between the concrete fish passage facility and the Sacramento River would be excavated down to an elevation of 5 feet.

Similar to the new weir, the majority of the fish passage facility would be constructed behind the existing Sacramento River levee with the exit pool construction happening in the last year. To construct the fish exit pool, a sheet-pile cofferdam is expected to be required so that the work area can be isolated and dewatered. It is anticipated that the exit pool will be lined with rock similar to that placed in front of the new weir, and that a cofferdam will be required to complete the construction of this component of the fish passage facility. An estimated 6,720 CYs of rock slope protection will be placed in the fish exit pool.

Fish Ladder

Downstream of the control structure, a vertical slot fish ladder will provide a fish passage route when the water level in the Sacramento River is between elevation 15 feet and 26 feet. The fish ladder is a 398.5-foot-long vertical slot fish ladder with pools separated by baffles. Baffle numbers and slot configurations are still in development with the PDT; however, 16 single slot baffles with a bottom orifice for sturgeon are proposed. Slot widths will increase progressively downstream.

The fish ladder entrance pool is located immediately downstream of the fish ladder. This area also serves as the transition pool between the fish passage channel and fish ladder. The entrance pool provides fish access to the fish ladder. It is about 29 feet wide and 34 feet long with a flat bottom of elevation 7 feet.

Fish Passage Channel

The channel would begin at the downstream end of the flow control structure and run parallel to the north wall of the fish ladder. Downstream, the channel would turn to connect to the fish ladder entrance pool, and then continue west, aligned with the fish ladder centerline. Three hundred feet downstream of the fish ladder, the entrance pool of the fish passage channel would turn southwest. The channel would continue approximately 260 feet downstream before turning west and continuing into Tule canal.

The intent of the fish passage channel is to provide fish passage for the lower stages of the Sacramento River and to provide a channel readily passible by sturgeon. The lower stages of the Sacramento River is a headwater range of 9 feet to 15 feet, with a current expectation to operate to elevation 10 to 12 feet based on consultation with the PDT. The floor of the open channel fishway will be at an elevation of 8 feet to receive flow for this entire range. Providing ease of navigation for sturgeon includes the incorporation of resting pools, lower velocities, and less of a vertical climb than the fish ladder.

The Corps believes it may be necessary to install a vibratory driven sheet-pile cofferdam to dewater the work area where relatively high groundwater levels may otherwise limit dry conditions for channel grading and shaping.

Stilling Basin Drain

The stilling basin of the new weir drains to the fish passage channel. The stilling basin drain provides a path for adult and juvenile green sturgeon that may pass over the new weir to exit the stilling basin and return to the Sacramento River. Design of the stilling basin will continue to be updated further during 95% design planning.

Construction - Fish Rescue and Salvage

Construction of portions of the new weir and the fish passage channel may require isolation and dewatering of areas in the Sacramento River and Tule Canal where in water work would occur. Isolation and dewatering of these work areas has the potential to result in stranding and/or the loss of NMFS-regulated species. To minimize any potential effects during dewatering activities, the Corps would design a comprehensive fish rescue and salvage plan, which the Corps would submit to NMFS for approval no less than 30 days prior to any isolation of in-water work areas. Isolation methods may vary between areas in the Sacramento River and in Tule Canal. For example, installation of a sheet-pile cofferdam may be required to effectively isolate the work area in the Sacramento River, whereas the work area in Tule Canal may require the use of water bladder dams and bypass of flow. Because of these area-specific considerations and site fidelity of species, the Corps' plan will address rescue and salvage activities targeted for the Tule Canal and Sacramento River areas, as they may differ from each other.

If isolated areas are to be dewatered, the fish rescue and salvage plan would have two phases: clearing the isolation area of aquatic species prior to full isolation, followed by final fish rescue and salvage during dewatering. If isolated areas are not to be dewatered, the plan would consist of only the first phase. These phases would be repeated, as necessary, should the fish exclusionary barrier fail during the fish passage facility construction. The fish rescue and salvage plan would be implemented by a fish rescue team composed of several qualified fisheries biologists and/or technicians, each with experience in fish capture and handling.

- Exclusionary barriers used to create the isolation area may vary depending on the means of project implementation, but may include a turbidity curtain or sheet-pile cofferdam. If used, the exclusionary barrier would be installed from an upstream to downstream direction. At the downstream extent of the isolation area, the exclusionary barrier would be left open to allow biologists to herd any fish out of the isolation area. To cover the entire depth of the water column, biologists would sweep the isolation area by stacking seine nets top-to-bottom and end-on-end, as needed, to push fishes and aquatic species outside of the exclusionary barrier. Fish would not be handled during this process, reducing the potential for additional stress. The goal would be to clear aquatic inhabitants before the work area is completely isolated. While the exact length of the seine nets may vary based on conditions (for example, depth, velocity, aquatic vegetation) and professional judgment, the following characteristics would be consistent for all potential nets employed:
    - Individually 6 to 8 feet deep;
    - 5/8 inch mesh;
    - Floats 1 foot apart on top; and
    - 4-ounce lead weights 1 foot apart on bottom.

  Biologists would conduct a minimum of three passes through the partially isolated work area prior to installing the final section of the exclusionary barrier. After each pass, a block net would be installed at the downstream opening in the exclusionary barrier to prevent fish from re-entering the area.

- The second phase of the fish rescue and salvage plan would take place after the area has been completely isolated, usually the day after Phase I of the plan. If the isolation area is to be dewatered, the fish rescue and salvage effort would occur as dewatering is occurring. Any pumps used to dewater the area would be fitted with NMFS-approved screens. This phase of the effort would be conducted using a combination of seines and dip nets, and would occur in the early morning hours to take advantage of the coolest temperatures. Immediately after collection, all fish, including native and non-native fish, would be placed in aerated 5-gallon buckets and/or coolers filled with river water (and freshened with new water as necessary), identified, measured, enumerated, and transported to a location outside of the isolation area for release back into the main channel. Listed fish would be processed before any other fish. In the event that water temperatures become stressful (>21° Celsius) or are elevated upon arrival (19 to 20° Celsius), a biologist would be assigned to rapidly transport fish from the work area to the release area as they are sampled without counting or identification to expedite the rescue. The biologist(s) would remain on site during the entire process of dewatering, if implemented. The rescue would end when few or no non-listed fish are rescued after multiple seine pass attempts.

Fish Monitoring

Fish monitoring will occur in both the Sacramento River and Tule Canal. Active construction monitoring would consist of deploying a hydro acoustic receiver array and acoustic positioning systems. This technology is currently being utilized throughout the west coast, and complements other ongoing acoustic studies in the area. The array and positioning system will determine the fish's site fidelity and behavioral characteristics within the project area as construction activities are occurring. Pre-construction monitoring is anticipated to occur in the spring of 2020, using the acoustic array. Pre-construction monitoring is occurring to establish baseline conditions within the project/action area.

Fish monitoring will include the placement of up to twenty-five individual 14-inch diameter steel poles or pilings to be placed throughout the ARCF action area in the Sacramento River. Minor pile driving activities are anticipated to occur, both vibratory and impact hammer methods may be used. The purpose of the poles is for the placement/tethering of multi-functioning fish acoustic monitoring equipment, water quality monitoring equipment and an acoustic Doppler current profiler. There will be navigation warning signs placed on top of each station. Monitoring will provide data for majority of the fish studies occurring within the Sacramento River. Cooperative agency monitoring would include agencies from DWR, U.S. Geological Survey (USGS), the Corps, CDFW, NMFS and USFWS. Additionally, the installation would comply with the criteria from Interim Criteria for Injury of Fish Exposed to Pile Driving Operations (Popper et al. 2006).

1.3.5. Utility Relocation

Many utilities will be avoided; however, some utilities may need to be temporarily removed or relocated prior to construction. Temporary bypass pumping may be required for sanitary sewers. SAFCA and the construction contractors will coordinate with utility owners to manage the utilities in advance of construction. Disturbed utilities will be restored after construction consistent with CVFPB requirements.

1.3.6. Stormwater Pollution Prevention

Temporary erosion/runoff best management control measures would be implemented during construction to minimize stormwater pollution resulting from erosion and sediment migration from the construction, borrow, and staging areas. These temporary control measures may include implementing construction staging in a manner that minimizes the amount of area disturbed at any one time; secondary containment for storage of fuel and oil; and the management of stockpiles and disturbed areas by means of earth berms, diversion ditches, straw wattles, straw bales, silt fences, gravel filters, mulching, revegetation, and temporary covers as appropriate. Erosion and stormwater pollution control measures will be consistent with National Pollutant Discharge Elimination System (NPDES) permit requirements and included in a Stormwater Pollution Prevention Plan (SWPPP).

After completion of construction activities, the temporary facilities (construction trailers and batch plants) will be removed and the site would be restored to pre-project conditions. Site restoration activities for areas disturbed by construction activities, including borrow areas and staging areas, will include a combination of regrading, reseeding, constructing permanent diversion ditches, using straw wattles and bales, and applying straw mulch and other measures deemed appropriate.

1.3.7. Geotechnical Explorations

Geotechnical explorations include activities, such as geotechnical borings, erosion jet tests, geotechnical trenching, and geotechnical potholing. A brief description of each follows below.

Geotechnical Borings – Borings are done to determine the geologic composition of the foundation of various flood features (erosion protection, slurry walls, and Sacramento Weir). Each borehole will be about 4 to 6 inches in diameter, and will be drilled to a depth of 50 to 100 feet. Equipment will include a tire-mounted drill rig, a support truck, and three crew trucks. Prior to initiating drilling, the workers will clear surface vegetation within the immediate borehole location (about 12 inches in diameter at each borehole). Woody vegetation will be avoided. Upon completion of each boring, the borehole will be backfilled with cement-bentonite grout. Drilling fluid and cuttings will be disposed of at an offsite location.

Erosion Jet Tests – Soil jet tests are used to classify erosion conditions along the waterside banks of the rivers. Tests will be conducted as close to the bank toe as feasibly possible. All jet tests will occur in the dry but may occur below the OHWM. Two to six jet tests will be conducted at each site.

Geotechnical Trenching – This action involves digging trenches about 10 feet deep. The purpose of geotechnical trenching is to validate the composition of the levee embankment or other surface soil conditions. Additionally, trenching is often conducted in a similar manner as part of preconstruction geoarchaeological studies to determine the potential for presence of buried archaeological resources in the project area. Following site characterization, the trenches will be back-filled with soil.

Geotechnical Potholing – Geotechnical potholing is a method whereby the location of underground utilities is exposed. Potholing involves the drilling of exploratory holes, the depth of which spans from ground level to the required extent of the investigation. Potholing confirms the location of utility features on site that have the potential to be damaged by other techniques. The potholing is carried out using a vacuum truck to minimize potential damage to the utilities, and to biological resources. Any excess excavated material will be hauled offsite. All disturbed areas will be returned to their original state upon completion of each pothole.

1.3.8. Borrow Sites and Haul Routes

Borrow Sites **-** The estimated maximum amount of borrow material is shown below in Table 2, and will be needed to construct the ARCF Project. Detailed studies of the borrow material needs have not been completed. Actual volumes exported from any single borrow site will be adjusted to match demands for fill.

To identify potential locations for borrow material, soil maps and land use maps were obtained for a 20-mile radius surrounding the project area. Borrow site selection will include the following criteria: avoid threatened and endangered species effects and habitat, current land use patterns, and soil types. Fill may be borrowed from bank protection sites, when available, for the use of project-related mitigation.

Clean rock will be commercially acquired in order to construct the American and Sacramento River bank protection sites. For the Sacramento River, rock will be acquired from a commercial source in the Bay Area and barged up the Sacramento River to the construction sites (see Table 2 for total barge trips estimated). Rock for the American river sites will be acquired from a commercial source within a 50-mile radius and will be hauled in trucks to the construction sites.

Table 2. Barge Traffic associated with ARCF activities.

Activity	Total # of Round Trips	Total maximum volume of material transported
Sacramento Weir and Bypass 2021	28 barge trips	25,000 cubic yards (cy)
Sacramento Weir and Bypass 2023	83 barge trips	75,000 cy
Sacramento River Erosion Contract 1	26 barge trips	23,000 cy
Sacramento River Erosion Contracts 2, 3 and 4	2,188 barge trips	1,000,000 cy

Haul Routes – Haul routes will be determined during the design phase and will depend on what borrow sites and staging areas are selected. Haul routes will be selected based on existing commercial routes and levee roads. Haul routes will be selected that minimize effects to federally listed species.

1.3.9. Construction Process, Staging, Sequencing, and Equipment

Mobilization – Site Access and Staging Area

Mobilization will take place at each project site. Mobilization may include creation of temporary access roads, if needed; securing the site; and transporting equipment and materials to the site (*e.g.*, clearing and grubbing, and construction of the repair). Access to construction sites will occur primarily along existing roads, levee crown roads, or unpaved private farm roads. Barges will be used to transport rock to the sites on the Sacramento River. At several sites, a barge crane may be used to transport and stockpile rock and soil to the site. The staging areas will be selected, so removal of native trees or shrubs are minimized and previously disturbed areas will be preferred. Landside staging areas may frequently be required for stockpiling materials and equipment. For landside and certain waterside repairs, staging areas may require construction easements from the landowners adjacent to the construction site. Activities that will occur within staging areas would include storing necessary imported materials (*e.g.*, rock, soil); parking, refueling, and servicing of construction equipment; establishing a temporary restroom; and parking construction staff transportation vehicles.

Site Preparation

Vegetation clearing may need to occur for site access and construction purposes. Site preparation may also include the removal of submerged instream woody debris and fallen trees within the construction footprint. A turbidity curtain, cofferdam, or other NMFS approved minimization measure will be installed prior to any in-water work conducted on the waterside of the levee where there is potential for listed fish within range. The work limits and staging areas will be fenced (orange construction fencing) to prevent vehicles and equipment from approaching the waterside edge of the existing bank where applicable, to protect sensitive habitat, and to identify disturbance area limits.

Where necessary, existing vegetation within the work area will be removed during project construction except for trees or shrubs identified and marked for protection prior to construction. Trees within the repair area identified for protection and outside the work limit may require trimming or removal for equipment clearance, excavation, or due to severely undermined tree health. All tree and sensitive plant removal will be documented. The construction site may be cleared of grasses, ground cover, or any other undesirable materials, using mechanized equipment.

Construction Process

Rock or other fill material (*e.g.*, sand, soil, and cobble) will be placed using a long-arm bucket excavator, barge crane, or other heavy equipment. As necessary, fill may need to be compacted using vibrating plates. IWM may be installed, if feasible, near the water surface during time of construction to replace or enhance riverine aquatic habitat to the repair area.

1.3.10. Vegetation Plantings Installation

Vegetation within the sites will be developed in coordination with NMFS and USFWS during the design phase. A variety of materials for revegetation and site-enhancement may be used depending on the site-specific conditions. Below is a description of commonly used materials and methods used for revegetation purposes.

Instream Wood Material

The incorporation of IWM functions into site designs are intended to replace lost instream cover and habitat from construction impacts. Entire trees with root balls and canopies are used as the IWM. The trees shall be anchored into the quarry stone to one-half of the tree length. They are placed to be submerged when fish are generally present in the area.

Willow Fascines

Willow fascines, which are live bundles of willow cuttings, are also incorporated into the site designs in order to replace lost instream cover and habitat due to construction. The fascines are anchored just above the winter mean water surface elevation at 15-foot spacing triangular spacing.

Other Plant Materials

Plant material installation is designed to mitigate for lost riparian and SRA habitat post construction. The proposed planting design includes an appropriate mix of local system native riparian trees and shrubs. Plantings will be incorporated into the sites at appropriate elevations to maximize on-site mitigation to the extent feasible.

1.3.11. Demobilization, Rehabilitation, and Clean-up

Following construction, all equipment and materials will be removed from the work area and excess materials will be disposed of at appropriate facilities. All areas would be cleaned and cleared of rubbish and left in a safe and suitable condition.

1.3.12. Operation and Maintenance

Operation and maintenance (O&M) of the levees in the Sacramento area are the responsibility of the local maintaining agencies, including the American River Flood Control District, the DWR, and the City of Sacramento (Table 3). The applicable O&M Manual for the Sacramento area levees is the Standard Operation and Maintenance Manual for the Sacramento Flood Control Project. Typical levee O&M in the Sacramento in the Sacramento area currently includes the following actions:

- Vegetation maintenance up to four times a year by mowing or applying herbicide.
- Initial vegetation maintenance will include irrigation that may need pumping from the nearest waterside of the levee. Riparian establishment may require irrigation and pumping activities between March through November initially (see Table 3 for full irrigation details). Pumps will be screened to NMFS screen criteria.
- Control of burrowing rodent activity monthly by baiting with pesticide.
- Slope repair, site-specific and as needed, by re-sloping and compacting.
- Patrol road reconditioning up to once a year by placing, spreading, grading, and compacting aggregate base or substrate.
- Visual inspection at least monthly, by driving on the patrol road on the crown and maintenance roads at the base of the levee.
- Post-construction, groundwater levels will be monitored using the piezometers.

The Corps will work with local maintaining agencies to develop the maintenance activities necessary for long-term operations and maintenance. This will occur during the preconstruction engineering and design phase of the project.

Following construction, the O&M manual for these reaches will be adjusted to reflect the vegetation variance and the SWIF plan. Under the adjusted O&M manual, large trees that are protected in place under the variance will be allowed to remain on the waterside slopes and additional vegetation will be planted on the planting benches. Vegetation maintenance includes keeping maintenance roads clear of overhanging branches.

Table 4. O&M by Maintaining Agency

Local Maintaining Agency	Levee Systems Covered
American River Flood Control District	Lower American River, Arcade Creek, NEMDC
Maintenance Area 9	Sacramento River east levee between Sutterville Road and the Beach Lake Levee
City of Sacramento	Sacramento River East Levee between the confluence of the American River and Sutterville Road

1.3.13. Green Sturgeon Habitat, Mitigation, and Monitoring Plan

Through collaboration with NMFS, the Corps will implement the following additional measures to minimize adverse effects to green sturgeon habitat.

1) The Corps will develop a green sturgeon habitat, mitigation, and monitoring plan (HMMP) in coordination with other project consultations (Sacramento River Bank Protection Project (the Corps, 2019) and West Sacramento General Reevaluation (the Corps, 2015). The GS HMMP will include adaptive management, based on findings and is expected to be ongoing throughout construction of erosion protection on the Sacramento River and construction of the Sacramento Weir.

    a) The purpose of the HMMP, as it relates specifically to ARCF, is to monitor any potential take occurring during and post-construction through observation of green sturgeon behavior in the project area via acoustic telemetry tracking, and make recommendations to minimize impacts to sturgeon in future bank protection projects. Post-construction monitoring will occur for up to three years for erosion protection actions on the Sacramento River and when the Sacramento Weir fish passage structure is activated, not to exceed five years post-construction.

    b) Because the HMMP will not be finalized until September 2021, any specific mitigation recommendations based on the current understanding of fish behavior under the HMMP may only benefit Sacramento Weir and later erosion actions on the Sacramento River. As the Corps is proposing to move forward with a large-scale mitigation site for erosion protection actions and in essence ARCF is "first through the door" on a multi-year HMMP process, the lessons learned, best practices, and other recommendations from the HMMP are more likely to benefit the West Sacramento GRR Project and the Sacramento River Bank Protection Project.

    c) The broad umbrella goal of developing the HMMP is to ensure that adverse impacts to green sturgeon resulting from Corps erosion protection projects are fully mitigated in order to maintain the growth, survival, and recovery of the species in the action area for these projects.

2) The Corps purchased 20 acres of green sturgeon conservation bank credits. These credits were purchased by the Corps on July 22, 2019, from the Fremont Landing Conservation Bank, to mitigate effects associated with ARCF. In addition to benefiting green sturgeon, these credits can apply to California Central Valley steelhead (steelhead), Central Valley sping-run Chinook salmon (spring-run Chinook salmon), and Sacramento River winter-run Chinook salmon (winter-run Chinook salmon).

In the BA, the Corps recognizes flaws from the existing Standard Assessment Model (SAM). It is not producing functional assessments and mitigation recommendations that appear to be reasonable based on species' use of aquatic habitats in the area during different life stages or times of the year. Updating the SAM and including a green sturgeon module is anticipated to reduce the overall mitigation burden for future projects (*e.g.,* West Sacramento and potentially later contracts of ARCF erosion on the Sacramento River). The SAM update with the green sturgeon module, when it is delivered in 2022, would mostly benefit future flood risk reduction erosion protection activities as a part of the West Sacramento GRR and Sacramento Bank projects, but also could benefit later erosion action contracts under ARCF in 2023 and 2024.

The Corps proposes to either refine the SAM or develop an alternative green sturgeon survival and growth response model that reflects green sturgeon's preference for benthic habitat and that accounts for the physical loss of habitat from revetment footprints instead of the convention used by the SAM where the fish response is evaluated at the intersect of seasonal water surface elevations. The new modeling may include hydraulic modeling, but must be capable of evaluating green sturgeon survival in response to levee repair projects in the project impact area and their effects on all habitat conditions, not exclusively flow changes.

The ARCF Project, part of the larger Supplemental Program funding package issued to the Corps in 2018, was required to commence construction on project features with acceptable designs and PED began immediately after. Construction on Sacramento River East Leave Reach D Contract 1 began in 2019 and construction on the remainder of ARCF will conclude by 2024. PED was truncated or in some instances eliminated for most activities under ARCF based on the funding and schedule directive received under the Supplemental Program.

Without the habitat model, impacts to green sturgeon may be larger than originally assessed in the 2015 NMFS BO. Therefore, the Corps has coordinated with NMFS to develop the following alternative measure to minimize effects to green sturgeon that does not rely on the SAM:

Mitigation commitments of the 2021 USFWS BO for Delta smelt require a minimum of 90 acres of Delta smelt habitat to be restored to minimize project effects based on anticipated impacts from the ARCF project (USFWS 2015; 2017; 2019). If this mitigation occurs within green sturgeon critical habitat, green sturgeon will also benefit. By selecting mitigation sites that benefit multiple listed species, in this case the Delta smelt and the green sturgeon, any excess impacts that could not be measured by the previously proposed habitat model (SAM) will be offset for this project.

1.3.14. Green Sturgeon Study

The Corps is proposing to award 5 million dollars in funding to a qualified agency or academic institution by grant (or other funding mechanism), to conduct a study that leads to a better understanding of juvenile green sturgeon behavior in proximity to unscreened diversions, analyze how river substrate characteristics effect green sturgeon behavior, and develop adult green sturgeon passage requirements that apply to conditions the species encounter in their habitat within the Central Valley. The Corps asserts that the information developed by such a study will benefit the species by providing a better understanding of the sturgeon's behavior, result in the development of diversion screen criteria that may reduce entrainment of the species range-wide, and help the development of regionally appropriate fish passage criteria that can be applied to new and existing diversions and barriers to reduce stranding. A better understanding of green sturgeon behavior in the system would contribute to the recovery of the species. The results of the study would also likely benefit other listed species under the jurisdiction of NMFS known to occur in the ARCF WRDA 16 Project area including spring-run Chinook salmon, winter-run Chinook salmon, and steelhead.

Given federal acquisition process timelines, including those applying to grants, it is anticipated that the study would be funded and commence by 2022. NMFS will be invited to participate on the technical team to inspect the performance work statement and the deliverables produced.

The Corps has put forth and NMFS has agreed that funding such a study will be applied to reduce the temporal mitigation ratio by a factor of 1. For example, the 2015 NMFS BO outlined a 1:1 ratio for mitigation prior to construction, 2:1 ratio for mitigation done during construction, or 3:1 ratio for mitigation completed after construction. With the addition of this grant proposal, the mitigation ratios will be reduce to 1:1 for mitigation done during construction or 2:1 for mitigation done after construction. These ratios are further described below in 1.3.17 *Compensatory Mitigation*.

The large-scale mitigation site is anticipated to be 100 to 200 acres in size and provide aquatic habitat that would be used by all life stages of winter-run Chinook salmon, spring-run Chinook salmon, steelhead, and juvenile green sturgeon. If the site is constructed below the I Street Bridge, it would also benefit delta smelt.

The mitigation project is likely to require a levee setback to connect the prospective property to the Sacramento River. The site will be appropriately graded to slowly drain to prevent stranding that may occur in a tidally influenced area or seasonal water elevation changes. Where it is found to be feasible, some mosaic riparian habitat will be established within the site and along the perimeter. In-stream woody material and other constituents of SRA will be incorporated into the design where feasible. The Corps will require that the contractor constructing the site maintain a ledger similar to those maintained by mitigation banks to determine how much acreage has been used for ARCF activities. Any remainder acreage not used to compensate for construction effects may be applied to effects related to O&M activities for the project, or depending on an authority's analysis, may be applied to construction effects generated by Sacramento Bank or West Sacramento GRR projects.

Although it is unanticipated, if the large-scale mitigation site is unable to fully compensate for effects from ARCF construction, one or more smaller mitigation sites may need to be constructed or mitigation bank credits may be used to round fulfill the remaining mitigation requirements.

1.3.15. Fisheries Conservation Measures

The Corps has proposed the following minimization measures, including mitigation, to minimize and offset effects of the Proposed Action on federally listed fish species. A number of measures will be applied to the entire project or species-specific actions, and other measures may be appropriate at specific locations within the project area. Avoidance activities to be implemented during final design and construction may include, but are not limited to, the following:

General Minimization Measures

The Corps will:

1. Conduct construction activities within in-water work windows to avoid and minimize effects to critical salmonid life stages (juvenile rearing, and juvenile and adult passage), from July 1 through October 31, with a two week extension until November 15 to work in the dry, below OHWM. Any requested in-water work outside this window will be coordinated with NMFS.

2. Develop a Storm Water Pollution Prevention Plan and Water Pollution Control Plan that minimize soil or sediment from entering the river, which includes daily inspections of all heavy equipment for leaks.

3. Screen any water pump intakes for activities, such as irrigation or dewatering, to maintain an approach velocity of 0.2 feet per second or less when working in areas that may support federally listed fish species.

4. Minimize the removal of existing vegetation during project-related activities. When feasible, removed or disturbed vegetation will be replaced with native riparian vegetation.

5. Implement measures to prevent slurry seeping out to river and install piping system on land- side only.

6. Stockpile construction materials, such as portable equipment, vehicles, and supplies, at designated construction staging areas and barges.

7. Stockpile all liquid chemicals and supplies at a designated impermeable membrane fuel and refueling station with a 110% containment system (container with 10% extra capacity).

8. Limit site access to the smallest area possible in order to minimize disturbance.

9. Minimize ground and vegetation disturbance during project construction, project

limits will be clearly marked, including the boundaries of designated equipment staging areas; ingress and egress corridors; stockpile areas for spoils disposal, soil, and materials; and equipment exclusion zones.

10. Observe a 20-mile-per-hour speed limit or less within construction areas for all project-related vehicles, except on County roads and on State and Federal highways.

11. Secure or remove litter and debris from the project area daily. Such materials or waste will be deposited at an appropriate disposal or storage site.

12. Immediately (within 24 hours) clean up and report any spills of hazardous materials to the USFWS, NMFS, and CDFW. Any such spills, and the success of the efforts to clean them up, shall also be reported in post-construction compliance reports.

13. Designate a NMFS-approved biologist as the point-of-contact for any contractor who might incidentally take a living, or find a dead, injured, or entrapped threatened or endangered species. This representative will be identified to the employees and contractors during an all employee education program. If lethal take is to occur on any ESA listed species, the Corps and NMFS will be contacted immediately.

14. Avoid adverse effects from nighttime construction activities. For Sacramento River East Levee work, the Corps will use the minimal amount of lighting necessary to safely and effectively illuminate the work areas. Shielding and focusing lights on work areas and away from the water surface (*e.g.,* Sacramento River), to the maximum extent practicable.

15. Make efforts to compensate for impacts to native riparian habitat in the places where the impacts occur, or in close proximity. Riparian vegetation impacted will be replaced on a 2:1 habitat acreage basis. Where possible, riparian habitat will be established in the Lower American River Parkway in areas where it will also provide SRA. If sites along the Lower American River are unavailable, other sites or banks may be used between Verona and Walnut Grove along the Sacramento River mainstem.

16. Develop a Conservation Strategy, which is consistent with the Sacramento Regional County Park's Natural Resource Management Plan. It will cover riparian habitat restoration, focused on the Lower American River Parkway with the overall goal of maximizing the ecological function and value of riparian project mitigation on-site and off- site as to provide contiguous habitat and SRA. The Corps will deliver this document to the Services before the first contract commences on the Lower American River and utilize it as a means to track mitigation opportunities completed in the Parkway.

17. Participate in the Sacramento County Park's Natural Resources Management Plan development that will guide riparian restoration opportunities in the Parkway.

18. Develop compensatory mitigation plans and associated monitoring and adaptive management plans for on-site mitigation efforts. Monitoring for the establishment of riparian tree and shrub species within shaded riparian aquatic habitat is expected to last approximately 5 to 8 years, not to exceed 10 years. Establishment success will be based on criteria determined on a site-by-site basis with NMFS. Once the monitoring period is complete, all vegetation maintenance and monitoring will transfer and be the responsibility of the non-federal sponsor and local maintaining agency.

19. Provide a copy of the issued BO, or similar documentation, to the prime contractor, making the prime contractor responsible for implementing all requirements and obligations included in these documents and to educate and inform all other contractors involved in the project as to the requirements of the issued BO. A notification that contractors have been supplied with this information will be provided to the NMFS. A NMFS-approved Worker Environmental Awareness Training Program for construction personnel will be conducted by the NMFS-approved biologist for all construction workers prior to the commencement of construction activities. The program will provide workers with information on their responsibilities with regard to federally listed fish, their critical habitat, an overview of the life-history of all the species, information on take prohibitions, protections afforded these animals under the ESA, and an explanation of the relevant terms and conditions of the issued BO. Written documentation of the training will be submitted to NMFS within 30 days of the completion of training.

20. Conduct acoustic fish monitoring at ARCF sites pre-construction, during and post-construction. For erosion prevention features along the Sacramento River, the Corps would conduct telemetry monitoring of green sturgeon for 3 years post-construction. Since the new Sacramento Weir fish passage structure would not be expected to operate annually, adding a reasonable amount of monitoring time to post-construction monitoring of the fish passage structure is warranted. The Corps therefore proposes to conduct fish monitoring at the fish passage structure while in operation up to, but not to exceed, five years post-construction. Acoustic telemetry will occur in the ARCF action area and would involve staff monitoring of the real-time telemetry data available online.

21. Continue to implement a benthic substrate sampling monitoring program, to coincide with the need for the GS HMMP. Substrate sampling that will occur in the ARCF action area will include both pre-construction, during, and post-construction sampling within construction-impacted areas.

22. Use their authorities to ensure the widening of the Sacramento Weir will fully compensate for fish passage impacts by including a green sturgeon and salmonid adult fish passage facility. Measures also shall be taken to modify the downstream side of the Weir to prevent adult and juvenile green sturgeon from stranding in the spillway basin.

23. Identify all habitats containing, or with a substantial possibility of containing,

listed terrestrial, wetland, aquatic, and/or plant species in the potentially affected project areas. The project will minimize effects by modifying engineering design to avoid potential effects.

24. Where feasible, use a rock soil mixture to facilitate re-vegetation and/or a soil-filled trench. The soil-rock mixture (70% rock and 30% soil) would be placed on top of the of the rock revetment that is below the water to allow native riparian vegetation to be planted to insure that SRA habitat lost is partially replaced or enhanced.

25. Ensure that the widening of the Sacramento Bypass is designed and constructed to minimize stranding of fish at the weir facilities and in the depressions of the bypass though grading, construction of drainage channels, or other mechanisms. The Corps has and will continue to coordinate with NMFS to ensure the Sacramento Bypass and Weir is constructed in a manner that includes an operational structure to allow for controlled ramp down rates of water into the Sacramento Bypass to alleviate impacts to listed fish species.

26. Work with local cost-share sponsors to ensure that ARCF GRR-related future flood risk reduction actions related to widening the Sacramento Weir shall fully mitigate upstream and downstream fish passage effects at the weir and within the spillway basin. The goal is to ensure that adult spring-run Chinook salmon, winter-run Chinook salmon, steelhead, and green sturgeon are able to migrate upstream, while the weir is spilling into the bypass, and that juvenile stranding in the spillway basin is minimized to the maximum extent possible.

27. Update the O&M manual to require: (1) that the operations of the Sacramento Bypass and Weir include a Weir Gate Operations Plan. The Plan will allow for ramp down flows in a manner that minimize juvenile fish stranding in the Sacramento Bypass, (2) integration of Sacramento Weir and Bypass operations with the Yolo Bypass.

28. Develop a stranding monitoring plan for the Sacramento Bypass that includes baseline post-project monitoring. The monitoring plan will be developed in coordination with NMFS. A separate section 7 consultation with NMFS and USFWS will be needed for the updated O&M manual, which will occur at a later date.

29. Install IWM on a case-by-case basis where it is compatible with erosion protection measures being installed to provide a portion of the on- site mitigation for lost SRA from the project. The purpose of IWM is to enhance the structural diversity of the shoreline, with woody material being a component of SRA, and ultimately to maximize the refugia and rearing habitats for juvenile fish.

30. Mix in choke stone (or cobble/gravel) to reduce interstitial spaces for predator habitat where riprap may not be covered by soil.

1.3.16. Riparian Habitat Mitigation Site Maintenance

Adverse effects to NMFS listed species may occur as a result of pumping for irrigation activities associated with riparian habitat mitigation site maintenance, both onsite and offsite, in or near the American River Parkway. Maintenance activities commence immediately following completion of the initial planting. The following activities are performed throughout the year, though some vary according to weather and season. General clean-up maintenance, including picking up trash, vandalism repairs, and the removal of used planting accessories (bamboo stakes, ties, browse guards, etc.), would occur throughout the year. For irrigation, maintenance crews would connect a screened pump to the irrigation system for each irrigation cycle per the irrigation schedule described in Table 4. Crews would weed within the watering basins of the transplants and within an 18” radius of each woody and grass associate plant, so non-native herbaceous growth does not compromise the health of the transplants. The estimated schedule for irrigating and weeding is shown in Table 6.

Table 5. Estimated three to five year maintenance schedule for riparian habitat mitigation.

Monitoring Year	Watering (Years 1 & 2: March 15-November 15) (Year 3-5: April 1-October 31)	Plant Replacement Like species* (size and type) with fertilizer and mulch
Year 1 (March 15-November 15)	50 gallons per plant or 3 inches of spray applied precipitation every 10 to 14 days	Replant to original amount of planting installed
Year 2 (March 15-November 15)	30 gallons per plant or two inches of spray applied precipitation every week to 10 days	Replant to original amount of planting installed
Year 3-5	10 gallons per plant or one inch of spray applied precipitation twice a week	No replanting
Weeding	Four times per year between March 1 and September 30	Four times per year between March 1 and September 30

* Adjustments may be made to the species palette based on observations of success and failure.

1.3.17. Compensatory Mitigation

The Corps will seek to avoid and minimize construction effects on listed species and their critical habitat, and will implement on-site and off-site compensation actions as necessary.

For identified designated critical habitat, compensation for impacts will be as close as possible to the place of occurrence. An interagency approved Standard Assessment Model (SAM) has been used throughout the Sacramento River basin and Delta flood control system to inform impacts to designated critical habitat, SRA, and instream components. Estimates of suitable habitat in the field will be verified in the field by the Corps prior to initiating proposed actions to determine the extent of suitable habitat present NMFS. The Corps will develop and implement a compensatory mitigation accounting plan to ensure the tracking of compensatory measures associated with implementation of the Proposed Action. The Corps will continue to coordinate with NMFS after construction during the monitoring periods for habitat establishment via written monitoring reports, electronically, and through site visits as requested.

The Corps will incorporate compensation for SRA habitat losses either by project constructed compensation sites (on-site and/or off-site) or in combination with purchase of credits at a NMFS-approved conservation bank, where appropriate. The Corps will construct a large-scale tidal marsh or shallow water aquatic habitat mitigation site between I Street Bridge Sacramento, California, and Antioch, California.

An updated mitigation proposal was received by the Corps on November 25, 2020 (Large Scale mitigation Site Crediting Memo, Revised) amending the mitigation as follows. If the site is constructed, with site contouring and planting substantially complete (over 50% done) by December 31, 2024, the Corps proposes the following mitigation ratios for NMFS species based on the RM distance from the southern extent of the area of impact of the project:

a. 0 to 20 miles (RM marker 27 to 47):
    i. 1:1 mitigation acres to impact acres (Sacramento to Walnut Grove vicinity).
b. 20 to 40 miles (RM marker 7 to 27):
    i. 1.5:1 mitigation acres to impact acres (Walnut Grove to Decker Island area)
c. c. 40 to 47 miles (RM marker 7 to 0):
    i. 1.75:1 mitigation acres to impact acres (Decker Island to Antioch).

If mitigation is not substantially complete (over 50% done) by the end of 2024, as committed to in the September 2020 BA for NMFS, the Corps would be responsible for the following mitigation ratios for NMFS species:

a. 2:1 for sites 0 to 20 miles away
b. 2.5:1 for sites up to 40 RMs away from the southern extent of project effects.
c. 2.75:1 for sites up to 47 RMs away from the southern extent of project effects.

Off-site mitigation in the Lower American River includes fish habitat mitigation at Arden Pond that would benefit fall-run Chinook, late fall-run Chinook and steelhead. Riparian plantings to support fish and wildlife species will be installed onsite on planting benches and slopes. The two sites near Rio Americano High School will provide upland riparian habitat primarily to support valley elderberry longhorn beetle. An additional shallow floodplain area will be considered in the Lower American River is at Glenn Hall Park, and has the potential to provide some benefit for the above listed salmonids.

Offsite mitigation will be required outside of the Sacramento River project footprint due to a lack of available space on the waterside and landside of the east levee. Compensatory mitigation for impacts along the Sacramento River are not able to be fully mitigated on the Lower American River because of the different fish species on these streams. Green sturgeon and winter-run Chinook salmon may be impacted on the Sacramento River, but are not known to occur upstream of RM 1.0 on the American River.

Mitigation on the Sacramento River will ideally be sited between the areas of Verona and Walnut Grove, and preferably south of the I Street Bridge in Sacramento as described above. The purpose of the location is to benefit all fish species (including delta smelt) impacted by the project. NMFS and USFWS will serve on the mitigation site technical team.

The Corps will explore the feasibility of developing a large-scale mitigation site to account for fisheries impacts not otherwise accounted for (tidally influenced shallow water and/or tidal marsh) along the Sacramento River mainstem (smelt, Chinook salmon, steelhead, and sturgeon). Riparian and fish habitat may not be able to be completely mitigated at the same site, so it is the Corps' intent to continue to pursue restoration and establishment of these habitat types within the Lower American River Parkway in combination with the purchase of bank credits.

Shaded Riparian Aquatic Vegetation Plantings along the American River

Mitigation sites are currently being pursued by the Corps, DWR, and SAFCA in coordination with the County of Sacramento. Riparian plantings may be utilized for erosion protection projects along the American River. As a form of project mitigation, the following actions are typical to establish riparian plantings:

Access and Stating

Permanent and temporary access to the sites is necessary for plant installation and establishing the site and long-term maintenance. A temporary staging area would also be established to house an 8-foot by 16-foot storage container, a portable toilet, and a wash station.

Planting Site Elements

The sites would be cleared of existing grasses and non-native vegetation. Existing native trees, shrubs, and listed species would be protected in place by construction fencing. The sites would be trimmed with hand held string trimmers. Invasive plant species would be removed by hand and disposed off-site. No grading of the riparian sites would occur.

A temporary above grade irrigation system would be installed for establishment and maintenance period of riparian habitat mitigation. A 1.5-inch or 2-inch polyvinyl chloride (PVC) schedule 40 pipe would be installed above grade for the establishment and maintenance period. Irrigation water would be applied manually by drip or spray irrigation connected to a screened portable water pump at the river edge. Due to seasonal inundation, the irrigation system may be partially or entirely removed for seasonal high water flows. The pump system would conform to the Fish Screening Criteria for Anadromous Salmonids (NMFS 2011).

Plantings would be spaced out in rows four to six feet apart. Seedlings would be planted in holes that are at least 12-inch wide by 12-inch deep and cuttings would be placed in holes created by a digging bar. Browse guards would be used to deter wildlife for at least the first three years and may consist of cages and/or perimeter fencing. See Table 5 for an example of a native woody riparian planting palette. Planting mixture may slightly vary on a site-by-site basis.

Table 6. Example of a potential planting mix.

Alnus rhombifolia	White alder	15%
Baccharis salicifolia	Mulefat	5%
Cephalanthus occidentalis	Buttonbush	5%
Populus fremontii	Fremont cottonwood	25%
Salix exigua	Sandbar willow	25%
Salix lasiolepis	Arroyo willow	25%

Sacramento Weir Existing Stilling Basin

The Corps-proposed improvements to the existing stilling basin would be equivalent to up to 13.5 acres of habitat being restored, and could be used as mitigation to offset habitat loss from the construction of the Sacramento Weir and erosion protection on the Sacramento River as a result of the proposed action. This repair will be constructed at the same time as the new weir and fish passage facility.

The Corps proposes to make minor modifications to the stilling basin of the existing weir, and to provide a new drainage canal that will connect the stilling basin of the existing weir with the proposed fish passage facility.

The improvements to the existing stilling basin could involve creating new orifices at the base of the four guide vanes. To create the orifices, a 42-inch by 84-inch section of each guide vane would be removed. The purpose of the orifices is to provide an escape route for fish as floodwaters recede. In addition to the orifices, the Corps is proposing to create a new drainage feature that will extend from the north end of the existing stilling basin to the fish passage channel and structure. The design for the improvements to the existing stilling basin are in the conceptual stages and will likely evolve as the design advances; however, the overall objectives of the improvements will remain the same: reduce stranding potential of fish during the descending limb of the hydrograph by providing an opportunity for escape via the new fish passage facility from the existing basin. The improvements to the existing stilling basin will occur concurrently with the construction of the new weir.

No effects to listed species are expected to occur during construction, as the stilling basin is well above the river channel. If construction happens during a higher water year and water is retained in the stilling basin, a fish rescue may need to occur to ensure no listed fish are stranded in the stilling basin prior to being conducted. The Corps would conduct fish rescue efforts and would follow the procedures outlined above, and propose to coordinate with CDFW and NMFS prior to implementation.

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

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

2.1. Analytical Approach

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

The designation(s) of critical habitat for (species) use(s) the term primary constituent element (PCE) or essential features. The 2016 critical habitat regulations (50 CFR 424.12) replaced this term with physical or biological features (PBFs). The shift in terminology does not change the approach used in conducting a "destruction or adverse modification" analysis, which is the same regardless of whether the original designation identified PCEs, PBFs, or essential features. In this BO we use the term PBF to mean PCE or essential feature, as appropriate for the specific critical habitat.

The 2019 regulations define effects of the action using the term "consequences" (50 CFR 402.02). As explained in the preamble to the regulations (84 FR 44977), that definition does not change the scope of our analysis and in this opinion we use the terms "effects" and "consequences" interchangeably.

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

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

2.1.1. Use of Analytical Surrogates

The effects of the Common Features GRR in 2015 were primarily analyzed using Standard Assessment Methodology (SAM). The Corps provided the background data, assumptions, analyses, and assessment of habitat compensation requirements for the federally protected fish species relevant to the 2015 consultation. In the 2015 consultation, the Corps proposed updating the SAM model when numerous limitations of the model became obvious.

As the model has not been updated at the time of this 2021 reinitiation, the method of determining habitat impacts will utilize a combination of the SAM model, as well as expected construction and mitigation footprints.

Once site-specific designs are completed, the SAM analysis will be run. The planned project footprint and scale of on-site mitigation will then be compared against the SAM analysis to determine accuracy of the analysis. In instances where on-site mitigation and impacts are determined by NMFS to not be represented properly by the SAM analysis, impacts will be calculated by projects footprints and impacts will be agreed upon between NMFS and the Corps.

Standard Assessment Methodology Analysis

The SAM was designed to address a number of limitations associated with previous habitat assessment approaches and provide a tool to systematically evaluate the impacts and compensation requirements of bank protection projects based on the needs of listed fish species.

It is a computational modeling and tracking tool that evaluates bank protection design alternatives by taking into account several key factors affecting threatened and endangered fish species. By identifying and then quantifying the response of focal species to changing habitat conditions over time, project managers, biologists and design engineers can make changes to project design to avoid, minimize, or compensate for impacts to habitat parameters that influence the growth and survival of target fish species by life stage and season. The model is used to assess species responses as a result of changes to habitat conditions, through quantification of bank stabilization design parameters (*e.g.,* bank slope, substrate).

The assumptions, model variables, and modeling approaches used in the SAM have been developed to be adapted and validated through knowledge gained from monitoring and experimentation within the SRBPP while retaining the original overall assessment method and framework. The first update to the SAM included the addition of green sturgeon, as well as a number of modifications to modeled-species responses based upon updated literature reviews and recent monitoring efforts at completed bank protection sites (Stillwater Sciences 2012, The Corps 2012).

The SAM quantifies habitat values in terms of a weighted species response index (WRI) that is calculated by combining habitat quality (*i.e.*, fish response indices) with quantity (*i.e.*, bank length or wetted area) for each season, target year, and relevant species/life stage. The fish response indices are derived from hypothesized relationships between key habitat attributes (described below) and the species and life stage responses. Species response indices vary from 0 to 1, with 0 representing unsuitable conditions and 1 representing optimal conditions for survival, growth, and/or reproduction. For a given site and scenario (*i.e.*, with or without project), the SAM uses these relationships to determine the response of individual species and life stages to the measured or predicted values of each habitat attribute for each season and target year, and then multiplies these values together to generate an overall species response index. This index is then multiplied by the linear feet or area of shoreline to which it applies to generate a weighted species response index expressed in feet or square feet. The species WRI provides a common metric that can be used to quantify habitat values over time, compare project conditions to existing conditions, and evaluate the effectiveness of on-site and off-site compensation actions.

The WRI represent an index of a species growth and survival based on a 30-day exposure to post project conditions over the life of the project. As such, negative SAM values can be used as a surrogate to quantify harm to a target fish species by life stage and season. Also, although SAM values represents an index of harm to a species, since the values are expressed as “weighted bank line feet” or “weighted area”, these values can be used to help quantify compensatory conservation actions such as habitat restoration, and are used for that purpose in this BO.

During this reinitiated consultation, the Corps and NMFS identified several shortcomings with the SAM as a tool for relaying the impacts and onsite mitigation accurately when the impacts or benefits span beyond the small area where SAM focuses, making it an unreliable tool. The primary shortcoming is that the SAM evaluates habitat conditions at the average seasonal water surface intersection with the riverbank. While potentially relaying impacts and benefits at those specific water levels, it does not quantify impacts above or below those water levels.

2.1.2. Compensation Timing

As described in the proposed action, this project proposes compensation for unavoidable effects to species and impacts to habitat. Under the initial Corps BA (Corps 2015), compensation timing was defined by the SAM modeled impact at the proposed timing (Green sturgeon: 15 years: Chinook salmon, 5 years: Central Valley steelhead, 4 years) as being sufficient to compensate for project effects. NMFS adopts a slightly different approach to the analysis of this 2021 BO in that the timing for completed compensation should be to target avoiding exposure of more than one generation of a population with a multiple age class structure. Although the approach is different, the number of years for each species is the same under both approaches. Negative impacts extending beyond those years (Green sturgeon: 15 years: Chinook salmon, 5 years: Central Valley steelhead, 4 years) may have additional detrimental effects to the species. Beyond those timeframes, impacts would reduce the species survival and recovery in the wild, or substantially reduce the value of habitat for the conservation of the species, because the adverse effects (reduced growth and survival of individuals) would begin to reduce the number of reproducing individuals across multiple generations. As such, this BO applies the following maximum timing for completed compensation as general targets for meeting the intended value of offsetting long-term effects of the proposed action:

- Chinook salmon, 5 years
- Central Valley steelhead, 4 years
- Green sturgeon: 15 years

The combination of on-site and off-site mitigation and associated timing included in the proposed action has a substantial portion of mitigation that will occur during construction or immediately following, so as not to surpass the earliest of those targets (steelhead, 4 years). The large scale of the project increases the need for resolving temporal impacts in a more concise manner. The large-scale off-site mitigation has an associated timeline proposed with it (substantial function by 2024 secures a lower credit ratio), to assist in reaching the species compensation targets listed above.

We expect, with the combination of pre-construction bank credit purchases, research funding, on-site mitigation, and large offsite mitigation, and with the variety of minimization and conservation measures being implemented, the impacts to species and habitat will be offset over the course of the entire construction timeline, as opposed to having all adverse effects occurring simultaneously, and lag in mitigation execution.

2.1.3. Description of Assumptions Used In This Analysis

For the purpose of the analysis of the habitat being affected by the proposed action, some reasonable assumptions were made for aspects with some uncertainty. One assumption made was due to the uncertainty of final designs for a number of sites. In coordination with USFWS (whose BO also included riparian mitigation), and after discussions with the Corps, impacts to NMFS species are calculated from the OHWM and below for the purposes of calculating mitigation amounts. While NMFS analyzes all the likely effects of the project (whether above or below the OHWM), it is expected that by calculating the area of impact from the full rock placement (including rock placed at depths that would not generally be utilized by salmonids), that the calculation will be appropriate to provide an estimate of mitigation acreage for the Corps proposed compensation. If at any time this assumption proves to be inaccurate in determining the extent of effects, reinitiation will be required.

Another decision between multiple potential analytical methods for this BOs analysis is in regards to the calculation of area of impact. For all impacts on banks/levees, NMFS considers the full measure of the actual acreage of impacts measured across the full slope where these effects are occurring. Another method proposed uses of the "lateral extent" of the repairs, which involves calculation of the area of a straight line from the top of the repair, horizontally out into the center of the channel, to the end of the repair. When comparing these methods, the "lateral extent" method ranged in inaccuracy anywhere from 10% up to 50% in the acres actually being impacted. This method has thus been deemed inaccurate and unacceptable as a form of effects analysis, and will not be used by NMFS as a method of analysis. NMFS will use the actual area of impact to determine habitat effects.

2.2. Rangewide Status of the Species and Critical Habitat

This BO examines the status of each species that would be adversely affected by the proposed action. The status is determined by the level of extinction risk that the listed species face, based on parameters considered in documents such as recovery plans, status reviews, and listing decisions. This informs the description of the species' likelihood of both survival and recovery. The species status section also helps to inform the description of the species' current "reproduction, numbers, or distribution" as described in 50 CFR 402.02. The BO also examines the condition of critical habitat throughout the designated area, evaluates the value of the various watersheds and coastal and marine environments that make up the designated area, and discusses the current function of the essential PBFs that help to form that value for the conservation of the listed species.

Table 7. Description of species, current Endangered Species Act (ESA) listing classifications, and summary of species status.

Species	Listing Classification and Federal Register Notice	Status Summary
Sacramento River winter-run Chinook salmon ESU	Endangered, 70 FR 37160; June 28, 2005	According to the NMFS 5-year species status review (NMFS 2016e), the status of the winter-run Chinook salmon ESU, the extinction risk has increased from moderate risk to high risk of extinction since the 2007 and 2010 assessments. Based on the Lindley et al. (2007a) criteria, the population is at high extinction risk in 2019. High extinction risk for the population was triggered by the hatchery influence criterion, with a mean of 66% hatchery origin spawners from 2016 through 2018. Several listing factors have contributed to the recent decline, including drought, poor ocean conditions, and increased hatchery influence. Thus, large-scale fish passage and habitat restoration actions are necessary for improving the winter-run Chinook salmon ESU viability.

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

Species	Listing Classification and Federal Register Notice	Status Summary
Southern DPS of North American green sturgeon	Threatened, 71 FR 17757; April 7, 2006	According to the NMFS 5-year species status review (NMFS 2015) and the 2018 final recovery plan (NMFS 2018), some threats to the species have recently been eliminated, such as take from commercial fisheries and removal of some passage barriers. Also, several habitat restoration actions have occurred in the Sacramento River Basin, and spawning was documented on the Feather River. However, the species viability continues to face a moderate risk of extinction because many threats have not been addressed, and the majority of spawning occurs in a single reach of the main stem Sacramento River. Current threats include poaching and habitat degradation. A recent method has been developed to estimate the annual spawning run and population size in the upper Sacramento River so species can be evaluated relative to recovery criteria (Mora et al. 2017).

Table 8. Description of critical habitat, Listing, and Status Summary.

Critical Habitat	Designation Date and Federal Register Notice	Description
Sacramento River winter-run Chinook salmon ESU	June 16, 1993; 58 FR 33212	Designated critical habitat includes the Sacramento River from Keswick Dam RM 302 to Chipps Island (RM 0) at the westward margin of the Sacramento-San Joaquin Delta (Delta); all waters from Chipps Island westward to the Carquinez Bridge, including Honker Bay, Grizzly Bay, Suisun Bay, and the Carquinez Strait; all waters of San Pablo Bay westward of the Carquinez Bridge; and all waters of San Francisco Bay north of the San Francisco-Oakland Bay Bridge from San Pablo Bay to the Golden Gate Bridge. The designation includes the river water, river bottom and adjacent riparian zones used by fry and juveniles for rearing. PBFs considered essential to the conservation of the species include: Access from the Pacific Ocean to spawning areas; availability of clean gravel for spawning substrate; adequate river flows for successful spawning, Incubation of eggs, fry development and emergence, and downstream transport of juveniles; water temperatures at 5.8–14.1°C (42.5–57.5°F) for successful spawning, egg incubation, and fry development; riparian and floodplain habitat that provides for successful juvenile development and survival; and access to downstream areas so that juveniles can migrate from spawning grounds to the San Francisco Bay and the Pacific Ocean. Although the current conditions of PBFs for SR winter-run critical habitat in the Sacramento River are significantly limited and degraded, the habitat remaining is considered highly valuable.

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

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

Critical Habitat	Designation Date and Federal Register Notice	Description
Southern DPS of North American green sturgeon	October 9, 2009; 74 FR 52300	Critical habitat includes the stream channels and waterways in the Delta to the ordinary high water line. Critical habitat also includes the main stem Sacramento River upstream from the I Street Bridge to Keswick Dam, the Feather River upstream to the fish barrier dam adjacent to the Feather River Fish Hatchery, and the Yuba River upstream to Daguerre Dam. Critical habitat in coastal marine areas include waters out to a depth of 60 fathoms, from Monterey Bay in California, to the Strait of Juan de Fuca in Washington. Coastal estuaries designated as critical habitat include San Francisco Bay, Suisun Bay, San Pablo Bay, and the lower Columbia River estuary. Certain coastal bays and estuaries in California (Humboldt Bay), Oregon (Coos Bay, Winchester Bay, Yaquina Bay, and Nehalem Bay), and Washington (Willapa Bay and Grays Harbor) are included as critical habitat for green sturgeon. PBFs considered essential to the conservation of the species for freshwater and estuarine habitats include: food resources, substrate type or size, water flow, water quality, migration corridor; water depth, sediment quality. In addition, PBFs include migratory corridor, water quality, and food resources in nearshore coastal marine areas. Although the current conditions of PBFs for green sturgeon critical habitat in the Central Valley are significantly limited and degraded, the habitat remaining is considered highly valuable.

Recovery Plans

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

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

Global Climate Change

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

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

Spring-run adults are vulnerable to climate change, because they over summer in freshwater streams before spawning in autumn (Thompson *et al.* 2011). Spring-run spawn primarily in the tributaries to the Sacramento River and those tributaries without cold-water refugia (usually input from springs) will be more susceptible to impacts of climate change.

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

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

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

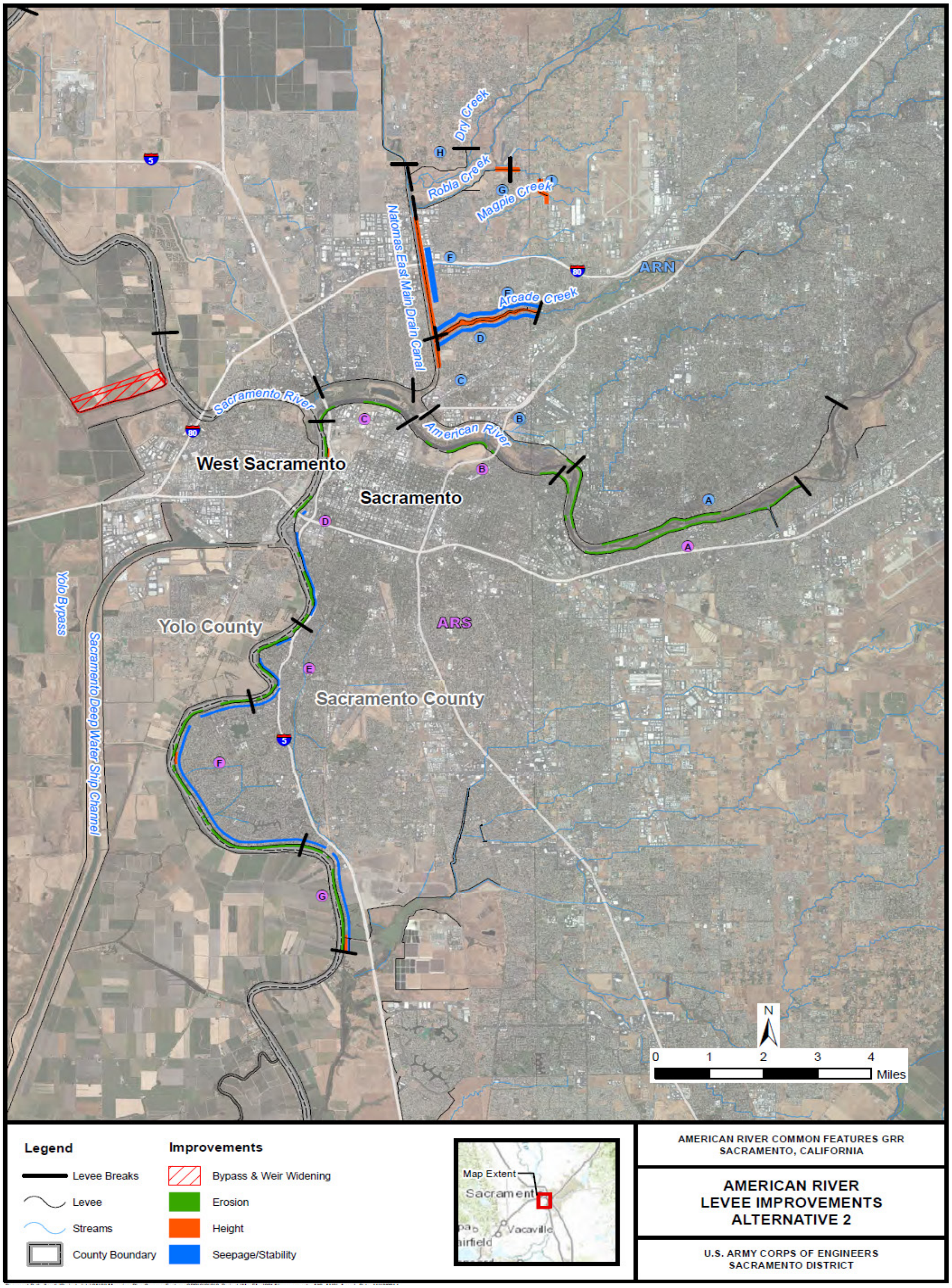
2.3. Action Area

"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 this section 7 consultation encompasses all areas that may be directly or indirectly affected as a result of activities for ARCF project and the broader area that, while outside the construction zone, may be directly or indirectly affected by implementation of the Proposed Action, such as vibrations, noise, increased turbidity, or sedimentation movement associated with the proposed action. This includes all areas that will be affected in the short-term and long-term, by the construction and maintenance for the ARCF project.

The Action Area encompasses areas along the Sacramento River from the Sacramento Bypass downstream to RM 45, the Yolo Bypass south the confluence of the Sacramento Bypass, the lower American River from Nimbus Dam to the confluence of the Sacramento River, Arcade Creek from Marysville Boulevard to the confluence of the NEMDC, the NEMDC from the south Dry Creek levee to just south of the NEMDC Arcade Creek confluence, the southern Dry Creek levee between Dry Creek Road and Rose Street, the borrow site along the NEMDC, and other haul, access, and borrow sites associated with construction activities.

Vessel traffic for construction material hauling may extend as far west as San Francisco in order to transport material to sites along the Sacramento River. The Action Area also includes any areas that may be affected by the implementation of conservation measures, including compensatory mitigation and planting areas, including the Fremont Landing Conservation Bank. These areas include on the mainstem Sacramento River down to RM 0, the American River watershed up to Nimbus Dam, areas adjacent to the expanded Sacramento Bypass, and adjacent waterways in the Sacramento-San Joaquin Delta legal boundaries.

Figure 4. Map of the American River Common Features Action Area as described by the Corps.



2.4. Environmental Baseline

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

This section describes the physical conditions and general vegetation, wildlife, and fisheries resources present within the ARCF Action Area. These conditions are first presented generally throughout the ARCF Action Area and then site specific SRA is analyzed as well as affected species in the ARCF Action Area.

The ARCF Action Area includes the mainstem Sacramento River from Freeport (RM 46) in the Delta upstream to the American River confluence (RM 60), and the Sacramento Bypass. The region also includes the lower American River from the confluence with the Sacramento River upstream to RM 11, NEMDC, Arcade Creek, Dry/Robla Creeks and Magpie Creek.

The Sacramento River watershed receives winter/early spring precipitation in the form of rain and snow (at higher elevations). Prior to the construction and operation of any reservoirs, winter rainfall events caused extensive flooding and spring snowmelt resulted in high flows during spring and early summer. Summer and fall flows were historically low. Currently, much of the total runoff is captured and stored in reservoirs for gradual release during the summer and fall months. High river flows occur during the winter and spring, but these are usually lower than during pre-European settlement times; summer and fall low flows are sustained by releases from upstream reservoirs.

Downstream from the American River confluence, the Sacramento River is moderately sinuous (average sinuosity of 1.3), with the channel confined on both sides by man-made levees enhanced by decades of man-made additions. The channel in this reach is of uniform width, is not able to migrate, and is typically narrower and deeper relative to the upstream reach due to scour caused by the concentration of shear forces acting against the channel bed (Brice 1977). Channel migration is similarly limited along the lower American River because of man-made levees and regulated flows from Folsom Dam.

The natural banks and adjacent floodplains of both rivers are composed of silt- to gravel-sized particles with poor to high permeability. Historically, the flow regimes caused the deposition of a gradient of coarser to finer material, and longitudinal fining directed downstream (sand to bay muds). The deposition of these alluvial soils historically accumulated to form extensive natural levees and splays along the rivers, 5 to 20 feet above the floodplain for as far as 10 miles from the channel (Thompson 1961). The present day channels consist of fine-grained cohesive banks that erode due to natural processes as well as high flow events (Corps 2012).

Most existing habitat impacts are the result of development of the basin-wide flood control system, the SRFCP (Sacramento River Flood Control Project), and other human developments. The current system evolved from private efforts begun in 1850 into the joint Federal-State SRFCP, which was essentially completed in 1960. Because the SRFCP removed large acreages of riparian floodplain and overflow basins from the river system, the natural regeneration of riparian woodland communities was negatively impacted. Additional effects occurred to recruitment of large woody material to the river system, spawning and rearing of fish in floodplain and floodplain functions, and allochthonous (imported) input of nutrients and food to the aquatic system. The SRFCP largely eliminated the possibility of natural channel migration and habitat renewal over a considerable portion of the river system. Reaches throughout the action area historically provided both shallow and deeper water habitat. However, channel confining levees and upstream reservoirs that maintain year-round outflow have eliminated much of the adjacent shallow water floodplain habitat. The existing levees influence the natural meander and ecosystem of the Sacramento and American Rivers, included in the action area. Many native fish species are adapted to rear in flooded, shallow water areas that provide abundant cover from prey. As a consequence of habitat alterations, and introduction of non-native species and pollutants, some native fish species are now extinct while most others are reduced in numbers (Moyle 2002).

The Proposed Action is occurring in the Sacramento River, American River, and other tributaries, most of which serve as rearing habitat and migratory corridors for listed winter-run Chinook salmon, spring-run Chinook salmon, steelhead, and green sturgeon. As mentioned above, much of the Sacramento and American River watersheds have been substantially altered from human activities, and this has dramatically reduced the habitat value of the watersheds for listed fish species. However, despite the impaired status of the Sacramento River watershed in the proposed action area, the value of the area for listed fish species is high, as it provides some of the last remaining critical habitat for listed fish. The lower Sacramento River is the essential migratory corridor for all winter-run Chinook salmon, and the majority of spring-run Chinook salmon populations, steelhead populations, and green sturgeon, and contains habitat elements that support the rearing and growth of juveniles and the successful upstream migration of adults. The same high value habitat can be attributed to the lower American River for spring-run Chinook salmon, steelhead, and green sturgeon.

Seasonal high flows enter the adjacent Yolo Bypass from this reach of the Sacramento River via the Sacramento Bypass (RM 63). Tidal influence emanating from Suisun Bay extends up the Sacramento River for 80 miles to Verona, with greater tidal variations occurring downstream during low river stages in summer and fall.

NEMDC is an approximately 13.3-mile, human-made, partially leveed drainage channel that provides drainage from Sankey Road and connects streams of the American Basin (Dry, Robla, and Arcade Creeks) to the American River. South of the confluence with Arcade Creek, the east and west levees of NEMDC are dominated by wild oats grasslands, while the channel is characterized by Fremont cottonwood forest, with smaller amounts of valley oak woodland, smart-weed cocklebur patches, and perennial rye grass fields.

The approximately 16.2-mile-long channel of Arcade Creek extends east-to-west from Orangevale to the American River, via NEMDC. The north and south levees are dominated by wild oats grasslands. Valley oak woodland is the main riparian vegetation type along Arcade Creek, but Fremont cottonwood forest occurs in small patches along the easternmost reach of Arcade Creek near NEMDC. Hardstem bulrush marsh is found within Arcade Creek near Norwood Avenue while water primrose wetlands are predominant within the channel of Arcade Creek from approximately the confluence with NEMDC to Norwood Avenue. East of Norwood Avenue, the creek channel becomes narrower, and dominated by a shaded canopy of valley oak woodland.

Vegetation in the Action Area

The Action Area consists of primarily riparian forest, valley oak woodland, riparian scrub-shrub habitat, and typically non-native annual grassland. Scrub-shrub generally refers to areas where the woody riparian canopy is composed of young trees or shrubs less than 20 feet high. Species that are typically found in riparian forest, valley oak woodland, and scrub habitats include cottonwood, several willow species, sycamore valley oak, black walnut, Oregon ash, white alder, boxelder, blue elderberry, buttonbush, Himalaya blackberry, wild grape, and poison oak. Understory vegetation may consist of an herbaceous layer of sedges, rushes, grasses, and forbs.

Riparian forest typically has a dominant overstory of cottonwood, California sycamore, black walnut, black willow, or valley oak. Dominant species found in the sub canopy may also include alder, ash and box elder. Layers of climbing vegetation make up part of the subcanopy, with wild grape being a major component, but wild cucumber and clematis vines are also found in riparian communities.

Several species of invasive non-native trees, shrubs and vines may be present in some riparian locations, predominantly red sesbania, Himalayan blackberry, tamarix, false bamboo, tree-of-heaven, eucalyptus, and ivy.

The herbaceous ruderal groundcover, primarily nonnative annual grassland, is found on most levees along the Sacramento River. It occurs on the levees and also within gaps in the riparian habitats. Plant species include wild oats, soft chess, ripgut brome, red brome, wild barley, Bermuda grass, and foxtail fescue. Common forbs include broadleaf filaree, red stem filaree, turkey mullein, clovers, and many others. The majority of these plants are not native to the Action Area.

Early riparian habitat may be called scrub-shrub. Scrub-shrub generally refers to areas where woody riparian canopy is composed of trees or shrubs approximately 20 feet high. Species that are typically found in these habitats include young cottonwood (*Populus trichocarpa*), willow (*Salix* spp.), elderberry (*Sambucus* spp.), buttonbush (*Cephalanthus occidentalis*), Himalaya blackberry (*Rubus armeniacus*), wild grape (*Vitis vinifera*), and poison oak (*Toxicodendron spp.*).

Riparian herbaceous cover includes herbland cover and gravel and sand bar community types. Areas are designated as riparian herbaceous cover if they are enclosed by riparian vegetation or the stream channel. Gravel and sand bar community types were included in this grouping by the the Corps, because these areas support annual and short-lived perennial species, including herbs, grasses and subshrubs that cover less than 50% of the area (Nelson 2000). Species that are typically found in these habitats include European annual and native perennial grasses; native perennials, such as Douglas' sagewort (*Artemisia douglasiana*), Santa Barbara sedge (*Carex barbarae*), smooth horsetail (*Equisetum laevigatum*), California pea (*Lathyrus jepsonii* var. *californicus*) and cudweed (*Gnaphalium* sp.); non-native forbs and grasses, such as garden asparagus and Bermuda grass (*Cynodon dactylon*); and invasive plants, such as yellow star-thistle (*Centaurea solstitialis*). Monospecific stands of the invasive exotic giant reed (*Arundo donax*) are also included in this vegetation type category.

Emergent marsh includes valley freshwater marsh and common reed plant community types. Common species found in emergent marsh habitat include cattails (*Typha* spp.) and tule (*Scirpus* spp.) with some sedge or associated broad-leaved aquatic species (such as *Verbena hastata*), and common reed (*Phragmites australis*), which can grow in inundated areas along the channel edge.

Other cover types found in the action area include bare ground (areas devoid of vegetation), agricultural, ruderal vegetation (areas with sparse to moderate herbaceous plant cover dominated by weedy upland species), and urban (including structures, roads and parks, but are usually located on the landward side of the levee).

Historical Human Resource Use and Current Riparian Vegetation

Historical precipitation and runoff patterns resulted in the Sacramento River being bordered by up to 500,000 acres of riparian forest, with valley oak woodland covering the higher river terraces (Katibah 1984). However, human activities of the 1800s and 1900s have substantially altered the hydrologic and fluvial geomorphic processes that create and maintain riparian forests within the Sacramento basin, resulting in both marked and subtle effects on riparian communities. Riparian recruitment and establishment models (Mahoney and Rood 1998; Bradley and Smith 1986) and empirical field studies (Scott et al. 1997, 1999) emphasize that hydrologic and fluvial processes play a central role in controlling the elevational and lateral extent of riparian plant species. These processes are especially important for pioneer species that establish in elevations close to the active channel, such as cottonwood and willows (*Salix* spp.). Failure of cottonwood recruitment and establishment is attributed to flow alterations by upstream dams (Roberts et al. 2001) and to isolation of the historic floodplain from the river channel. In addition, many of these formerly wide riparian corridors are now narrow and interrupted by levees and weirs. Finally, draining of wetlands, conversion of floodplains to agricultural fields, and intentional and unplanned introduction of exotic plant species have altered the composition and associated habitat functions of many of the riparian communities that are able to survive under current conditions.

Site-Species Analysis of Riparian Vegetation

Analysis of total LF of SRA was conducted using Google Earth Pro for the reaches only associated with bank protection on the American and Sacramento Rivers in the ARCF Action Area (Table 8). However, site-specific conditions at proposed bank protection sites will evaluate SRA habitat values using the SAM method of analysis to determine impacts and onsite compensation value based on actual designs. It is not anticipated that trees would need to be removed within the Sacramento Bypass as a result of the levee relocation effort, since the footprint of the expanded Bypass area is open farmland with no trees present. However, trees along the Sacramento River would be removed to construct the new 1,500-foot Sacramento Weir.

Below in Table 8 is the estimate of linear footage of existing riparian habitat along the reaches of the American and Sacramento Rivers where bank protection is expected to be constructed.

Table 9. Summary of Reach-Specific SRA Analysis from ARCF BA (Corps, 2020)

	American River		**Sacramento River**
Reach	**Linear Feet (LR) of SRA**	**Reach**	**Linear Feet (LR) of SRA**
Total	45,367	**Total**	51,804

2.4.1. Previous Flood Management within the Action Area

The environmental baseline also includes past and present flood management actions within the action area. The action area is encompassed by levees built from around 1850 up through 1960. Several large-scale bank repair actions have occurred within the action area prior to this consultation. The largest are by far the Sacramento River Bank Protection Program (SRBPP) and the West Sacramento General Re-evaluation Study (West Sac GRS), a sister project to the ARCF proposed action.

The SRBPP was originally authorized by the Flood Control Act of 1960, in order to protect levees and flood control facilities of the SRFCP from erosion damage. The SRBPP has been thus far described in two phases: SRBPP Phase I and Phase II. Each phase includes flood risk management actions consisting mainly of bank protection and levee repairs to correct erosion problems and protect low-lying areas of the Sacramento Valley and Sacramento-San Joaquin Delta from damaging floods. Phase I was constructed from 1962 to 1975. Phase II was originally authorized in 1974 and consists of 405,000 LF of bank protection. An additional 80,000 LF was added to Phase II by the Water Resources Development Act (WRDA) of 2007, and 30,000 LF of this has been consulted on previously with NMFS.

The West Sac GRS was consulted on in 2015 and has not yet been constructed. Based on information provided by the Corps, it is likely that construction will begin concurrently with the ARCF proposed action. The West Sac GRS will be constructing erosion repairs on the west side of the Sacramento River from the Sacramento Bypass, stretching down 11 miles as well as installing cut-off walls and further repairs within the Deep Water Ship Channel and levees within the Yolo Bypass. The construction will require the removal of most of the riparian vegetation from the levee temporarily, with up to 66% permanent vegetation loss possible. The construction was mitigated for locally through the Southport levee setback, a large floodplain construction action that was completed in 2018. This provided access to 120 acres of historic floodplain habitat to offset the impacts of the construction of the West Sac GRS action.

Although site-level impacts have been addressed from compensatory mitigation associated with the SRBPP and West Sac GRS, ecosystem impacts have largely been left unaddressed. Levees constructed as part of the SRBPP have replaced the naturally occurring shallow water habitat that existed along the banks of rivers and sloughs, which historically provided a spectrum of complex habitats. Shallow water habitats had a broad range of depths, water velocities, riparian vegetation, fallen trees and woody materials (*i.e.*, IWM), and gave the river the ability to migrate across the floodplain to create additional complexity in the geometry of its cross section. Naturally flowing rivers were able to construct riverside benches and naturally formed levees during flood events. These benches could be up to 20 feet high and extended for considerable distances inland, creating suitable conditions for the establishment and successful development of structurally diverse riparian vegetation communities (The Bay Institute 1998). Large, continuous corridors of riparian forests and vegetation were present along major and minor rivers and streams in the Central Valley. Native fish species, including listed salmonids and green sturgeon, evolved under these environmental conditions.

The construction of levees and the "reclamation" of floodplains eliminated these riparian areas. Only remnant riparian forests exist in the action area today, as many of the levees are extensively riprapped with stone armoring. Only in a few areas where waterside benches exist outside of the levee toe and vegetation is allowed to grow, does naturally established vegetation exist. These stands of riparian vegetation are discontinuous and frequently very narrow in width, providing a fraction of the ecological benefits of their historical predecessors.

In particular, the loss of large wood recruitment and IWM on a large-scale is becoming increasingly concerning, as our understanding of the functionality of IWM for fish and other wildlife resources continues to develop. IWM is very important to fish, playing key roles in physical habitat formation, sediment and organic-matter storage, and in maintaining essential habitat complexity and refugia (USFWS 2004). Loss of IWM reduces habitat quality and carrying capacity (USFWS 2004). The act of riprapping river banks not only removes any existing IWM, but prevents recruitment of IWM along the riprapped banks and reduces the retention of IWM recruited from any upstream, non-armored areas (USFWS 2004). In fact, "the cumulative loss of IWM functioning for the lower Sacramento River is now likely at least 67-90%, or more, compared to pre-SRBPP conditions" (USFWS 2004).

Loss of IWM negatively impacts salmonids through multiple phases of their life history. Schaffter et al. (1983) showed that juvenile Chinook salmon densities along riprapped banks are one third that of natural banks with the presence of fallen trees and their root balls in the water. They concluded that traditional riprap methods of protection will likely cause decreases in the salmon numbers in the Sacramento River basin. USFWS (2000) reported that in studies conducted in the Sacramento River near the Butte Basin, the highest number of juvenile Chinook salmon were associated with the nearshore areas with woody material, sloping banks, and moderate velocities. Juvenile Chinook salmon catches (*i.e.*, measured as catch per unit effort) were consistently lowest at riprapped sites and highest at natural bank sites with overhead cover and IWM, and intermediate in areas where experimental mitigation studies with artificially placed IWM. USFWS (2000) reported that additional studies conducted between Chico Landing and Red Bluff on the Sacramento River confirmed the low value of riprapped banks, the high value of natural banks with varying degrees of instream and overhead woody cover, and the intermediate value of mitigated sites.

In large mainstem streams and rivers such as the Sacramento River, the primary benefit of IWM occurs along channel margins. The woody materials act to deflect and break up stream flow, creating small eddies, pools, undercut banks, variability in channel depth, and back water areas conducive to rearing and growth (Murphy and Meehan 1991, Bisson et al. 1987). Sediment that is trapped by the woody material and stored along the channel margins contributes to the hydraulic and biologic complexity of the stream reach, particularly where organically rich materials are present (Bisson et al. 1987). These storage areas create new habitat complexity by trapping inorganic material that creates bars and holes and organic materials that contribute energy and carbon to the local food web of the stream reach (Murphy and Meehan 1991, Bisson et al. 1987). These breaks in the river flow also create ideal holding areas with plentiful food resources and the conditions where salmonids can hold with minimal energy expenditure and feed while rearing. These areas are also beneficial to a wide range of other species native to the system. Such refuges are critically important to the lower river reaches where levee construction and riprapping have disconnected the rivers from the adjoining floodplain where slow water refugia and rearing habitats formerly existed.

Riprapping affects the stability of IWM along the river channel margin. Stable wood retention is important for creating and maintaining good fish habitat (Bisson et al. 1987). Whole trees and their root balls are more important for long-term stability than smaller fragments, as they tend to stay in place for long periods of time. These large pieces of wood may remain in place for decades and in the process trap additional IWM, thus adding complexity to the overall bank structure. The longevity of IWM, however, may mask changes in the input of woody materials to the river. Since these large pieces of wood would normally be slow to decay, a decline in the woody material input may be masked. Riprapping of the upper river and Delta waterway banks prevents the normal input of upstream woody materials through erosion. The homogeneity and unvarying hydraulic roughness along the riprapped banks prevents pieces of woody materials from becoming anchored and remaining in place. The woody materials are transported downstream, but the riprapping of the lower river and Delta waterway banks further limit these pieces from becoming lodged on the banks and the woody material is lost to the system. There is a continuing reduction of IWM input from upstream and local waterways, so much so, that the presence of IWM in the Delta is becoming exceedingly rare. Spring-run Chinook salmon, winter-run Chinook salmon, steelhead, and green sturgeon must all migrate through the Delta in order to survive, and therefore the large-scale removal of IWM upstream affects listed species growth and survival. Existing pieces that are removed or break apart from decay are not being replenished from upstream.

Riprapping halts the accretion of point bars and other depositions where new riparian vegetation can colonize (DWR 1994 cited in USFWS 2004). Riprapping also halts the meander migration and reworking of floodplains, which eventually reduces habitat renewal, diversity, complexity, and heterogeneity (DWR 1994; Larson 2002; USFWS 2004). This, in turn, has adverse effects on aquatic ecosystems, ranging from carbon cycling to altering salmonid population structures and fish assemblages (Schmetterling 2001; USFWS 2004). Riprapping can also incise the thalweg of the river adjacent to the riprapped area, narrowing the low-flow channel width, resulting in decreased hydrological and biological diversity (DWR 1994, USFWS 2004). Riprapping decreases river sinuosity, which increases the river channel slope, increasing the bedload transport and possible bed degradation and scour near the toe of the riprapped bank (USFWS 2004, Larson 2002). Riprapping alters the future channel planform of the river at the riprapped site as well as downstream from the site, which can cause more erosion of the channel bank downstream than if the riprap revetment were not present (USFWS 2004, Larson 2002).

Riprapping creates a relatively smooth surface along the riverbank, which is contrary to the habitat hydrodynamic complexity required for endangered salmonids (Lister 1995; NRC 1996; USFWS 2004). Riprap fills in sloughs, tributary channels, and oxbow lake areas, causing loss of nearby wetland habitat and diversity (USFWS 2004, DWR 1994). Riprap limits the lateral mobility of the river channel, decreasing general habitat complexity in the near-shore aquatic area and reducing complex lateral habitat, including small backwaters and eddies, which removes important refugia for plants, invertebrates, fish, birds, and mammals (USFWS 2004; Welcomme 1979). Riprapping also decreases near-shore roughness, which causes stream velocities to increase more rapidly with increasing discharge, further eliminating critical refugia areas for fish and other aquatic organisms during high flows and causing accelerated erosion downstream, which can in turn result in riprap creating the need for more riprap (Gregory 1991; USFWS 2004). Riprap also halts erosion and reduces habitat complexity, which in turn reduces the ability of near-shore areas to retain sediments and organic materials, and isolates the river from its watershed (Gregory 1991; USFWS 2004). Riprap impedes plant growth, resulting in vegetation being pushed far back from the shoreline, further reducing food resources for aquatic invertebrates that would have been provided from such vegetation (Murphy 1991; USFWS 2004).

The above effects of riprapping are well documented, but there are additional, complex, and relatively poorly understood and unaddressed effects of large-scale riprapping, which warrant additional study and consideration (USFWS 2004). Studies that seek to provide insights into presently poor understood effects of large-scale riprapping include those related to the effects of bank stabilization of channelization on rivers, and the effects of snagging and clearing operations (USFWS 2004).

Environmental Effects of the Corps Vegetation Policy

The continuation of the Corps Engineering Technical Letter (ETL) policy of no vegetation within 15 feet of the levee toe on both the waterside and landside of the levee greatly exacerbates the negative attributes of the currently armored levee habitat in the area. Removal of the vegetation on the waterside and landside of the levees prevents the input of allochthonous organic materials to adjacent waterways and severely reduces the function of riparian and nearshore habitat along the affected levee reaches. By preventing the input of organic materials that serves as a source of energy and organic carbon, aquatic and terrestrial food webs are negatively impacted and the quantity and quality of nearshore rearing habitat is measurably reduced. Removal of riparian vegetation has reduced the amount of overhead shade along significant stretches of the Sacramento River mainstem and tributaries.

Compliance with the ETL policies prevents the establishment of riparian vegetation communities. The ETL policy does not allow woody vegetation to become established that could eventually be recruited into the adjacent aquatic habitat through erosion or death of the woody plants. Allowance of only grasses, sedges, and small bushes to grow on the waterside banks of the levees will not create the full functionality of a riparian zone, or create the equivalent complexity of habitat that a full riparian vegetation community would possess.

The NMFS Salmonid Recovery Plan identifies loss of juvenile rearing habitat in the form of lost natural river morphology and function, and lost riparian habitat and instream cover as a “very high stressor" affecting the viability of salmon and steelhead in the Central Valley (NMFS 2014). The Recovery Plan also establishes a strategic approach to recovery, which identifies critical recovery actions for the Central Valley, as well as watershed- and site-specific recovery actions. Watershed-specific recovery actions address threats occurring in each of the rivers or creeks that currently support spawning populations of the Sacramento River winter-run Chinook salmon ESU, the Central Valley spring-run Chinook salmon ESU, or the California Central Valley steelhead DPS. Site-specific recovery actions address threats to these species occurring within a migration corridor (*e.g.*, Sacramento River [SAR], San Francisco Bay, or the Delta [Del], Feather River [FER], American River [AMR]). Relevant recovery actions proposed include:

CEV-1.8 (Priority 1): *Develop and implement State and National levee vegetation policies to maintain and restore riparian corridors.*

Del-1.4 (Priority 1): *Conduct landscape-scale restoration of ecological functions throughout the Delta to support native species and increase long-term overall ecosystem health and resilience.*

Del-1.7 (Priority 1): *Restore, improve and maintain salmonid rearing and migratory habitats in the Delta and Yolo Bypass to improve juvenile salmonid survival and promote population diversity.*

SAR-1.2 (Priority 1): *Restore and maintain riparian and floodplain ecosystems along both banks of the Sacramento River to provide a diversity of habitat types including riparian forest, gravel bars and bare cut banks, shade vegetated banks, side channels, and sheltered wetlands, such as sloughs and oxbow lakes following the guidance of the Sacramento River Conservation Area Handbook (Resources Agency of the State of California 2003).*

SAR-2.1 (Priority 2): *Ensure that riverbank stabilization projects along the Sacramento River utilize bio-technical techniques that restore riparian habitat, rather than solely using the conventional technique of adding riprap.*

SAR-2.8 (Priority 2): *Implement projects that promote native riparian (e.g., willows) species including eradication projects for non-native species (e.g., Arundo, tamarisk).*

SAR-2.11 (Priority 2): *Improve instream refuge cover in the Sacramento River for salmonids to minimize predatory opportunities for striped bass and other non-native predators.*

AMR-1.6 (Priority 1): *Implement a long-term wood management program to provide habitat complexity and predator refuge habitat.*

AMR-2.5 (Priority 2): *Develop and implement programs and projects that focus on retaining, restoring and creating river riparian corridors within their jurisdiction in the American River Watershed.*

AMR-2.7 (Priority 2): *Utilize bio-technical techniques that integrate riparian restoration for riverbank stabilization instead of conventional riprap in the American River.*

ETL compliance that reduces or eliminates the potential for establishing riparian communities along the program's levee reaches will significantly impair implementation of these key recovery actions and will make it difficult to recover the ecosystems upon which ESA-listed salmon and steelhead in the Central Valley depend. Furthermore, the ongoing requirement under the ETL to remove vegetation will typically require the application of herbicides to control vegetation on the levee faces. Herbicides and their additives, such as surfactants, can have negative or deleterious effects upon sensitive receptors of fishes, invertebrates, or plants, in the aquatic environment. Spraying of herbicides on "unwanted" vegetation can create situations where the herbicides drift into adjacent waters and contaminate those water bodies, or is contained in runoff from surface flow during rain events.

Future projects should focus on channel margin enhancement to protect and restore key migratory and rearing areas. Degradation of channel margins by retaining riprap and removing riparian and nearshore vegetation should be mitigated on-site first or at least elsewhere on the migratory corridor. Benefits from off-site mitigation should be carefully evaluated, as the species impacted from the program development may not benefit at all from mitigation conducted elsewhere, particularly if the mitigated area is removed from the migratory corridors of the impacted fish populations (*i.e.*, the ESUs and DPSs of listed fish species).

The reduction in the quality and quantity of beneficial habitat through previous actions, and the continued maintenance of these poorly functioning habitats through discretionary actions of vegetation management results in the severely diminished habitat value for ESA-listed fish species.

2.4.2. Status of the Species in the Action Area

The action area, which is described above, encompasses the mainstem and tributaries of the Sacramento River, from RM 45 to the Sacramento Weir and Bypass (RM 63), the lower 12 miles of the American River, and all associated floodplains and riparian areas at and adjacent to the proposed construction sites. These sites function as a migratory corridor for spring-run Chinook salmon, winter-run Chinook salmon, steelhead, and green sturgeon. The action area is also used for rearing and adult feeding.

Presence of Sacramento River winter-run Chinook salmon in the Action Area

The temporal occurrence of Sacramento River winter-run Chinook salmon smolts and juveniles within the action area are best described by a combination of the salvage records of the CVP and SWP fish collection facilities and the fish monitoring programs conducted in the northern and central Delta. Based on salvage records at the CVP and SWP fish collection facilities, juvenile Sacramento River winter-run Chinook salmon are expected in the action area starting in December. Their presence peaks in March and then rapidly declines from April through June. The majority of winter-run juveniles will enter the action area during February through June. Presence of adult Chinook salmon is interpolated from historical data. While no spawning population of winter-run exists within the American River, rearing juveniles have been captured at the screw traps at RM 9, and expected to be present within the Lower American River in similar time windows as their presence in the Sacramento River. Adult winter-run Chinook salmon are expected to enter the action area starting in January, with the majority of adults passing through the action area between February and April.

The action area contains CV winter-run Chinook salmon from the Basalt and Porous Lava Diversity group (*i.e.*, mainstem Sacramento River below Keswick Dam). Within the action area, there are "Core 1" populations of CV winter-run Chinook salmon, as designated in the Recovery Plan for the species (NMFS 2014). Core 1 watersheds possess the known ability or potential to support a viable population. For a population to be considered viable, it must meet the criteria for low extinction risk for Central Valley salmonids (Lindley *et al*. 2007). The criteria include population size, population decline, catastrophic decline and hatchery influence.

Presence of CV spring-run Chinook salmon in the Action Area

CVP/SWP salvage records and the northern and Central Delta fish monitoring data indicate that juvenile spring-run Chinook salmon first begin to appear in the action area in December and January, but that a significant presence does not occur until March and peaks in April. By May, the salvage of juvenile CV spring-run Chinook salmon declines sharply and essentially ends by the end of June. The data from the northern and central Delta fish monitoring programs indicate that a small proportion of the annual juvenile spring-run emigration occurs in January and is considered to be mainly composed of older yearling spring-run juveniles based on their size at date. Adult spring-run Chinook salmon are expected to start entering the action area in approximately January. Low levels of adult migration are expected through early March. The peak of adult spring-run Chinook salmon movement through the action area is expected to occur between April and June with adults continuing to enter the system through the summer. Currently, all known populations of CV spring-run Chinook salmon inhabit the Sacramento River watershed.

The action area contains CV spring-run Chinook salmon from the Basalt and Porous Lava Diversity group, Northwestern California Diversity group, and the Northern Sierra Nevada Diversity group. Within the action area, there are both "Core 1", "Core 2", and "Core 3" populations of CV spring-run Chinook salmon, as designated for by NMFS recovery plan for the species (NMFS 2014). The Core 1 populations include Battle Creek, Clear Creek, Butte Creek, Deer Creek, and Mill Creek. Core 2 populations meet, or have the potential to meet, the biological recovery standard for moderate risk of extinction. The Core 2 populations within the actions area include the Mainstem Sacramento (below Keswick), Cottonwood/Beegum Creek, Yuba River, Big Chico Creek, and Antelope Creek. These watersheds have lower potential to support viable populations, due to lower abundance, or amount and quality of habitat. These populations provide increased life history diversity to the ESU/DPS and are likely to provide a buffering effect against local catastrophic occurrences that could affect other nearby populations, especially in geographic areas where the number of Core 1 populations is lowest. Core 3 watersheds have populations that are present on an intermittent basis and require straying from other nearby populations for their existence. These populations within the action area are Thomes Creek and Stony Creek. These populations likely do not have the potential to meet the abundance criteria for moderate risk of extinction. Core 3 watersheds are important because, like Core 2 watersheds, they support populations that provide increased life history diversity to the ESU/DPS and are likely to buffer against local catastrophic occurrences that could affect other nearby populations. Dispersal connectivity between populations and genetic diversity may be enhanced by working to recover smaller Core 3 populations that serve as stepping stones for dispersal.

Presence of steelhead in the Action Area

The CCV steelhead DPS final listing determination was published on January 5, 2006 (71 FR 834) and included all naturally spawned populations of steelhead (and their progeny) downstream of natural and manmade barriers in the Sacramento River and its tributaries. FRFH steelhead are also included in this designation. Depending on the year, there is potential spawning habitat present within the action area in the American River. There is also rearing and migration habitat present in the action area. Juveniles use rearing and migration habitat rear year-round in the mainstem Sacramento River and tributaries. Juveniles and smolts are most likely to be present in the action area during their outmigration, which begins in November, peaks in February and March, and ends in June.

Adult steelhead originating in the Sacramento River watershed will have to migrate through the action area in order to reach their spawning grounds and to return to the ocean following spawning. Likewise, all steelhead smolts originating in the Sacramento River watershed will also have to pass through the action area during their emigration to the ocean. The waterways in the action area also are expected to provide some rearing benefit to emigrating steelhead smolts. The steelhead DPS occurs in both the Sacramento River and the surrounding watersheds.

The action area contains steelhead from the Basalt and Porous Lava Diversity group, Northwestern California Diversity group, and the Northern Sierra Nevada Diversity group. Within the action area, there are both “Core 1”, “Core 2”, and “Core 3” populations of steelhead, as designated by NMFS Recovery Plan for the species (NMFS 2014). Core 1 populations include Battle Creek, Clear Creek, Deer Creek, Mill Creek, and Antelope Creek. Core 2 populations include Cow Creek, Mainstem Sacramento (below Keswick), Little Sacramento, Redding Area Tributaries, Putah Creek, Thomes Creek, Cottonwood/Beegum Creek, American River, Auburn Ravine, Feather River, Yuba River, Big Chico Creek, and Butte Creek. Core 3 populations are Stony Creek, Dry Creek, and Bear River.

Presence of North American Green Sturgeon in the Action Area

The Sacramento River is an important migratory corridor for larval and juvenile sturgeon during their downstream migration to the San Francisco Bay Delta and Estuary. Detailed information regarding historic and current abundance, distribution and seasonal occurrence of North American green sturgeon in the action area is limited due to a general dearth of green sturgeon monitoring. The action area is located on the main migratory route for adults moving upstream to spawn, post spawn adults migrating back to the ocean, juvenile outmigrants, and rearing subadults (NMFS, 2018). Juvenile green sturgeon are routinely collected at the CVP and SWP salvage facilities throughout the year. Based on the salvage records, green sturgeon may be present during any month of the year, and have been particularly prevalent during July and August. Adult green sturgeon begin to enter the Delta in late February and early March during the initiation of their upstream spawning run. The peak of adult entrance into the Delta appears to occur in late February through early April with fish arriving upstream in April and May. Adults continue to enter the Delta until early summer (June-July) as they move upriver to spawn.

It is also possible that some adult green sturgeon will be moving back downstream in April and May through the action area, either as early post spawners or as unsuccessful spawners. Some adult green sturgeon have been observed to rapidly move back downstream following spawning, while others linger in the upper river until the following fall. It is possible that any of the adult or sub-adult sturgeon that inhabit the Delta may enter the American River.

2.4.3. Status of Critical Habitat within the Action Area

The action area and includes the mainstem Sacramento River (RM 45-63), Yolo and Sacramento Bypasses, the lower American River, and numerous tributaries. Designated critical habitat for winter-run Chinook salmon (June 16, 1993, 58 FR 33212), spring-run Chinook salmon (September 2, 2005, 70 FR 52488), steelhead (September 2, 2005, 70 FR 52488) and green sturgeon (October 9, 2009, 74 FR 52300) occur in the ARCF action area.

The PBFs of critical habitat essential to the conservation of winter-run Chinook salmon, spring-run Chinook salmon, and steelhead are physical habitat, water quality and quantity, available forage required to maintain habitat for spawning, larval and juvenile transport, rearing, and adult migration. PBFs for Chinook salmon and steelhead within the action area include freshwater rearing habitat and freshwater migration corridors. The PBFs essential to the conservation of winter-run Chinook salmon, spring-run Chinook salmon, and steelhead include the following: sufficient water quantity and floodplain connectivity to form and maintain physical habitat conditions necessary for salmonid development and mobility, sufficient water quality, food and nutrients sources, natural cover and shelter, migration routes free from obstructions, no excessive predation, adequate forage, holding areas for juveniles and adults, and shallow water areas and wetlands. Habitat within the action area is primarily utilized for freshwater rearing and migration by steelhead and Chinook salmon juveniles and smolts and for adult freshwater migration. steelhead also utilize the parts of the American River within the action area for spawning habitat.

The PBFs essential to the conservation of green sturgeon are physical parameters needed for spawning, larval and juvenile transport, rearing, and adult migration. The action area includes the following green sturgeon PBFs: adequate food resources for all life stages; water flows sufficient to allow adults, subadults, and juveniles to orient to flows for migration and normal behavioral responses; water quality sufficient to allow normal physiological and behavioral responses; unobstructed migratory corridors for all life stages; a broad spectrum of water depths to satisfy the needs of the different life stages; and sediment with sufficiently low contaminant burdens to allow for normal physiological and behavioral responses to the environment.

The substantial degradation over time of several of the PBFs in the action area has diminished the function and condition of the freshwater rearing and migration habitats in the area. The action area now only has rudimentary functions compared to its historical status. The channels of the lower Sacramento and American Rivers have been replaced with coarse stone riprap on artificial levee banks and have been stabilized in place to enhance water conveyance through the system. The extensive riprapping and levee construction has precluded natural river channel migrations. The natural floodplains have essentially been eliminated, and the once extensive wetlands and riparian zones have been “reclaimed” and subsequently drained and cleared for agriculture.

Even though the habitat has been substantially altered and its quality diminished through years of human actions, its value remains high for the conservation of spring-run Chinook salmon, winter-run Chinook salmon, steelhead, and green sturgeon. Many of the factors affecting these species throughout their range are discussed in the Rangewide Status of the Species and Critical Habitat section of this BO, and are considered the same in the action area. This section describes all factors that have resulted in the current state of critical habitats in the action area, particularly focusing on factors most relevant to the proposed action. During dry years, all out-migrating individuals from the Sacramento River and tributaries will travel through the action area, as this section is the bottleneck prior to opening into the Delta. During wet years, access to the Yolo Bypass allows fish to bypass the action area. The ARCF action area encompasses a very important portion of the remaining critical habitat for these species, and it is therefore critical to maintain the habitat functionality of what remains of the riparian corridors in the action area.

The magnitude and duration of peak flows during the winter and spring are reduced by water impoundment in upstream reservoirs affecting listed salmonids in the action area. Instream flows during the summer and early fall months have increased over historic levels for deliveries of municipal and agricultural water supplies. Overall, water management now reduces natural variability by creating more uniform flows year-round. Current flood control practices require peak flood discharges to be held back and released over a period of weeks to avoid overwhelming the flood control structures downstream of the reservoirs (*i.e*., levees and bypasses). Consequently, managed flows in the mainstem of the river often truncate the peak of the flood hydrograph and extend the reservoir releases over a protracted period. These actions reduce or eliminate the scouring flows necessary to mobilize gravel and clean sediment from the spawning reaches of the river channel.

High water temperatures also limit habitat availability for listed salmonids in the lower Sacramento River. High summer water temperatures in the lower Sacramento River can exceed 72ºF (22.2ºC), and create a thermal barrier to the migration of adult and juvenile salmonids (Kjelson 1982). In addition, water diversions for agricultural and municipal purposes have reduced in-river flows below the dams. These reduced flows frequently result in increased temperatures during the critical summer months which potentially limit the survival of holding/spawning adults, incubating eggs, emerging fry, and juvenile salmonids (Reynolds 1993). The elevated water temperatures compel many salmon juveniles to migrate out of the valley floor systems quickly and forgo adequate rearing time before summer heat creates temperatures unsuitable for salmonids. Those fish that remain either succumb to the elevated water temperatures or are crowded into river reaches with suitable environmental conditions.

Levee construction and bank protection have affected salmonid habitat availability and the processes that develop and maintain preferred habitat by reducing floodplain connectivity, changing riverbank substrate size, and decreasing riparian habitat and SRA cover. Individual bank protection segments of the overall proposed action typically range from a few hundred to a few thousand LF in length. Such bank protection generally results in two levels of impacts to the environment: (1) site-level impacts which affect the basic physical habitat structure at individual bank protection sites; and (2) reach-level impacts which are the cumulative impacts to ecosystem functions and processes that accrue from multiple bank protection sites within a given river reach. Revetted embankments result in loss of sinuosity and braiding and reduce the amount of aquatic habitat. Impacts at the reach level result primarily from halting erosion and eliminating riparian vegetation. Reach-level impacts which cause significant impacts to fishes are reductions in habitat complexity, changes to sediment and organic material storage and transport, reductions of primary food-chain production, and reduction in IWM and SRA habitat.

The use of rock armoring limits recruitment of IWM (*i.e.*, from non-riprapped areas), and greatly reduces, if not eliminates, the retention of IWM once it enters the river channel. Riprapping creates a relatively homogeneous surface, which diminishes the ability of IWM to become securely snagged and anchored by sediment. IWM tends to become only temporarily snagged along riprap, and generally moves downstream with subsequent high flows. Habitat value and ecological functioning aspects are thus greatly reduced, because wood needs to remain in place to generate maximum values for fish and wildlife. Recruitment of IWM is limited to any eventual, long-term tree mortality and whatever abrasion and breakage may occur during high flows. Juvenile salmonids are likely being impacted by reductions, fragmentation, increased predation, and general lack of connectedness of remaining nearshore refuge areas.

Point and non-point sources of pollution resulting from agricultural discharge and urban and industrial development occur upstream of, and within the action area. The effects of these impacts are discussed in detail in the Rangewide Status of the Species and Critical Habitat section. Environmental stressors as a result of low water quality can lower reproductive success and may account for low productivity rates in fish (*i.e.*, green sturgeon, (Klimley 2002)). Organic contaminants from agricultural drain water, urban and agricultural runoff from storm events, and high heavy metals concentrations may deleteriously affect early life-stage survival of fish in the Sacramento River (USFWS 1995). Principle sources of organic contamination in the Sacramento River are rice field discharges from Butte Slough, Reclamation District 108, Colusa Basin Drain, Sacramento Slough, and Jack Slough (USFWS 1995). Other impacts to adult migration present in the action area, including migration barriers, water conveyance factors, water quality, are discussed in the Rangewide Status of the Species and Critical Habitat section.

The transformation of the Sacramento River from a sinuous, meandering waterway lined with a dense riparian corridor, to a highly leveed system under varying degrees of control over riverine erosional processes has resulted in homogenization of the river. These impacts include the removal of valuable pools and holding habitat for green sturgeon. In addition, channelization and removal of riparian vegetation and IWM have greatly reduced access to floodplain and off-channel rearing habitat. It has also diminished the quantity and quality of benthic habitat and the abundance of prey items in rearing, foraging, and holding habitats. A major factor in the decline of green sturgeon, and the primary reason for listing this species was the alteration of its adult spawning and larval rearing habitat in California's Sacramento River Basin (71 FR 17757, April 7, 2006).

Rapid reductions in flow create isolation or stranding within the existing Sacramento Weir stilling basin and bypass during rapid reductions in flow. With normal flow scour, some areas can become isolated pools or even completely dewatered when flood flows reduce. Juveniles seek slower flow habitat as resting stops when the bypass is inundated, which can cause high numbers of strandings. Adults will also seek deeper pools to avoid rapidly reducing flows and be caught within deeper pools and scour holes. CDFW monitoring reports show a range of numbers of different species and runs of anadromous fish observed and rescued in these efforts (Email communication, Shig Kubo June 21, 2019). Stranding within the current weir stilling basin and

Sacramento Bypass have been documented to occur every 10 years or so, and were most previously documented in 2011 and 2018.

2.4.4. Mitigation Banks and the Environmental Baseline

While the Corps is proposing on-site and off-site mitigation to offset the impacts from the proposed action, mitigation bank credits may be purchased to offset impacts. There are several conservation or mitigation banks approved by NMFS with service areas that include the action area considered in this BO. These banks occur within critical habitat for spring-run Chinook salmon, winter-run Chinook salmon, steelhead, and green sturgeon. These include:

***Liberty Island Native Fisheries Conservation Bank*:** Established in 2010, the Liberty Island Conservation Bank (Bank) is a conservation bank that serves the Delta region. It is located in the southern Yolo Bypass in Yolo County, CA. The Bank consists of 186 acres located on the still leveed northernmost tip of Liberty Island. Approved in July 2010 by NMFS, USFWS, and CDFW, the Bank provides compensatory mitigation for permitted projects affecting special-status Delta fish species within the region. The Bank provides habitat for all Delta fish species including: Sacramento River winter-run Chinook salmon, Central Valley spring-run Chinook salmon, California Central Valley steelhead, delta smelt, and Central Valley fall- and late fall-run Chinook salmon. Of the 186 total acres, 139.11 acres can be used for salmonid conservation credits. Of the 139.11 acres available for salmonids, approximately 82 acres have been allocated. The habitat includes tidally influenced shallow freshwater habitat, SRA habitat, and tule marsh SRA habitat. The increased ecological value of the enhanced rearing habitat for juvenile salmonids (and potentially green sturgeon) which have already been purchased are part of the environmental baseline for the Project. While this bank does not service the Lower American River, all features of this bank are within the designated critical habitats for the species analyzed in this BO within the Sacramento River.

Fremont Landing Conservation Bank: Established in 2006, the Fremont Landing Conservation Bank is 100-acre floodplain site along the Sacramento River (RM 80) and was approved by NMFS to provide credits for impacts to winter-run Chinook salmon, spring-run Chinook salmon, and steelhead. There are off-channel shaded aquatic habitat credits, SRA habitat credits, and floodplain credits available. To date, there are roughly 9 acres credits available to service increased rearing habitat for juvenile salmonids. The increased ecological value of the enhanced rearing habitat for juvenile salmonids (and potentially green sturgeon) which have already been purchased are part of the environmental baseline for the Project. All features of this bank are within the designated critical habitats for the species analyzed in this BO.

Bullock Bend Mitigation Bank: Established in 2016, the Bullock Bend Mitigation Bank is a 119.65-acre floodplain site along the Sacramento River at the confluence of the Feather River (Sacramento RM 106) and was approved by NMFS to provide credits for impacts to winter-run Chinook salmon, spring-run Chinook salmon, and steelhead. There are salmonid floodplain restoration, salmonid floodplain enhancement, and salmonid riparian forest credits available. To date, there have been approximately 61 acres of credits sold and the ecological value (*i.e.*, increased rearing habitat for juvenile salmonids) of the sold credits are part of the environmental baseline. All features of this bank are within the designated critical habitats for the species analyzed in this BO.

2.5. Effects of the Action

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

The Proposed Action includes activities that are likely to adversely affect Sacramento River winter-run Chinook salmon, Central Valley spring-run Chinook salmon, California Central Valley steelhead, green sturgeon, and their associated critical habitats. The following is an analysis of the potential effects to the species and their critical habitat that are reasonably certain to occur as a result of the implementation of this project.

Of the 43,000 LF of proposed erosion protection work along the Sacramento River, up to 76.6 acres of SRA and benthic habitats are expected to be altered and modified within the Action Area by construction of rock revetment or placement of other materials associated with site-specific designs. This calculation is based on measurements from the river's OHWM down to the end of the repair area that is expected to be altered by construction activities. Similarly, of the 31,000 LF within the construction footprint along the lower American River, an estimated range of 97.9 to 195.7 acres of SRA and benthic habitats are expected to be modified or altered by construction activities. This range of impact is derived from applying a uniform assumption, based on best available information, that impacts would occur 100 to 200 feet from the OHWM down into the wetted channel to where the rock placements ends. As stated in the Corps 2020 BA, the OHWM elevation is based on an 18,500 cfs 2-year reoccurrence interval flow scenario (determined from the Folsom Dam Water Control Manual period of record analysis). While these assumptions were used to estimate the extent of habitat impacts, actual site designs may vary. The accounting plan will verify that tracking of impacts as site designs are developed to ensure the level of adverse effects does not extend beyond what is analyzed here.

Ancillary to erosion protection, site-specific designs will aim to avoid or minimize effects to federally listed species and designated critical habitat to the extent feasible, and will implement on-site and off-site compensation actions as necessary to offset the loss of vegetated habitat along the rivers. Depending on the effects from erosion protection measures, a site design may incorporate various features to compensate for the loss of habitat. The sites will be designed in coordination with the resource agencies (NMFS and USFWS), in a manner to ensure the Corps is minimizing effects to listed species and critical habitat and maximizing on-site mitigation for each site.

2.5.1. Effects to Listed Fish Species

The Lower American River portion of the Action Area is a National Wild and Scenic River, and managed by the National Park Service. In an effort to allow the National Park Service to separate the effects analysis within this BO between watersheds, effects that will occur within the Lower American River will be indicated within each section. For the majority of the effects described below, they are similar between the species unless addressed in a more species-specific manner.

Physical Disturbance

Physical disturbance effects are expected within the entirety of the Action Area, including the Lower American River.

Physical disturbance in aquatic habitat will occur during construction activities, such as placement of materials (rock, soils, etc.), which have the potential to affect the juvenile and adult life stages of salmonids and green sturgeon through displacement, disruption of their normal behaviors, and direct injury or death from crushing during rock placement.

Instream construction activities may cause mortality and reduced abundance of benthic aquatic macroinvertebrates within the erosion footprint, due to the placement of rock over the existing streambed. These effects to aquatic macroinvertebrates are expected to be long-term as permanent bank armoring alters the natural streambed (USFWS 2004). The amount of food available for adult and juvenile salmonids and green sturgeon in the Action Area is therefore expected to be permanently decreased in the areas where submerged riprap is being placed.

During construction activities, both juvenile and adult fish may be able to detect areas of active disturbance and avoid those portions of the project footprint where equipment is actively operated or a turbidity plume occurs, particularly adults. Juveniles may also stay and hunker down in the activity zone. Occasionally, feeding juvenile salmonids and green sturgeon may be attracted to activity stirring up sediment, but are generally expected to avoid areas disturbed by active equipment. Juveniles will have opportunities to move to other portions of the channel where they can avoid potential injury or mortality. Adult salmonids and green sturgeon are expected to move out of the area to adjacent suitable habitat before equipment enters the water, or before gravel or boulders are placed over them due to the disturbance caused by vibrations on land. Some level of injury and death from crushing by construction equipment and rock placement is expected due to the large scale of the project footprint, but will be reduced through avoidance and minimization measures.

Due to the large project footprint of this Proposed Action, it is expected that a small number of juveniles of each species will be injured or killed as a result of the physical disturbance and rock placement. Though adults are more likely able to avoid rock placement, it is possible that a few adults may also be injured or killed due to the large scale of the Proposed Action. Proposed operations and maintenance (O&M) will cause intermittent small-scale physical disturbance over the long-term. While small disturbances from levee O&M may cause some minor injury or localized behavioral disturbances, it is not expected to cause any mortality to species.

Increased Turbidity and Suspended Sediment

Increased turbidity effects are expected within the entirety of the Action Area, including the Lower American River.

All activity within the Action Area with waterside repairs have the potential to temporarily increase turbidity and suspended sediment levels within the project work site and downstream areas. The re-suspension and deposition of instream sediments is an effect of construction equipment disturbances and rock entering the river. Increased exposure to elevated levels of suspended sediments have the potential to result in physiological and behavioral effects. The severity of these effects depends on the extent of the disturbance, duration of exposure, and sensitivity of the affected life stage.

Salmonids have been observed avoiding streams that are chronically turbid (Lloyd 1987) or moving laterally or downstream to avoid turbidity plumes (Sigler et al. 1984). Chronic exposure to high turbidity and suspended sediment may also affect growth and survival by impairing respiratory function, reducing tolerance to disease and contaminants, and causing physiological stress (Waters 1995).

Elevated turbidity and suspended sediment levels have the potential to adversely affect salmonids during all freshwater life stages. Specifically increased turbidity can clog or abrade gill surfaces, adhere to eggs, hamper fry emergence (Phillips and Campbell 1961), bury eggs or alevins, scour and fill in pools and riffles, reduce primary productivity and photosynthesis activity (Cordone and Kelley 1961), and affect intergravel permeability and dissolved oxygen levels (Lisle and Eads 1991; Zimmermann and Lapointe 2005).

Fish behavioral and physiological responses indicative of stress include: gill flaring, coughing, avoidance, and increased blood sugar levels (Berg and Northcote 1985; Servizi and Martens 1992). Excessive sedimentation over time can cause substrates to become embedded, which reduces successful salmonid spawning and egg and fry survival (Waters 1995). Changes in turbidity and suspended sediment levels associated with water operations may negatively impact fish populations temporarily when deposition of fine sediments fills interstitial substrate spaces in food-producing riffles, reducing the abundance and availability of aquatic insects and cover for juvenile salmonids (Bjornn and Reiser 1991). Suspended solids and turbidity generally do not acutely affect aquatic organisms unless they reach extremely high levels (*i.e.*, levels of suspended solids reaching 25 mg/L). At these high levels, suspended solids can adversely affect the physiology and behavior of aquatic organisms and may suppress photosynthetic activity at the base of food webs, affecting aquatic organisms either directly or indirectly (Alabaster and Lloyd 1980; Lloyd 1987; Waters 1995).

Increased turbidity can also affect fish by reducing feeding efficiency or success and stimulating behavioral changes. Sigler et al. (1984b) found that turbidities between 25 and 50 Nephelometric Turbidity Units (NTU) reduced growth of juvenile Coho salmon and steelhead, and Bisson and Bilby (1982) reported that juvenile Coho salmon avoid turbidities exceeding 70 NTUs. Turbidity likely affects Chinook salmon in much the same way it affects juvenile steelhead and Coho salmon because of similar physiological and life history requirements between the species. Newcombe and Jensen (1996) also found increases in turbidity could lead to reduced feeding rate and behavioral changes such as alarm reactions, displacement or abandonment of cover, and avoidance, which can lead to increased predation and reduced feeding. At high-suspended sediment concentrations for prolonged periods, lethal effects can occur.

Based on similar projects conducted by DWR and the Corps (*i.e.*, levee repair work and placement of riprap), construction activities are expected to result in periodic increases in localized turbidity levels up to or exceeding 75 NTUs. In the past, levee protection work on the Sacramento River has produced turbidity plumes that travel for several hundred feet downstream of the activity. However, once construction stops, water quality is expected to return to background levels within a few hours, depending on how high the percentage of fines in the material are. Adherence to erosion control measures and avoidance and minimization measures will minimize the amount of disturbed sediment from construction activities and will minimize the potential for post-construction turbidity changes should precipitation events occur after construction has been completed.

Generally, we expect that most fish will actively avoid the elevated turbidity plumes when possible, during construction activity. For those fish that do not or cannot avoid the turbid water, exposure is expected to be brief (*i.e*., minutes to hours) and is not likely to cause injury or death from reduced growth or physiological stress. This expectation is based on the general avoidance behaviors of salmonids and the requirement to suspend construction when turbidity exceeds Central Valley Regional Water Quality Control Board standards (2020 Corps BA). However, some juveniles that are exposed to turbidity plumes may be injured or killed by predatory fish that take advantage of disrupted normal behavior. Once fish move past the turbid water, normal feeding and migration behaviors are expected to resume. A low proportion of fish that are exposed to the area of increased turbidity are expected to be adversely affected by increased predation due to displacement and the lowered visibility caused by the suspended sediment. Proposed operations and maintenance will cause intermittent small-scale increases in turbidity over the lifetime of the proposed action. Small increases in turbidity are expected to result in minor, brief localized behavioral disturbances, and not expected to cause any injury or mortality to species.

Acoustic Impacts during Construction Activities

Acoustic effects are expected within the entirety of the Action Area, including the Lower American River.

Noise, motion, and vibrations produced by heavy equipment operation are expected at each site. The use of heavy equipment will occur outside the active channel, in addition to the infrequent, short-term use of heavy equipment in the wetted channel. Most listed fishes will be expected to move away and avoid interaction with instream machinery by temporarily relocating either upstream or downstream into suitable habitat adjacent to the worksite. As a result, we anticipate minimal localized effects to listed fishes from instream machinery acoustic impacts. Due to the large span of the project, the aggregated acoustic effects are expected to have adverse effects to listed fish.

The excavation and placement of rock below the waterline will produce noise and physical disturbance, which could displace juvenile and adult fish into adjacent habitats. Similarly, construction activities carried out in close proximity to the river channel have the potential to transfer kinetic energy through the adjoining substrates, disturb the water column, and cause behavioral changes to fish in the nearby area. These effects are expected to occur during construction activities and to cease once rock placement is completed.

Multiple studies have shown responses in the form of behavioral changes in fish due to human produced noise (Wardle et al. 2001, Slotte et al. 2004, Popper and Hastings 2009). Instantaneous behavioral responses may range from slight variations, a mild awareness, to a startle response. Fish may also vacate their normally occupied positions in their habitat for short or long durations. Depending on the behavior that is being disrupted, the short- and long-term negative effects could vary. Behavioral effects are likely to affect juvenile fish more than adults, as there are essential behaviors to their maturation and survival, such as feeding and sheltering, as adults generally use the action area only for migration and potentially spawning. Overall, construction could disrupt behavior in some instances, but because the proposed timing of activities resulting in underwater noise disturbances would be high when the fewest fish and least sensitive life stages are present, effects would be minimal. Proposed operations and maintenance will cause intermittent small-scale increases in noise over the lifetime of the proposed action, but will also occur during windows where fish are unlikely to be present.

Acoustic Impacts during Pile-Driving Activities

Pile-driving activities and associated effects are expected within the entirety of the Action Area, including the Lower American River.

Pile driving will occur both within the channel for cofferdam installation, and outside the channel for construction and monitoring efforts. Large posts will need to be driven to support walls of cofferdams, attach monitoring equipment to, and as supports for the Sacramento Weir. Piles that are driven into riverbed substrate propagate sound through the water, which can damage a fish's swim bladder and other organs by causing sudden rapid changes in pressure, rupturing or hemorrhaging tissue in the bladder (Gisiner 1998, Popper et al. 2006). The swim bladder is the primary physiological mechanism that controls a fish's buoyancy. A perforated or hemorrhaged swim bladder has the potential to compromise the ability of a fish to orient itself both horizontally and vertically in the water column. This can result in diminished ability to feed, migrate, and avoid predators. Sensory cells and other internal organ tissue may also be damaged by noise generated during pile driving activities as sound reverberates through a fish's viscera (Gaspin 1975). In addition, morphological changes to the form and structure of auditory organs (saccular and lagenar maculae) have been observed after intense noise exposure (Hastings et al.1996). It is important to note that acute injury resulting from acoustic impacts should be scaled based on the mass of a given fish. Juveniles and fry have less inertial resistance to a passing sound wave and are therefore more at risk for non-auditory tissue damage (Popper and Hastings 2009). Fish can also be injured or killed when exposed to lower sound pressure levels for longer periods of time. Hastings (1996) found death rates of 50% and 56% for gouramis (*Trichogaster* sp.) when exposed to continuous sounds at 192 decibel (Db) (re 1 μPa) at 400 Hz and 198 dB (re 1 μPa) at 150 Hz, respectively, and 25% for goldfish (*Carassius auratus*) when exposed to sounds of 204 dB (re 1 μPa) at 250 Hz for 2 hours or less. Hastings (1995) also reported that acoustic "stunning," a potentially lethal effect resulting in a physiological shutdown of body functions, immobilized gourami within 8 to 30 minutes of exposure to the aforementioned sounds. While the effects to salmonids and sturgeon may not be identical, it is assumed that these effects would be similar for salmonids and sturgeon.

The Corps proposes to implement Interim Criteria for Injury of Fish Exposed to Pile Driving *Operations* (Popper 2006). This criteria uses a combined interim single strike criterion for pile driving received level exposure; a sound exposure level (SEL) of 187 dB re: 1 μPa^2 •sec and a peak sound pressure of 208 dB re: 1 μPa_{peak} as measured 10 m from the source. Using these criteria is expected to reduce the potential for permanent and lethal impacts to fish that are within the area and may be exposed to pile driving activities. Fish that are exposed to the area where pile driving is occurring are expected to be adversely affected by behavioral modification during increases in noise and vibration within the water column. While this will be a short-term effect for most fish, some injury or mortality is expected to occur due to the potential for use of pile driving over 5 or more construction seasons, and over such a large span of habitat. While pile-driving noise may cause some localized behavioral disturbances to a higher number of fish, injury or lethal effects are expected to occur to only a few fish over the course of project implementation.

Cofferdam Installation and Dewatering

Cofferdam installation and dewatering activities and associated effects are expected within the entirety of the Action Area, including the Lower American River.

Installation of cofferdams may be necessary during construction of a small proportion of sites, though the exact number is uncertain because full designs are not completed for all sites. Sites that may require cofferdams are generally sites that have soil being placed at low water areas to keep a more natural bank line or install a planting bench (as it is very difficult to place soil underwater). Cofferdams will be installed during the proposed work windows when fish will be less prevalent and would be in place for a single construction season. Cofferdams will remain closed during construction, eliminating the ability for fish to re-enter the area. Cofferdams will be either constructed of sand bags (placed by hand), or sheet pile (requiring pile driving, effects of which are described above), depending on the level of dewatering needed for construction.

Dewatering activities within the cofferdam areas would cause adverse effects to any fish isolated within the area. The amount of fish trapped within the area initially would be minimized with BMPs, but there is still the chance of a few juvenile fish being entrained within the cofferdam area. Dewatering activities pose the risk of increased turbidity, stress, desiccation, and possible impingement from pumping activity. Capture/relocation efforts are described below.

Fish that evade capture and remain in the construction area may be injured or killed from construction activities. This includes desiccation if fish remain in the dewatered area or death if fish are crushed by personnel or equipment. However, because experienced biologists will be collecting fish, most are expected to be removed from the area before construction. While BMPs will reduce effects, injury and mortality of a few fish are still likely due to the large scale of this project over several years of construction.

Fish Capture and Relocation Effects

Fish capture and relocation activities and associated effects are expected within the entirety of the Action Area, including the Lower American River.

Fish relocation may need to occur during implementation of the Proposed Action. Relocation will be needed during activities that require a cofferdam, but also may be needed during rescue efforts within the Sacramento Weir. For cofferdam installation, fish will be attempted to be gently "herded" out of the area before any direct handling occurs. If fish cannot be herded, they will be collected using seining or dip netting. Any adults present are expected to move out of the area of activity and avoid capture. Juveniles are more likely to be entrained or isolated in the coffer dammed work areas and any that avoid herding, would require capture and relocation prior to dewatering and construction activities. Cofferdams will be constructed immediately after fish are "herded" out of the area, with netting continuing to occur as the area is dewatered.

Fish relocation activities pose a risk of injury or mortality since any fish relocation or collection gear has some associated risk to fish, including stress, disease transmission, injury, or death. The amount of unintentional injury and mortality attributable to fish relocation varies widely depending on the method used, ambient conditions, and the experience of the field crew. Elevated air and water temperatures during handling may cause added fish stress and increased mortality. Potential sub-lethal temperature effects on juvenile salmonids include slowed growth, delayed smoltification, desmoltification, and extreme physiological changes, which can lead to disease and increased predation (Myrick and Cech 2004). Since fish relocation activities will be conducted by qualified fisheries biologists following NMFS guidelines, injury and death is expected to be minimized. As multiple relocations may need to occur throughout implementation of the Proposed Action, a small proportion of juvenile fish injury and mortality is expected to occur at each work site that requires relocation. Currently relocation efforts are expected at 1 to 2 sites on the Sacramento River, the Arden Pond site on the American River, and at the location for the new Sacramento Weir. Proposed operations and maintenance may require intermittent fish rescues over the lifetime of the proposed action. For example, if there is a debris blockage within the fishway, fish may need to be captured and relocated if the debris cannot be quickly removed to restore passage.

Impingement

Impingement effects resulting from pumping activities are expected within the entirety of the Action Area, including the Lower American River.

Pumping activities are being proposed both for dewatering activities and for irrigation purposes during the Proposed Action. Impingement may occur when the approach velocity of the screen exceeds the swimming capability of a fish, creating substantial body contact with the surface of a fish screen.

Injury resulting from impingement may be minor and create no long-term harm to the fish, or result in injuries leading to mortality either immediately or at some time in the future after contact with the screen, including predation or infections from wounds and abrasions associated with the screen contact.

NMFS' screening criteria (NMFS 2011) will be followed for all pumping activities of the Proposed Action. The NMFS' criteria are such that they will reduce exposure time of fish to a screen and, therefore, the potential for impingement as fish move past it. Other aspects of the criteria include appropriate screen mesh sizing to prevent entrainment of juvenile salmonids. The efficacy of the screening criteria is untested on juvenile green sturgeon, however. As pumping activities will only be occurring in the action area which is low down in the river system, larval green sturgeon are unlikely to be present and therefore exposure to pumping that will risk impingement or entrainment is unlikely.

As the pumping activities will adhere to NMFS screening guidelines, injury to fish caused by impingement will be minimized. However, pumping activities may occur for several years during construction across large spans of the action area. A small portion of fish exposed to the pumping activities are expected to be injured or killed from impingement. Pumping activities will only occur during the initial planting period and are not proposed beyond the first 5 years of planting.

Stranding

Stranding effects are only expected to occur within the Sacramento Weir and Bypass, and are not expected in the Lower American River.

Rapid reductions in flow can adversely affect fish. Juvenile salmonids are particularly susceptible to isolation or stranding during rapid reductions in flow. Isolation can occur when the rate of reductions in stream flow inhibits an individual's ability to escape an area that becomes isolated from the main channel or dewatered (U.S. Fish and Wildlife Service 2006). The effect of juvenile isolation on production of Chinook salmon and steelhead populations is not well understood, but isolation is frequently identified as a potentially important mortality factor for the populations in the Sacramento River and its tributaries (Jarrett and Killam 2014; National Marine Fisheries Service 2009; U.S. Bureau of Reclamation 2008; U.S. Fish and Wildlife Service 2001; Water Forum 2005).

Juveniles typically rest in shallow, slow-moving water between feeding forays into swifter water. These shallower, low-velocity margin areas are more likely than other areas to dewater and become isolated with flow changes (Jarrett and Killam 2015). Accordingly, juveniles are most vulnerable to isolation during periods of high and fluctuating flow when they typically move into inundated side channel habitats. Isolation can lead to direct mortality when these areas drain or dry up or to indirect mortality from predators or rising water temperatures and deteriorating water quality.

Isolation is currently a potential stressor in the Sacramento Bypass. Juveniles seek slower flow habitat as resting stops when the bypass is inundated by higher flows. With normal flow scour, some areas can become isolated pools or even completely dewatered when flood flows reduce. CDFW monitoring reports show a range of numbers of different species and runs of anadromous fish observed and rescued in these efforts (Email communication, Shig Kubo June 21, 2019). The dependence of isolation risk on factors, such as rate of snowmelt and timing and rate of flood flows makes the quantification of stranding risk difficult. While stranding risk may be increased with the expansion of the Sacramento Weir and Bypass, the proposed fish passage facility will increase the amount of adults able to return to the Sacramento River, and juveniles able to reach the Tule Canal.

As the new stilling basin is designed to drain fully, no stranding is expected to occur within it. However, stranding is possible within the less hardened areas of the new bypass and fish transport channel where some scour and elevation change may occur over time. Rescues will be performed by the Corps or DWR as often as conditions allow. Conditions that may not allow rescues include elevated flows or rain events that would make it dangerous for personnel to enter the bypass. Cases of stranding adults and juveniles of all species is still likely to occur for the life of this project due to the natural process of erosion and creation of deeper pools within the bypass. The benefits of the increased adult passage occurring at the Sacramento Weir are expected to offset the impacts of stranding risks in the future.

The design of the fish passage facility is expected to minimize potential stranding risk within the bypass and allow a longer period of time for adults to make their way back into the mainstem river. The proposed changes to the existing Sacramento Weir stilling basin is expected to greatly reduce juvenile stranding within the current weir's stilling basin. While the expansion of the bypass and weir may cause increased stranding risk, it is expected that the other aspects of the weirs designs and new maintenance activities will reduce impacts and minimize overall stranding within the bypass and stilling basin. Stranding effects are only expected to occur within the Sacramento Weir and Bypass, and are not expected in the Lower American River.

Chemical Contamination

Chemical contamination effects could occur within the entirety of the Action Area, including the Lower American River.

Equipment refueling, fluid leakage, concrete pouring, and maintenance activities within and near the stream channel pose some risk of contamination and potential impacts to listed fish species. Concrete work will be performed during certain aspects the Project. Contact with uncured concrete may cause significant increase in the pH of the surrounding waters, negatively affecting aquatic life. Lime is a major component of cement and concrete work. It easily dissolves in water and drastically changes the pH of water increasing the alkalinity (pH 11-13), which causes burns on fish and kills other aquatic life. Project activities that cause concrete to contact water include raw concrete spills, disposal of concrete, dampening freshly laid concrete, and washing equipment. However, all projects will include the minimization measures outlined above in Section 1.3.15 *Fisheries Conservation Measures*, which address and minimize pollution risk from equipment operation. Therefore, water quality degradation from toxic chemicals associated with the rehabilitation projects is expected to be improbable. Chemical contamination effects could occur within the entirety of the Action Area, but is improbable and therefore extremely unlikely to occur.

Increased Vessel Traffic in the Action Area

Effects resulting from project-related increased vessel traffic are expected within the Sacramento River portions of the Action Area, but not within the Lower American River.

The proposed action would significantly increase vessel traffic during times where riprap is being transported to the construction sites. The impacts from project-related vessel traffic may lead to mortality or may induce changes in behavior that impair feeding, rearing, migration, and/or predator avoidance. The Proposed Action requires barge usage to transport riprap from as far away as the San Francisco Bay up to and throughout the Action Area on the Sacramento River. The increase in barge traffic to the multiple erosion protection sites will concurrently increase the number of salmonids and green sturgeon that will have possible encounters with the propellers of the tugboats pushing the barges.

As construction operations will be occurring at times to avoid peak migration of all listed species (July 1 through October 31), the interactions with the project-related barge traffic will be minimized to the extent possible. As barges will be traveling within the Delta and mainstem Sacramento Rivers, the channel width and depth should allow adult fish the opportunity to swim out of the path of the propellers and avoid injury. Smaller fish may not have the swimming capacity to evade the propeller and may be injured or killed. As barge trips could total up to 2,325 trips from the San Francisco area up to the action area and back down over a total of 5 years of construction, there will be an increased chance for injury or death to fish encountered in those areas. A small proportion of juvenile spring-run Chinook salmon, winter-run Chinook salmon, steelhead, and green sturgeon are expected to be injured or killed during the construction phases of the Proposed Action due to propeller strikes caused from proposed action barge traffic.

Fish Passage Facility Operations

Fish passage effects are expected to be limited to the Sacramento River and Bypass.

Operation of the proposed fish passage structure would provide improved connectivity for ESA-listed fish species to enter the Sacramento River from the Yolo Bypass. As the Sacramento bypass has had a historic occurrence of stranding both adult and juvenile fish (Johnston et al. 2020), the facility and connection of the fish passage channel to Tule canal is expected to reduce both adult and juvenile stranding. This enhanced connectivity should increase individual survival, as well as potentially increase spawning success of fish that migrate through the Yolo Bypass. While the fish passage facility is not likely to completely remedy the existing stranding occurrences along the Sacramento Weir and Bypass, it is expected to considerably improve conditions and greatly reduce stranding. As such, fish rescues are anticipated to be less of a need as a result of this project component.

The fish passage facility is designed to reduce the frequency and likelihood of stranding that has historically occurred on these types of fish passage structures. The slide gate closure may cause impingement in rare cases, but as the gates will only be closed at very low water levels, fish are expected to generally be able to swim away from the gates during closing. While cases may be low, because this facility is expected to be operated for the next 50 years or longer, it is likely that a small number of adults and juveniles would be impinged on a gate at the new fish passage facility during the life of the project.

Potential issues that may occur with the facility include gate failures, debris blockages, or other damage that may fail to allow the facility to operate as intended. While O&M are expected to resolve these issues, adverse effects to fish may occur in the time it takes for such issues to be safely corrected. In these types of situations, passage delays through the facility are expected. Delays may include adults and juveniles becoming stranded within the Bypass. Risks to juveniles in this situation include impingement on debris/blockage if the facility is clogged with debris, and possible stranding if the facility is not operating correctly (Gregory et al. 1992). These situations may cause death or severe injury when they occur. For adults delayed by malfunction of the facility, they may have an opportunity to turn around and attempt passage through the Fremont Weir if it is operating. If the blockage is not able to be cleared in a timely manner, it may cause severe delays in spawning, death, straying, or inability to reach spawning grounds. While these types of occurrences are not expected annually, the Sacramento River has a high debris load, so this type of blockage is likely to happen several times over the life of the project.

The Corps' proposed action includes the adaptive management of the facility in order to reduce take, and maximize passage. The adaptive management plan will include flexible operations of the gates in coordination with NMFS technical staff, and is not expected to have any additional effects to species other than those described above.

2.5.2. Effects to Designated Critical Habitat

Critical habitat has been designated within the Action Area for spring-run Chinook salmon, winter-run Chinook salmon, steelhead, and green sturgeon. The general PBFs of critical habitat within the Action Area are rearing and migratory corridors. Spawning habitat PBFs are present on the American river for steelhead.

Placement of Riprap

Effects from Riprap placement activities are expected within the entirety of the Action Area, including the Lower American River.

The continual input of riprap into the Sacramento and American rivers will permanently alter critical habitat in the system. Garland *et al.* (2002) found that juvenile salmonids are significantly less likely to be found in riprap habitats versus unaltered habitats. The study found that as substrate size decreased, likelihood of fish presence increased (until reaching sand substrate). Placement of riprap is expected to adversely affect the value of freshwater migratory and rearing habitat PBFs for juvenile salmonids and reduce the amount of useable rearing habitat. Placement of riprap is also expected to adversely affect the amount of salmonid spawning habitat available within the American River. No spawning habitat is present within the Sacramento River portions of the Action Area. Placement of riprap will also reduce sediment quality for green sturgeon and change the substrate type or size in areas it is placed, which could reduce food availability and effect water quality and flow. Instream rock placement will cause impacts to rearing habitat quality from reduced abundance of benthic aquatic macroinvertebrates within the footprint of the repairs, due to the placement of rock over the existing streambed. Increased sediment size also creates more habitat for predators to hide and ambush prey from, causing an increase in juvenile predation. These effects to aquatic macroinvertebrates are expected to be long-term as permanent bank armoring alters the natural streambed (USFWS, 2004). The amount of food available for adult and juvenile salmonids and sturgeon in the Action Area is therefore expected to be permanently decreased (habitat quantity and quality) where submerged riprap is placed.

In some areas, riprap will be buried and formed into a launchable trench to protect the levee in case of future erosion. While this type of construction is not anticipated to have negative impacts on salmonid habitat initially, it is designed to launch rock down the bank to protect it in case of scour. As the final design of this bank is a bare rock face, that design is also being analyzed as the future site design. These designs are intended to launch over the next 50 years, and vary in their durability to launch on a 10-year flood or higher flow in some scenarios. Due to expected changing water conditions from climate change (described in Section 2.6.5 below), high flow events are expected to occur more frequently, making the launching of these sites even more likely. Once launched, these sites will permanently lose exposed native soil, riparian vegetation, and native habitat function. This will cause permanent reduction in quality of migratory and rearing habitat. As sites may span for long distances (over 1 mile), or back up right to another site to span several miles, this reduction in quality of habitat may substantially reduce food availability throughout the entirety of the action area.

Another form of rock protection being used is launchable toe rock. This rock, while buried mostly under the planting benches, is also designed to launch to protect the levee from scour. The launching of this type of stone is likely to result in the loss of some of the mitigation planting bench. As this bench is being created to offset the loss of habitat and create some relief habitat among riprap, it is of high value in a system that is so constrained by levees already. As these benches are being constructed to offset the impacts of habitat loss, the lack of durability of this mitigation is concerning. As it cannot be accurately determined at what future time this planting bench will be damaged from launchable rock, the overall benefit of the mitigation becomes less certain. It is assumed that there will be some temporal benefits, but not new habitat created and maintained permanently.

Within the Sacramento River, up to 76.6 acres of permanent degradation of salmonid and sturgeon critical habitat from riprap placement is expected. Within the lower American River, an estimated range of 97.9 to 195.7 acres will have permanent habitat degradation due to rock placement. Due to the close proximity of all the sites, the degradation of rearing and migratory corridor habitat PBFs in the action area will result in reduced growth, reduced survival, and reduced fitness. While effects will be minimized by the use of BMPs such as soil-filled rock, replanting disturbed areas, and minimizing vegetation removal overall, the Corps also proposes to mitigate unavoidable habitat impacts with a combination of on-site planting bench creation, off-site mitigation, or purchase of conservation bank credit.

Toxic Substance Spills

Toxic substance effects could occur within the entirety of the Action Area, including the Lower American River.

Operation of power equipment, such as an excavator, in or near aquatic environments increases the potential for toxic substances to enter the aquatic environment and have negative effects on ESA-listed anadromous fish species and designated critical habitat (Feist et al. 2011). Spills of toxic substances could negatively affect the freshwater migratory corridor and freshwater rearing habitat PBFs.

Equipment refueling, fluid leakage, and maintenance activities within and near the stream channel pose some risk of contamination and potential impacts to listed fish species. The Proposed Action includes the development of a hazardous materials spill prevention and countermeasures plan. The Proposed Action includes daily inspections of all heavy equipment for leaks. With inclusion of these measures, the potential effects from hazardous materials entering the aquatic environment and adversely affecting designated critical habitat are not expected to occur.

Loss of Riparian Habitat Functions and Vegetation

Degradation of rearing and migratory habitat will occur, resulting from riparian habitat loss within the entirety of the Action Area, including the Lower American River.

During the development of the Recovery Plan for Central Valley Chinook Salmon and Steelhead (NMFS 2014), loss of riparian habitat and instream cover was identified as a primary stressor affecting the recovery of the species. This threat primarily affects the juvenile rearing and outmigration life stage of these species, from the upper reaches of their watershed of origin through the Delta.

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 be a healthy riparian habitat and many terrestrial invertebrates also depend on this habitat. Studies by the California Department of Fish and Wildlife (CDFW) as reported in NMFS (NMFS 1997) demonstrated that a significant portion of juvenile Chinook salmon diet is composed of terrestrial insects, particularly aphids which are dependent on riparian habitat.

The Proposed Action will remove and reduce riparian habitat within designated critical habitat for spring-run Chinook salmon, winter-run Chinook salmon, steelhead, and green sturgeon in the Action Area. The current amount of habitat estimated is presented in Table 9 below. While not all SRA habitat will be disturbed during project activities, as it is described being within the Action Area, a significant portion is likely to be impacted. These modifications to designated critical habitat are expected to reduce the PBFs of rearing habitat (reduced quantity and quality, increased predation, reduced cover, and reduced benthic invertebrate production), and will also adversely affect the PBFs of migratory habitat by decreasing the habitat quality. Potential adverse impacts to PBFs of rearing habitat include reduced benthic invertebrate production, disrupted migration, and/or displacement (resulting in increased predation).

Table 10. Current SRA habitat within the Action Area as described in the Corps 2020 BA

Reach	**American River Linear Feet (LF) of SRA**	**Reach**	**Sacramento River Linear Feet (LF) of SRA**
A	31,174	D	9,643
B	7,259	E	7,709
C	6,934	F	21,263
		G	11,689
		Sac Weir	1,500
Total	**45,367**	**Total**	**51,804**

Impacts to rearing habitat and migratory corridor PBFs are expected to occur through reduced riparian vegetation, both temporary and permanent. Loss of riparian vegetation is expected to result from maintaining temporary access points to the river, and covering vegetation with gravel/rock. While vegetation removal will be minimized to the maximum extent possible, large-scale riparian vegetation removal will be needed throughout the course of the construction sequences. The impacts to rearing habitat and migratory corridor PBFs from loss of riparian habitat, including that which provides SRA functions, is expected to cause short- and long-term loss in quality habitat. Degraded SRA habitat will affect migrating and rearing fish through loss of food input, cover, and cooling from shade. This is expected to result in reduced feeding/growth, increased predation, and reduced survival. Unavoidable adverse effects will be compensated through a combination of on-site, off-site, and/or mitigation bank credit purchases as described in 1.3.17 *Compensatory Mitigation* above.

Fish being exposed to the areas losing riparian habitat may be more susceptible to predators due to loss of cover and have changes to their food foraging behavior. 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).

Impacts to existing vegetation will be avoided to the extent practicable. The loss of riparian vegetation may occur creating and maintaining temporary access points to the river, and placement of riprap or other bank armor. As the overall spatial aspect of the Proposed Action is extensive, the total loss of riparian vegetation is expected to be substantial. With the amount of vegetation potentially needing to be removed throughout such a long stretch of migratory corridor, the ability of the PBFs to support listed fish will diminish. Proposed O&M will cause intermittent small-scale removal of riparian vegetation to maintain maintenance roads over the lifetime of the proposed action. No overall loss is expected beyond standard maintenance trimming of vegetation. Proposed operations and maintenance will cause intermittent small-scale vegetation removal and trimming over the lifetime of the proposed action. Vegetation removal and trimming will only occur to maintain the access roads as described in the engineering designs for each site. No vegetation removal is anticipated beyond what is described in the proposed action (and will be determined during the PED phase for each site).

Permanent habitat loss is expected to occur at sites where rock is being placed within existing riparian habitat. Mitigation credits are being purchased or other NMFS-approved mitigation actions to offset impacts that are both temporary and permanent. The *Compensatory Mitigation section (1.3.17)* includes the mitigation ratios, which are site dependent. Planned repair sites are spaced out, such that preferable rearing and migratory corridor PBFs are available between bank repair sites, providing support for listed fish. In areas where bank repair occurs for longer reaches, on-site planting benches will provide support for rearing and migratory habitat through the action area. Degradation of rearing and migratory corridor PBFs of critical habitat will occur, resulting from riparian habitat loss within the entirety of the Action Area.

Increased Mobilization of Sediment

Effects of sediment mobilization are expected to occur within the entirety of the Action Area, including the Lower American River.

All project sites with waterside repairs will have temporary increases in turbidity and suspended sediment levels within the project work site and downstream areas. The re-suspension and deposition of instream sediments is expected to occur from construction equipment and rock entering the river. The deposition of sediment is expected to temporarily reduce food availability and feeding efficiency due to the natural substrate being coated with a new layer of sediment. Short-term increases in turbidity and suspended sediment levels associated with construction may negatively impact rearing habitat PBFs temporarily through reduced availability of food and reduced feeding efficiency. Short-term increases in turbidity and suspended sediment will also disrupt the ability of rearing habitat to support feeding fish resulting in avoidance or displacement from preferred habitat.

Incorporation of the BMPs described above in section 1.3.14 is expected to minimize the extent of adverse effects to critical habitat PBFs to a minimal level. Proposed operations and maintenance will cause intermittent small-scale increases in turbidity over the lifetime of the proposed action. While small increases in turbidity may cause some short-term, localized disturbances to habitat, it is not expected to cause any long-term impacts to habitat.

Acoustic Impacts

Effects of acoustic disturbance to critical habitat are expected within the entirety of the Action Area, including the Lower American River.

Impacts to freshwater rearing habitat and migratory corridor PBFs are expected to occur due to pile-driving activities. As a result, we anticipate some localized reduction in the quality of habitat within the Action Area during construction activities. Similarly, construction activities carried out in close proximity to the river channel have the potential to transfer kinetic energy through the adjoining substrates, disturb the water column, and temporarily generate increased turbulence and turbidity in the river (Kemp et al. 2011), affecting the ability of rearing and migratory PBFs to support fish.

Any excessive noise or vibrations may temporarily reduce usage of the habitat within the Action Area. Suitable habitat within to the worksite either upstream or downstream will likely be less utilized if machinery noise is present. Critical habitat effects from noise, motion, and vibration are expected to be temporary and minimal. Proposed O&M will cause intermittent small-scale increases in noise over the lifetime of the proposed action. While small increases in noise may cause some localized behavioral disturbances, they are not expected to cause any effects beyond what is described above.

Inaccessible Floodplain for Rearing

Inaccessible floodplain habitat effects are expected within the entirety of the Action Area, including the Lower American River.

The Proposed Action includes large-scale bank armoring within the Action Area. Bank armoring halts the meander migration and reworking of floodplains, which eventually reduces habitat renewal, diversity, complexity, and heterogeneity. This, in turn, has adverse effects on aquatic ecosystems, ranging from carbon cycling to altering salmonid population structures and fish assemblages (Schmetterling 2001; USFWS 2004). Riprapping decreases river sinuosity, which increases the river channel slope, increasing the bedload transport and possible bed degradation and scour near the toe of the riprapped bank (USFWS 2004).

Loss of floodplain habitat and loss of wetland function have been identified as primary stressors affecting the recovery of Central Valley salmonid species (NMFS 2014), and green sturgeon (NMFS 2018). This threat primarily affects the PBFs of juvenile rearing and outmigration 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 Floodplain Habitat are likely to result in a probable change in fitness of reduced growth and/or reduced survival probability.

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% of wetlands have been lost since the mid-1800s (Hanak *et al.* 2011, Garone 2013). Loss of Floodplain Habitat within 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 floodplain are key juvenile rearing habitats supporting significantly higher drift invertebrate consumption and therefore faster growth rates (Sommer *et al.* 2001, Katz et al. 2017). Otolith microstructure studies near the City of Chico recorded increased 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 that may be key influences of a Chinook cohort's success (Kareiva et al. 2000).

The Proposed Action will extend the useful life of over 20 miles of levees within listed species critical habitat, continuing blocking of access to historic floodplain rearing habitat PBFs. Although the proposed repairs include compensation for permanent impacts at each repair site (see section 1.3.16 above), extending the useful life of levees in the Action Area results in continued degraded quality and quantity of rearing habitat PBFs for juveniles.

Beneficial and Compensatory Effects of Proposed Mitigation Activities

Beneficial and compensatory effects of proposed mitigation effects are expected within the entirety of the Action Area, including the Lower American River.

The Proposed Action includes several aspects that will either restore lost habitat on-site, create new habitat off-site, or otherwise improve habitat for salmonids and green sturgeon. While many of these aspects will require construction and have impacts described above, there will be benefits to the habitat as well. The associated timing of the different aspects of mitigation proposed in the BA are planned to minimize temporal effects. As described above in section 2.1.2 *Compensation Timing*, reducing impacts to ensure a single generation is not exposed to multiple times. Ensuring that the riparian vegetation within migration corridors are returned to a functional level prior to, or within a few years of impacts occurring, ensures that fish exposed to impacts as juveniles, will not be exposed again as returning adults, which could compound the effects and significantly reduce growth and survival.

Planting benches with woody riparian vegetation and lower Tule vegetated benches are being included with the proposed action design when space within the levee prism (entirety of the levee) allows for it. These benches will allow for functional habitat within the levee repair, alleviate some of the effects of the riprap placement, and reduce the overall loss of riparian vegetation. This can provide improved PBFs, when compared to a bare rock slope alternative, for migratory corridor and juvenile rearing.

Beyond the on-site replanting, local mitigation sites are being proposed to compensate for unavoidable permanent effects. The large Arden Bar site being proposed is converting a bass pond into a useable side channel that will be used for juvenile rearing, migration, and potentially salmonid spawning habitat. This site creates 23.9 acres of high quality salmonid habitat that was previously poor quality. Another large mitigation site (100+ acres) is proposed, but as the exact site has not been chosen yet. While the final cite is not specified, effects of construction based on the bounds of the described anticipated site can be anticipated. A site of that size being returned to floodplain habitat can be expected to cause localized increases in turbidity during excavation and grading activities, increased noise, potential cofferdam placement, and other activities as described above. As this site is likely going to be dry during construction, effects to critical habitat are expected to be temporary and minimal. The site must be located on the Sacramento River mainstem to benefit all four NMFS species (as well as Delta Smelt for the USFWS). This large site is expected to produce high-quality juvenile rearing and migratory habitat for salmonids and sturgeon.

Another component of the Corps mitigation proposal is a research grant in the sum of $5 million. This grant is going to fund green sturgeon research to determine juvenile screening criteria, and begin the process of developing adult green sturgeon passage criteria. By determining accurate juvenile screening criteria, juvenile migratory habitat will greatly increase in safety, as pumping activities will not cause as high of a risk for rearing and migratory corridor PBFs. Being able to accurately determine successful passage mechanisms will increase the PBFs for passage and adult migration by ensuring proper criteria and minimizing delays to migration.

2.6. Cumulative Effects

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

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

2.6.1. Water Diversions and Agricultural Practices

Water diversions for irrigated agriculture, municipal and industrial use, and managed wetlands are found along the Common Features GRR action area. Depending on the size, location, and season of operation, these unscreened diversions entrain and kill multiple life stages of aquatic species, including juvenile listed anadromous species. For example, as of 1997, 98.5% of the 3,356 diversions included in a CV database were either unscreened or screened insufficiently to prevent fish entrainment (Herren and Kawasaki 2001).

Agricultural practices in the action area may adversely affect riparian and wetland habitats through upland modifications of the watershed that lead to increased siltation or reductions in water flow. Grazing activities from cattle operations can degrade or reduce suitable critical habitat for listed salmonids by increasing erosion and sedimentation, as well as introducing nitrogen, ammonia, and other nutrients into the watershed, which then flow into the receiving waters of the associated watersheds. Stormwater and irrigation discharges related to both agricultural and urban activities contain numerous pesticides and herbicides that may adversely affect listed salmonid and green sturgeon reproductive success and survival rates (Daughton 2002; Dubrovsky et al. 1998).

2.6.2. Aquaculture and Fish Hatcheries

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

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

Impacts of hatchery fishes can occur in both freshwater and the marine ecosystems. Limited marine carrying capacity has implications for naturally produced fish experiencing competition with hatchery production. Increased salmonid abundance in the marine environment may also decrease growth and size at maturity, and reduce fecundity, egg size, age at maturity, and survival (Bigler et al. 1996). Ocean events cannot be predicted with a high degree of certainty at this time. Until good predictive models are developed, there will be years when hatchery production may be in excess of the marine carrying capacity, placing depressed natural fish at a disadvantage by directly inhibiting their opportunity to recover (NPCC 2003).

2.6.3. Increased Urbanization

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

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

2.6.4. Rock Revetment and Levee Repair Projects

Cumulative effects include non-Federal riprap projects. Depending on the scope of the action, some non-Federal riprap projects carried out by state or local agencies do not require Federal permits. These types of actions and illegal placement of riprap occur throughout the action area. For example, most of the levees have roads on top of the levees that are maintained either by the county, reclamation district, owner, or by the state. Landowners may utilize and modify roads at the top of the levees to access part of their agricultural land. The effects of such actions result in continued fragmentation of existing high-quality habitat, and conversion of complex nearshore aquatic to simplified habitats that affect salmonids in ways similar to the adverse effects associated with this program.

2.6.5. Global Climate Change

The world is about 1.3°F warmer today than a century ago, the latest computer models predict that, without drastic cutbacks in emissions of carbon dioxide, and other gases released by the burning of fossil fuels, the average global surface temperature may rise by two or more degrees in the 21st century (IPCC 2001). Much of that increase likely will occur in the oceans, and evidence suggests that the most dramatic changes in ocean temperature are now occurring in the Pacific (Noakes 1998). Using objectively analyzed data Huang and Liu (2000) estimated a warming of about 0.9°F per century in the Northern Pacific Ocean.

Sea levels are expected to rise by 0.5 to 1.0 meters in the northeastern Pacific coasts in the next century, mainly due to warmer ocean temperatures, which lead to thermal expansion much the same way that hot air expands. This will cause increased sedimentation, erosion, coastal flooding, and permanent inundation of low-lying natural ecosystems (*e.g*., salt marsh, riverine, mud flats) affecting listed salmonid and green sturgeon PCEs. Increased winter precipitation, decreased snow pack, permafrost degradation, and glacier retreat due to warmer temperatures will cause landslides in unstable mountainous regions, and destroy fish and wildlife habitat, including salmon-spawning streams. Glacier reduction could affect the flow and temperature of rivers and streams that depend on glacier water, with negative impacts on fish populations and the habitat that supports them.

Summer droughts along the South Coast and in the interior of the northwest Pacific coastlines will mean decreased stream flow in those areas, decreasing salmonid survival and reducing water supplies in the dry summer season when irrigation and domestic water use are greatest. Global warming may also change the chemical composition of the water that fish inhabit: the amount of oxygen in the water may decline, while pollution, acidity, and salinity levels may increase. This will allow for more invasive species to overtake native fish species and impact predator-prey relationships (Peterson and Kitchell 2001, Stachowicz *et al.* 2002).

In light of the predicted impacts of global warming, the CV has been modeled to have an increase of between +2ºC and +7ºC by 2100 (Dettinger *et al.* 2004, Hayhoe *et al.* 2004, Van Rheenen *et al.* 2004, Stewart 2005), with a drier hydrology predominated by rainfall rather than snowfall. This will alter river runoff patterns and transform the tributaries that feed the CV from a spring and summer snowmelt dominated system to a winter rain dominated system. It can be hypothesized that summer temperatures and flow levels will become unsuitable for salmonid survival. The cold snowmelt that furnishes the late spring and early summer runoff will be replaced by warmer precipitation runoff. This will truncate the period of time that suitable cold-water conditions exist downstream of existing reservoirs and dams due to the warmer inflow temperatures to the reservoir from rain runoff. Without the necessary cold water pool developed from melting snow pack filling reservoirs in the spring and early summer, late summer and fall temperatures downstream of reservoirs, such as Lake Shasta, could potentially rise above thermal tolerances for juvenile and adult salmonids (*i.e.* winter-run Chinook salmon and steelhead) that must hold and/or rear downstream of the dam over the summer and fall periods.

2.6.6. Rock Revetment and Levee Repair Projects

Cumulative effects include non-Federal riprap projects. Depending on the scope of the action, some non-Federal riprap projects carried out by state or local agencies do not require Federal permits. These types of actions and illegal placement of riprap occur within the Sacramento and American River watersheds. The effects of such actions result in continued fragmentation of existing high-quality habitat, and conversion of complex nearshore aquatic to simplified habitats that affect salmonids in ways similar to the adverse effects associated with the Common Features Project.

2.7. Integration and Synthesis

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

In our *Rangewide Status of the Species* section, NMFS summarized the current status and likelihood of extinction of each of the listed species. We described the factors that have led to the current listing of each species under the ESA. These factors include past and present human activities, climatological trends, and ocean conditions that have been identified as influential to the survival and recovery of the listed species. Beyond the continuation of the human activities affecting the species, we also expect that ocean condition cycles and climatic shifts will continue to have both positive and negative effects on the species' ability to survive and recover. The *Environmental Baseline* section reviewed the status of the species and the factors that are affecting their survival and recovery in the Action Area. The *Effects of the Action* section reviewed the exposure of the species and critical habitat to the proposed action. NMFS then evaluated the likely responses of individuals, populations, and impacts to critical habitat. The *Cumulative Effects* section described future activities within the Action Area that are reasonably certain to have a continued effect on listed fish.

In order to estimate the risk to steelhead, spring-run Chinook salmon, winter-run, and green sturgeon as a result of the proposed action, NMFS uses a hierarchical approach. The condition of the ESU or DPS is summarized in the *Status of the Species* section of this opinion. We then consider how the populations in the Action Area are affected by the proposed action, as described in the *Environmental Baseline* section. Effects on individuals are summarized, and the consequence of those effects is applied to establish risk to the diversity group, ESU, or DPS.

In designating critical habitat, NMFS considers the PBFs (essential features) within the designated areas that are essential to the conservation of the species and that may require special management considerations or protection. Such requirements of the species include, but are not limited to: (1) space for individual and population growth, and for normal behavior; (2) food, water, air, light, minerals, or other nutritional or physiological requirements; (3) cover or shelter; (4) sites for breeding, reproduction, or rearing offspring, and generally; and (5) habitats that are protected from disturbance or are representative of the historic geographical and ecological distributions of this species [see 50 CFR § 424.12(b)]. In addition to these factors, NMFS also focuses on the principal biological or physical constituent elements within the defined area that are essential to the conservation of the species. Primary constituent elements may include, but are not limited to, spawning sites, food resources, water quality and quantity, and riparian vegetation.

2.7.1. Summary of Effects of the Proposed Action on the Sacramento River Winter-Run Chinook salmon ESU

Best available information indicates that the Sacramento River winter-run Chinook salmon ESU remains at a high risk of extinction. Key factors upon which this conclusion is based include: (1) the ESU is composed of only one population, which has been blocked from its entire historic spawning habitat; and (2) the ESU has a risk associated with catastrophes, especially considering the remaining population's dependency on the cold-water management of Shasta Reservoir (Lindley *et al.* 2007). The most recent 5-Year Status Review for winter-run Chinook salmon demonstrated that the ESU had further declined, and that continued loss of historical habitat and the degradation of remaining habitat continue to be major threats (NMFS 2016a). NMFS concludes that the Sacramento River winter-run Chinook salmon ESU remains at high risk of extinction.

The Sacramento River winter-run Chinook Salmon ESU was first listed as threatened in 1989 under an emergency rule. In 1994, NMFS reclassified the ESU as an endangered species. This ESU is also listed as "endangered" under the State of California's endangered species law (California Endangered Species Act or CESA). Currently, there is only one population, spawning downstream of Keswick Dam, making this species particularly vulnerable to environmental pressures. This vulnerability manifested during the recent drought when warm water releases from Shasta Reservoir contributed to egg-to-fry mortality rates of 85% in 2013, 94% in 2014, and 96% in 2015, the highest levels since estimates of that statistic began in 1996. Mortality decreased after the drought ended (76% and 56% mortality in 2016 and 2017, respectively), but the recovery criteria for this species, as written in the Central Valley Salmon and Steelhead Recovery Plan (NMFS 2014), include re-establishing populations into historical habitats in Battle Creek and upstream of Shasta Dam to reduce extinction risk due to compromised spatial structure.

The progeny of a captive broodstock from LSNFH were reintroduced to Battle Creek in 2017 and 2018 (U.S. Fish and Wildlife Service 2018). This "Jumpstart Project" is expected to continue until a "Transition Plan" is developed that merges the Jumpstart Project with the Reinitiation Plan (U.S. Fish and Wildlife Service 2018). The watershed currently has limited capacity to support a winter-run Chinook salmon population due to effects of a non-federal hydropower facility on habitat quantity and quality. However, Reclamation proposes a commitment of $14 million over ten years to accelerate the implementation of the Battle Creek Salmon and Steelhead Restoration Project. This project and Reclamation's commitment are expected to reestablish approximately 42 miles of prime salmon and steelhead habitat on the creek and another 6 miles on its tributaries. NMFS expects that this effort will support a second spawning population, improving the spatial structure of the ESU as anticipated in the recovery plan.

As described above, the risk to winter-run Chinook salmon posed by the proposed action is evaluated in the aggregate context of the species' status, the environmental baseline, cumulative effects, and effects from other activities that would not occur but for the Proposed Action and also reasonably certain to occur. Because the ESU is composed of one population, the effects of, and risks associated with, the proposed action at the population level also represent the risks at the ESU level. As the single population is within the Sacramento River, any reduction in habitat quality can be highly detrimental. The Action Area is the migratory corridor that is used by both adults and juveniles of the entire ESU. The continued blockage of access to historical floodplain habitat is a stressor that will be reinforced by the implementation of proposed action.

In NMFS' Recovery Plan (NMFS 2014), several elements of the proposed action are aligned with or directly implement recovery actions identified in the recovery plan. Examples include, but are not limited to:

- Providing and/or improving fish passage through the Yolo Bypass and Sutter Bypass allowing for improved adult salmonid re-entry into the Sacramento River (long-term)
- Ensure that riverbank stabilization projects along the Sacramento River utilize biotechnical techniques that restore riparian habitat, rather than solely using the conventional technique of adding riprap.
- Implement projects that promote native riparian (*e.g*., willows) species including eradication projects for nonnative species (*e.g*., Arundo, tamarisk).
- Improve instream refuge cover in the Sacramento River for salmonids to minimize predatory opportunities for striped bass and other non-native predators.

<u>Summary of Impacts of the Proposed Action on Sacramento River Winter-Run Chinook Designated Critical Habitat</u>

Critical habitat designation for Sacramento River winter-run Chinook salmon includes the Sacramento River from Keswick Dam (RM 302) to the westward margin of the Delta all waters westward to the Carquinez Bridge, all waters of San Pablo Bay westward of the Carquinez Bridge, and all waters of San Francisco Bay north of the San Francisco-Oakland Bay Bridge from San Pablo Bay to the Golden Gate Bridge ((58 FR 33212 1993) June 16, 1993). The proposed Action Area encompasses over 10 miles of riverine and estuarine critical habitat for this ESU within the primary migratory corridor, affecting the functioning of many of its physical and biological features.

The Sacramento River portions of the action area encompass winter-run critical habitat and will be affected by the proposed action. The 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 physical and biological features and slow or limit development of these features, with the exception of restoration actions, which will offset these effects to some degree.

Although the PBFs of critical habitat for Sacramento River winter-run Chinook salmon have been highly degraded, the addition of effects resulting from the proposed action are expected to be balanced out between the placement of new rock revetment with increased habitat features at adjacent sites within the project area. NMFS expects that while the bank repair described in the proposed action will result in diminished function of PBFs related to rearing and migration within designated critical habitat in the action area, the proposed conservation measures, passage improvements, and compensatory mitigation actions are expected to offset habitat function within the action area such that, on the whole, the function of physical and biological features of critical habitat will not be reduced appreciably.

2.7.2. Summary of Effects of the Proposed Action on the Central Valley Spring-run Chinook Salmon ESU

NMFS listed the CV spring-run Chinook salmon ESU as a threatened species in 1999 and reaffirmed the species' status in 2005 and 2016. The Central Valley technical recovery team estimated that there were once 18 or 19 independent populations along with a number of dependent populations within four distinct diversity groups: the northwestern California diversity group, the basalt and porous lava diversity group, the northern Sierra Nevada diversity group, and the southern Sierra Nevada diversity group (Lindley et al. 2004). The latter is no longer a functioning diversity group, but each one of the diversity groups supported multiple spring-run Chinook salmon populations historically, spreading risk within and among several Central Valley ecotypes.

Major concerns for this ESU are low numbers, poor spatial structure, and low diversity. At this time, demographically independent populations persist only in the northern Sierra Nevada diversity group (Mill, Deer, and Butte creeks, which are tributaries to the upper Sacramento River) (NMFS 2014).

NMFS (2016b) concluded that run sizes are declining over time in most of the CV spring-run Chinook salmon populations. Exceptions are the populations in Clear Creek, Battle Creek, and Butte Creek, which have seen recent growth. In particular, the number of spawners in the Battle Creek population, which was extirpated for decades, has increased 18% over the last decade and is trending towards a low to moderate risk of extinction. The population in Clear Creek has been increasing and is composed mostly of natural-origin fish, although (Lindley et al. 2004) classified this population as a dependent population (not expected to exceed the low-risk population size threshold of 2,500 fish). The Butte Creek spring-run Chinook salmon population has increased in part due to extensive habitat restoration and the accessibility of floodplain habitat in the Sutter-Butte Bypass for juvenile rearing in most years (Williams et al. 2016).

Based on the severity of the recent drought and the low escapements, as well as increased pre-spawn mortality in Butte, Mill, and Deer creeks in 2015, these CV spring-run Chinook salmon strongholds could deteriorate into high extinction risk in the coming years based on the population size or rate of decline criteria (NMFS 2016b). This predicted trend was validated in recent years through escapement data collected by CDFW for Mill and Deer creeks (California Department of Fish and Wildlife 2019). With adult returns below 500 individuals for the fourth consecutive year (2015-2018), these populations are at an increased risk of extinction (Lindley et al. 2007).

The recovery plan (NMFS 2014) listed a number of threats to the recovery of the Central Valley spring-run Chinook salmon ESU. Of these, passage barriers at Keswick and Shasta dams that block access to historical habitat in the upper Sacramento River watershed and barriers on Deer and Mill creeks that impede passage to existing habitats are ranked as very high stressors. The loss of rearing habitat in the lower and middle sections of the Sacramento River and the Delta and entrainment and predation in the Delta are also described as highly ranked stressors that are affected by the proposed action. Other threats include, but are not limited to operation of antiquated fish screens, fish ladders, and diversion dams; inadequate flows; and levee construction and maintenance projects that have greatly simplified riverine habitat and disconnected rivers from the floodplain (NMFS 2016b). The effects of the proposed action on individuals from this ESU include the reduction in quality of rearing habitat in the lower and middle sections of the Sacramento River resulting in increased predation.

As described above, the risk to the CV spring-run Chinook salmon posed by the proposed action is evaluated in the aggregate context of the species' status, the environmental baseline, cumulative effects, and effects from other activities that would not occur but for the Proposed Action and also reasonably certain to occur. As the Sacramento River portion of the Action Area is the main migratory corridor for all of the established spring-run populations (with the exception of the newly re-introduced San Joaquin river population), any reduction in habitat quality can be highly detrimental to the ESU. The Action Area is the migratory corridor that is used by both adults and juveniles, and continued blockage of access to historical floodplain habitat is a stressor that will be reinforced by the implementation of proposed action.

NMFS salmonid Recovery Plan (NMFS 2014), included several elements of the proposed action that are aligned with or directly implement recovery actions identified in the recovery plan. Examples include, but are not limited to:

- Providing and/or improving fish passage through the Yolo Bypass and Sutter Bypass allowing for improved adult salmonid re-entry into the Sacramento River (long-term)
- Ensure that riverbank stabilization projects along the Sacramento River utilize biotechnical techniques that restore riparian habitat, rather than solely using the conventional technique of adding riprap.
- Implement projects that promote native riparian (*e.g*., willows) species including eradication projects for nonnative species (*e.g*., Arundo, tamarisk).
- Improve instream refuge cover in the Sacramento River for salmonids to minimize predatory opportunities for striped bass and other non-native predators.

<u>Summary of Impacts of the Proposed Action on Central Valley Spring-run Chinook Salmon Designated Critical Habitat</u>

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

The majority of the proposed action area (the Sacramento River and the Lower portion of the American River) is within the designated critical habitat for CV spring-run Chinook salmon.

Individuals from all CV spring-run diversity groups must pass through the Lower Sacramento River in their migrations to and from the Pacific Ocean. The only exception is the experimental population that was recently reintroduced to the San Joaquin River, which will not have exposure to the long-term effects of the proposed action.

As described above, there have been many efforts to repair or restore the degraded condition of the physical and biological features of critical habitat for CV spring-run Chinook salmon over the last ten years. These actions have improved the freshwater spawning sites through water temperature management and spawning gravel augmentation; the migratory corridor through dam removal and fish passage improvements using fish ladders and through selective barrier installations such as at the Wallace Weir; freshwater rearing sites through habitat restoration projects and fish screen installation on water diversions; and estuarine habitat through habitat restoration.

Critical habitat for CV spring-Chinook salmon is highly degraded due to the effects of past and ongoing actions. Ongoing private, state, and federal actions and future non-federal actions are likely to continue to impair the function of physical and biological features and slow or limit development of these features, although restoration actions will counteract these effects to some degree. Climate change is expected to further degrade the suitability of habitats in the Central Valley through increased temperatures, increased frequency of drought, increased frequency of flood flows, overall drier conditions, and altered estuarine habitats. Proposed water management actions are expected to reduce some of these impacts by increasing water storage that can be released during summer months.

The proposed action is likely to affect a large continuous portion of the migration and rearing habitat within designated critical habitat for CV spring-run Chinook salmon. NMFS expects the proposed implementation of the Proposed Action will result in temporary diminished function of PBFs related to rearing and migration within designated critical habitat in the action area. The proposed conservation measures, passage improvements, and restoration actions are expected to improve habitat function within the action area such that, on the whole, the function of physical and biological features of critical habitat will not be appreciably reduced.

2.7.3. Summary of Effects of the Proposed Action on the California Central Valley Steelhead DPS

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

Many watersheds in the Central Valley are experiencing decreased abundance of steelhead (NMFS 2016c). Dam removal and habitat restoration efforts in Clear Creek appear to be benefiting the DPS as observers have reported unclipped (naturally produced) steelhead in recent years. However, adult numbers are still low, a large percentage of the historical spawning and rearing habitat is lost or degraded, and smolt production is dominated by hatchery fish. Many planned restoration and reintroduction efforts have yet to be implemented or completed. Most natural origin steelhead populations are not monitored and may lack the resiliency to persist for protracted periods if subjected to additional stressors, particularly widespread stressors such as climate change and drought (NMFS 2016c).

The risk to the steelhead DPS posed by the proposed action is considered in the aggregate context of the species' status, the environmental baseline, cumulative effects, and effects from other activities that would not occur but for the Proposed Action and also reasonably certain to occur. Currently the CCV steelhead DPS is at moderate risk of extinction (NMFS 2016c). However, there is considerable uncertainty with regard to the magnitude of that risk, due in large part to the general lack of information and uncertainty regarding the status of many of its populations. Here, the combined risk to individual populations are evaluated to determine the risk to the DPS as a whole.

As described above, the risk to steelhead posed by the proposed action is evaluated in the aggregate context of the species' status, the environmental baseline, cumulative effects, and effects from other activities that would not occur but for the Proposed Action and also reasonably certain to occur. Because the DPS is composed of several populations within four diversity groups, the effects of and risks associated with the proposed action must be considered in the context of the distribution of populations across multiple diversity groups. As the Proposed Action is potentially affecting a major shared migratory corridor between all of the Sacramento-based Diversity groups, any diversity group populations migrating through the action area will be impacted by changes to the habitat. The Action Area is the main migratory corridor that is used by both adults and juveniles of the entire northern portion of the DPS, comprising 4 of the 5 diversity groups. The continued blockage of access to historical floodplain habitat is a stressor that will be reinforced by the implementation of proposed action.

Summary of Impacts of the Proposed Action on California Central Valley Steelhead Designated Critical Habitat

The geographical 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. With the exception of Clifton Court Forebay, the entirety of the proposed action area in the Central Valley is designated critical habitat for steelhead. The PBFs for CV spring-run Chinook salmon critical habitat include (1) freshwater spawning sites, (2) freshwater migratory corridors, (3) freshwater rearing sites, and (4) estuarine habitat.

Critical habitat for steelhead in the mainstem Sacramento River and the American River is highly degraded due to the effects of past and ongoing actions. Ongoing private, state, and federal actions and future non-federal actions are likely to continue to impair the function of physical and biological features and slow or limit development of these features, with the exception of restoration actions, which may counteract these effects to some degree.

While there is additional critical habitat in several tributaries outside of the action area, the proposed action would affect key migratory reaches and a significant portion of rearing habitat within the designated critical habitat for steelhead. Although the current conditions of steelhead critical habitat are significantly degraded, the habitat that remains in the Sacramento watershed is considered to have high intrinsic value for species conservation, as it is critical to ongoing recovery efforts.

2.7.4. Summary of Effects of the Proposed Action on sDPS of North American Green Sturgeon

The sDPS of North American green sturgeon is listed as threatened under the ESA (71 FR 17757 2006). North American green sturgeon (*i.e.*, both the northern and southern DPSs) range from Baja California to the Bering Sea along the North American continental shelf. During the late summer and early fall, subadults and non-spawning adult green sturgeon aggregate in estuaries along the Pacific coast (Emmett et al. 1991; Moser and Lindley 2007). (Israel et al. 2008) found that green sturgeon within the Central Valley of California are sDPS green sturgeon. In addition, acoustic tagging studies show that green sturgeon spawning in the Sacramento River are exclusively from the southern DPS (Lindley et al. 2011). This DPS structure and distribution is corroborated by observations of spawning site fidelity (NMFS 2018).

Southern DPS green sturgeon are known to range through the San Francisco Bay estuary, the Delta, and the Sacramento, Feather, and Yuba rivers. (Mora et al. 2018) estimated that 9% of historical habitat has been blocked by dams. In the Yuba River, green sturgeon have been documented as far upstream as the barrier to potential spawning habitat at Daguerre Point Dam (Bergman et al. 2011). Similarly, green sturgeon have been observed at the Fish Barrier Dam on the Feather River. On the Sacramento River, the upstream extent of spawning appears to lie somewhere below Anderson-Cottonwood Irrigation District Dam (RM 298). It is uncertain if there is suitable spawning habitat in upstream reaches to Keswick Dam; this habitat may be too cold at present, but if passage was restored, could allow the spawning distribution to shift upstream in response to climate change effects.

Mora (2016) demonstrated that green sturgeon spawning sites are concentrated into very few locations. Just three sites accounted for over 50% of the spawning activity in the Sacramento River in 2010-2012. A population or DPS with a high concentration of individuals in just a few spawning sites is vulnerable to increased extinction risk due to catastrophic events.

Current available information indicates that the southern DPS of green sturgeon is composed of a single independent population, which principally spawns in the mainstem Sacramento River, but also opportunistically in the Feather and Yuba Rivers. The concentration of spawning into a very few locations makes the species highly vulnerable to catastrophic events. The apparent extirpation from upstream reaches in the San Joaquin River narrows the range of available habitat, leaving little buffer to these potential impacts.

The green sturgeon recovery plan (NMFS 2018) describes criteria for determining green sturgeon population recovery and alleviation of threats. Demographic recovery criteria are population metrics that if achieved demonstrate population recovery and alleviation of threats. Recovery actions for green sturgeon generally include improving access to spawning habitat in the Sacramento, Feather and Yuba rivers and through the Yolo Bypass; improving water temperature and flow management to support juvenile recruitment; managing water quality to reduce exposure to contaminants that limit growth and survival; reducing poaching and creating operational guidelines for fish screens and water diversions in the Central Valley.

Overall, NMFS considers the risk of extinction to be moderate because, although threats due to habitat alteration are thought to be high and the number of spawning adults is relatively low, the scope of threats and the accuracy of the population abundance estimates are uncertain (NMFS 2018). However, the sDPS does not meet the definition of viable 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. Additional information about green sturgeon will be critical to understanding the management needs for this species, especially with regard to robust abundance estimates and the characteristics and distribution of suitable habitats.

Given that the entire green sturgeon sDPS is represented by a single population, the discussion points above apply equally to both the population level analysis and that of the DPS as a whole. NMFS expects that the effects of the proposed action on abundance are likely to be moderate to low. When the Yolo Bypass is not activated, all juvenile green sturgeon in the DPS will be out-migrating through the action area. Any impacts to that area causing an increase of stressors, such as predation and reduced food availability, may have an exponential effect to the population due to limited spatial range of the species.

The action includes measures that may partially offset the stressors caused by the proposed action. The adult fish passage structure at the Sacramento Weir will reduce stranding within the Yolo Bypass and remove increased spawning delays if Fremont Weir is inoperable or impassable. The conservation measures targeted towards developing a green sturgeon HMMP and habitat impact model will significantly benefit our understanding of the species and the reality of impacts from future bank repair projects.

NMFS has finalized recovery planning for sDPS green sturgeon (NMFS 2018). Several elements of the proposed action are aligned with actions identified in the recovery plan, such as developing flow and temperature targets that support successful spawning, incubation and rearing habitat below impoundments. 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 green sturgeon in the future.

Summary of Impacts of the Proposed Action on sDPS of North American Green Sturgeon Designated Critical Habitat

Green sturgeon critical habitat was designated on October 9, 2009 (74 FR 52300 2009). In marine waters, designated critical habitat is: areas 60 fathom (110 meters) depth isobath from

Monterey Bay to the U.S.-Canada border. In freshwater, designated critical habitat is: the mainstream Sacramento River downstream of Keswick Dam (including the Yolo and Sutter bypasses), the Feather River below Oroville Dam, the Yuba River below Daguerre Point Dam, and the Sacramento-San Joaquin Delta.

PBFs in freshwater that are present in the action area:

- Substrate type or size suitable for egg deposition and development, including cobble and gravel
- Water flow including magnitude, frequency, duration, seasonality, and rate-of-change
- Water quality including temperature, salinity, oxygen content
- Migratory pathway for safe and timely passage within riverine habitats

PBFs in estuarine habitats that are affected by the proposed action are:

- Migratory pathway for safe and timely passage of all life stages between riverine and estuarine habitats

Many of the physical and biological features of green sturgeon designated critical habitat are currently degraded or impaired and provide limited high quality habitat. Although the current conditions of green sturgeon critical habitat are significantly degraded, the spawning habitat, migratory corridors, and rearing habitat that remain in both the Sacramento River watersheds and the Delta are considered to have high intrinsic value for the conservation of the species.

While the PBFs in the designated freshwater riverine and estuarine habitat are degraded under baseline conditions, they still function in providing access from the upper river habitat to the marine environment. NMFS expects the proposed action will result in diminished function of PBFs related to rearing and migration within designated critical habitat in the action area. The proposed conservation measures, passage improvements, research funding, and restoration actions are expected to offset the diminished habitat functions within the action area such that, on the whole, the function of physical and biological features of critical habitat will not be significantly reduced.

2.7.5. Status of the Environmental Baseline and Cumulative Effects in the Action Area

Salmon, steelhead and green sturgeon use the action area as an upstream and downstream migration corridor and for rearing. Within the action area, the essential features of freshwater rearing and migration habitats for salmon, steelhead and green sturgeon have been transformed from a meandering waterway lined with a dense riparian vegetation, to a highly leveed system under varying degrees of constraint of riverine erosional processes and flooding. Levees have been constructed near the edge of the river and most floodplains have been completely separated and isolated from the Sacramento River. Severe long-term riparian vegetation losses have occurred in this part of the Sacramento River, and there are large open gaps without the presence of these essential features due to the high amount of riprap. The change in the ecosystem as a result of halting the lateral migration of the river channel, the loss of floodplains, the removal of riparian vegetation, contribution from the riparian vegetation into the aquatic system, and IWM have likely affected the functional ecological processes that are essential for growth and survival of salmon, steelhead and green sturgeon in the action area.

The *Cumulative Effects* section of this BO describes how continuing and future effects, such as the discharge of point and non-point source chemical contaminant discharges, aquaculture and hatcheries, increased urbanization, and increased installation of rock revetment affect the species in the action area. These actions typically result in habitat fragmentation, and conversion of complex nearshore aquatic habitat to simplified habitats that incrementally reduces the carrying capacity of the rearing and migratory corridors.

The perpetuation of the current levee system will result in the continued diminished functioning of the aquatic and riparian ecosystems, which reduces the contributions of these habitats to the survival of rearing and migrating listed species, particularly salmonids. Given the extensive loss of upstream spawning grounds and the extreme modification of habitat in the Sacramento River and its tributaries, careful consideration of the impacts of future levee projects is needed.

2.7.6. Synthesis

Summary of Effects of the Proposed Action to Sacramento River Winter Run Chinook Salmon, CV Spring-run Chinook Salmon, CCV Steelhead, and sDPS Green Sturgeon Individuals

Effects of the levee repair on aquatic resources included both short- and long-term impacts. Short-term impacts include the impacts of construction during the repair (physical disturbances, increased turbidity, acoustic impacts, dewatering, fish relocation, impingement, and increased barge traffic. Long-term impacts include: the permanent physical alteration of the riverbank and riparian vegetation, continued blockage to the floodplain, stranding, and long-term levee and fish passage operations and maintenance.

1. Short-term Effects due to Construction

Effects associated with in-river construction work will result in temporarily altering in-river conditions. Any fishes that do not relocate during construction can be crushed or injured by construction equipment, rock placement, personnel, or may be affected behaviorally or physically from hydroacoustic impacts. However, only fishes that are holding adjacent to or migrating past the levee repair site will be directly exposed to construction activities. These construction type actions will occur during summer and early fall months, when the abundance of individual salmon, steelhead, and green sturgeon is low and is expected to result in correspondingly low levels of injury or death.

Other potential impacts due to construction include the releases of toxic substances and increases in turbidity. However, BMPs utilized are expected to prevent these impacts from adversely affecting salmonids or green sturgeon.

2. Long-term Effects Related to the Presence of Program Features

The effects of the proposed action could exacerbate many of the “Very Highly Ranked Threats” identified in the NMFS Recovery Plans to winter-run Chinook salmon, spring-run Chinook salmon and steelhead, and sDPS green sturgeon (NMFS 2014, NMFS 2018). Considering that site-specific actions will occur along primary migratory corridors of the Sacramento River, we expect that all Sacramento River Basin populations of these species are likely to be exposed and adversely affected by program actions. We do not expect the proposed action to affect the spatial structure or diversity of any of these species. Site-specific considerations, such as design configuration and planting densities, will determine the actual amount of on-site compensation that can be provided. The Corps future implementation will likely include replanting of vegetative features to provide habitat value for fish species. Some of this will be replaced as part of site design and construction, but there will be temporal gaps in function while the site plantings establish and grow.

Mitigative Effects of Proposed On-site and Off-site Conservation Measures

Section 1.2.7 of the Proposed Action describes the additional minimization and conservation measures (*i.e*., mitigation measures) that the Corps proposes to offset the unavoidable and residual adverse effects of the proposed levee repair actions. The Corp's Compensation Strategy incorporates alternatives; a mixture of local on-site mitigation, local off-site mitigation, research grant funding, and a large-scale restoration project in the Delta.

Summary of Long-term Effects to Species ESUs/DPSs as a Whole

Based on the reach-specific analysis of long-term project-related impacts to each analyzed species we determine that there will be appreciable adverse effects to each species in nearly all reaches and water surface elevations. Adverse effects at various water surface elevations, regions, and life stages are expected to last in many cases for several decades, affecting a high proportion and multiple generations of the species analyzed in this BO.

Most of the effects are related to long-term impacts to riparian habitat and IWM, as well as the continued lack of access to floodplain habitat. The perpetuating effects of the Corps Levee Vegetation Policy and riprap placement are clearly driving these effects.

Depending on final site designs, the effects of the proposed action could exacerbate stressors/threats to spring-run Chinook salmon, winter-run Chinook salmon, steelhead, and green sturgeon. Through conscientious design in coordination with NMFS and the mitigation procedures included in the program, these impacts are expected to be minimized, with unavoidable impacts mitigated. Considering that site-specific actions will occur along primary migratory corridors of the Sacramento River, we expect that all Sacramento River Basin populations of these species have the potential to be exposed and adversely affected by program actions. With the nature and potential duration of the effects, we expect the proposed action to temporarily reduce the productivity of a portion of each species during construction exposed to a project site and for the first 5 years as re-vegetation occurs. However, based on the proposed action, unavoidable impacts will be mitigated, such that the program is not expected to reduce appreciably the likelihood of both the survival and recovery of the species.

Summary of Program Effects on Sacramento River Winter-run Chinook Salmon, Central Valley Spring-run Chinook Salmon, California Central Valley Steelhead, and sDPS Green Sturgeon Critical Habitat

Within the action area, the general relevant PBFs of the designated critical habitat for listed salmonids are spawning habitat, migratory corridors, and rearing habitat, and for green sturgeon, the six PBFs include food resources, water flow, water quality, migratory corridor, depth, and sediment quality.

As described in the project description, this consultation analyzed a number of repair designs, which involve vegetation removal, bank fill stone protection installation of rock revetment, and potentially limited replacement of on-site habitat features, resulting in loss of SRA habitat and IWM at the project sites. These actions are expected to temporarily or permanently reduce the quality of habitat for rearing and migrating juvenile salmonids, due to the removal of SRA habitat and IWM. SRA habitat and IWM are important for rearing and out-migrating juvenile salmonids, because they enhance the aquatic food webs and provide high-value feeding areas for juvenile salmonids. Removal of SRA habitat and IWM is expected to temporarily reduce the growth and survival for juvenile salmonids exposed to the project sites.

Similarly, SRA habitat and IWM are critical in providing shade and cooling water temperatures for salmonids. Therefore, the removal of SRA habitat and IWM associated with the repairs will degrade freshwater rearing and migratory corridors for listed salmonids by temporarily increasing temperatures. The removal of IWM will also increase the risk of predation for juvenile salmonids. The Proposed Action further perpetuates the confinement of rivers within their banks, reducing river connectivity with adjacent floodplains, which serve as optimal rearing habitat. The severity of these effects and whether they are temporary or permanent is dependent on the repair type chosen at each site.

Green sturgeon PBFs of food resources are expected to be adversely affected by the proposed program, as program features will cover the soft benthic substrate where green sturgeon forage for food with riprap, reducing food availability. The lack of scientific information regarding bank protection actions on green sturgeon makes the extent of effects difficult to quantify. Ongoing efforts through the green sturgeon HMMP will develop methodology for quantifying and mitigating these effects.

Based on the proposed action, unavoidable impacts will be mitigated, such that the program is not expected to appreciably diminish the value of designated critical habitat.

2.8. Conclusion

After reviewing and analyzing the current status of the listed species and critical habitat, the environmental baseline within the action area, the effects of the proposed action, the effects of other activities caused by the proposed action, and cumulative effects, it is NMFS' biological opinion that the proposed action is not likely to jeopardize the continued existence of Sacramento River winter-run Chinook salmon, Central Valley spring-run Chinook salmon, sDPS North American green sturgeon, and California Central Valley steelhead or destroy or adversely modify their designated critical habitat.

2.9. Incidental Take Statement

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

2.9.1. Amount or Extent of Take

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

The most appropriate threshold for incidental take is an ecological surrogate of habitat disturbance, which includes the loss of SRA cover and riparian habitat through the placement of rock revetment and removal of vegetation. This degradation is expected to result in reduction in the growth and survival of individuals from predation, or by causing fish to relocate and rear in other locations and reduction of the quality of the existing habitat.

Incidental take, in the form of harm resulting in behavioral modifications or fish responses to habitat disturbance are described as follows. Increased predation is expected to occur during the construction phase due to construction-related disturbance and shoreline activity. Long-term behavioral modifications and increased predation vulnerability resulting from loss and degradation of shoreline riparian habitat and shallow water habitat is also expected to occur throughout the life of the levee. Quantification of the number of fish exposed to noise, shoreline activities, and increases in predation vulnerability is not currently possible with available monitoring data. Observations of individual fish within the river channel are not possible due to water clarity and depth. However, all fish passing through or otherwise present in the Action Area during construction activities or over the long term during their adult and juvenile rearing and migratory life history stages will be exposed to the disturbed shoreline habitat created by the rehabilitation sites. Thus, the footprint of each rehabilitation site defines the area in which projected incidental take will occur for this project due to the effects of construction actions and the long-term habitat disturbance associated with each site. NMFS anticipates incidental take will be limited to the following:

1. Harm to rearing and migrating juveniles is expected within the project footprint for areas below the OHWM due to rock placement within the channel. Rock placement is expected to result in injury or death to a small number of juvenile fish in the action area where riprap placement is occurring below OHWM. Harm to rearing juvenile SR winter-run, CV spring-run Chinook salmon, and CCV steelhead, and adult and juvenile green sturgeon from the repair will be limited to a total habitat impact of 278.5 acres of below OHWM. Therefore, allowable take will be exceeded if rock placement below OHWM exceeds 76.7 acres within the Sacramento River projects area (mouth of the American River down to the bottom of the action area), 195.7 acres within the American River, or 6.2 acres within the Sacramento Weir and Bypass.

2. Harm to rearing juvenile spring-run Chinook salmon, winter-run Chinook salmon, steelhead, and green sturgeon from increased turbidity in the footprint of the proposed project from construction activities, extending upstream and downstream 1,000 feet from the footprint of each individual site and 100 feet from the extent of the repair into the river channel. This disturbed habitat will affect the behavior of fish, including displacement, which is reasonably certain to result in increased predation, decreased feeding, and increased competition. NMFS does not expect any mortality or morbidity of these fish due to exposure to construction related turbidity. Quantification of the number of fish exposed to turbidity is not currently possible with available monitoring data. Observations of individual fish within the river channel are not possible due to water clarity and depth. However, all fish passing through or otherwise present during construction activities at the rehabilitation sites will be exposed to construction related turbidity events, particularly when the turbidity curtains are removed. Thus, the waterside footprint of each rehabilitation site plus the additional area of river channel where turbidity effects are expected to be observed defines the area in which projected take will occur for this project due to the effects of construction related turbidity. Allowable take will be exceeded if turbidity measured 1,000 feet downstream of the extent of the site exceeds double the upstream of site turbidity measurement.

3. Take in the form of harm, injury and death to listed fish, is expected due to pile driving. Activities will affect adults and juveniles through direct stress, injury, or death. Activities may also cause harm through displacement, increased predation, and loss of food, resulting in decreased fitness, growth, and survival. Allowable take will be exceeded if the single strike criteria exposure; a SEL of 187 dB re: 1 µPa2 •sec and a peak sound pressure of 208 dB re: 1 μPa_{peak} as measured 10 m from the source is exceeded.

4. Take in the form of harm, injury and death to listed fish, is expected due to dewatering, fish capture, and relocation activities. Activities will affect juveniles and adults through increased stress, injury, or death. Harm is also expected through displacement, increased predation, and loss of food, resulting in decreased fitness, growth, and survival. Allowable take will be exceeded if an excess of 2% of a species of fish handled annually are directly killed due to dewatering, capture and relocation activities.

5. Take in the form of harm, injury and death to listed fish, is expected due to fish impingement during pumping activities for riparian irrigation. Activities will affect juveniles through increased stress, injury, or death. Harm from stress or injury is also

expected to cause displacement, increased predation, and loss of food, resulting in decreased fitness, growth, and survival. Allowable take will be exceeded if pumping activities occur outside the timeframes indicated below, or above the amounts of water indicated in Table 5.

Table 11. Estimated 3-5 year maintenance schedule for riparian habitat.

Monitoring Year	**Watering (Years 1 & 2: March 15-November 15) (Year 3-5: April 1-October 31)**
Year 1 (March 15-November 15)	50 gallons per plant or 3 inches of spray applied precipitation every 10 to 14 days
Year 2 (March 15-November 15)	30 gallons per plant or two inches of spray applied precipitation every week to 10 days
Year 3-5	10 gallons per plant or one inch of spray applied precipitation twice a week

6. Take in the form of injury or death to adults and juvenile CV spring-run, Sacramento River winter-run Chinook salmon, CCV steelhead, and sDPS green sturgeon due to stranding on the declining hydrograph within the 660 acres of the widened bypass (Personal Communication, Anne Baker, Army Corps of Engineers). This take is expected to occur when flows are at or above the 2 year flow level, following the spilling of river water and as the flood flows recede stranding these species in the Sacramento Bypass. Allowable take will be exceeded if stranding of any fish occurs more than every two years within the expanded side of the bypass.

7. Take in the form of harm, injury and death to listed fish, is expected due to fish rescue and relocation within the expanded Sacramento Bypass. Stranding will affect juveniles and adults through increased stress, injury, or death, including from attempted relocation. Harm is also expected through displacement, increased predation, and loss of food, resulting in decreased fitness, growth, and survival. Allowable take will be exceeded if an excess of 2% of a species of fish handled annually are killed due to handling subsequent to stranding.

8. Take in the form of harm, injury and death to listed fish, is expected due to increased barge traffic in the Sacramento River. Activities will affect juveniles and adults through increased stress, injury, or death. Harm is also expected through displacement, increased predation, and loss of food, resulting in decreased fitness, growth, and survival. Allowable take will be exceeded if total barge trips exceed 2,325 round trips through construction activities.

9. Take in the form of harm, injury and death to listed fish, is expected due to fish passage gate closure at the Sacramento Adult Fish Passage Facility. Activities will affect juveniles and adults through increased stress, injury, or death. Allowable take will be exceeded if gate closures causes the death of more than one ESA listed fish during each water year.

10. Take in the form of harm, injury and death to listed fish, is expected due to normal operations (including debris blockages, gate failure, and standard operations) of the

Sacramento Adult Fish Passage Facility. Activities will affect juveniles and adults through increased stress, injury, or death. Harm is also expected through displacement, increased predation, and loss of food, resulting in decreased fitness, growth, and survival. Harm to adults is also expected through delays in spawning and straying. Allowable take will be exceeded if operations issues are not restored within 24 hours of it being safe to do so (during times when the facility would be operating), or prior to the facility operating (for maintenance needing to be done in the dry season).

11. Harm to rearing juvenile spring-run Chinook salmon, winter-run Chinook salmon, steelhead, and adult and juvenile green sturgeon from the loss of 278.5 acres of riparian habitat (see Table 11 below). This loss will affect juveniles through displacement, increased predation, and loss of food, resulting in decreased fitness, growth, and survival. Table 11 describes the anticipated area of disturbed habitat representing the ecological surrogate of incidental take at each site location for known project designs within the three main areas of the proposed action. Allowable take will be exceeded if impacts exceed 76.7 acres within the Sacramento River projects area (mouth of the American River down to the bottom of the action area), 195.7 acres within the American River, or 6.2 acres within the Sacramento Weir and Bypass.

Table 12. Maximum Acreages to be impacted in different Project areas.

Project Area	Permanent Acreage Impact below OHWM
Sacramento River	76.6
American River	195.7
Sacramento Weir and Bypass	6.2
TOTAL	278.5

2.9.2. Effect of the Take

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

2.9.3. Reasonable and Prudent Measures

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

1. Measures shall be taken to minimize the impacts of the proposed bank protection construction.

2. Measures shall be taken to ensure necessary monitoring and Management Plans are developed.

3. Measures shall be taken to ensure that contractors, construction workers, and all other

parties involved with these projects implement the projects as proposed in the biological assessment and this BO.

4. Measures shall be taken to present NMFS with further information on launchable flood features and their effects on ESA listed species and their habitat.

5. Measures shall be taken to monitor incidental take of listed fish and the survival of on-site plantings, reporting of annual repair status, purchase of mitigation credits, and submissions of site-specific designs.

2.9.4. Terms and Conditions

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

1. The following terms and conditions implement reasonable and prudent measure 1: "*Measures shall be taken to minimize the impacts of the proposed bank protection construction.*"

    a. The Corps shall participate in an existing Interagency Working Group or work with other agencies to participate in a new Bank Protection Working Group (BPWG) to coordinate stakeholder input into future flood risk reduction actions associated with the American River Common Features GRR. The BPWG will hold technical deliberations over proposed bank protection, including the need (basis of/for design), purpose and proposed designs (emphasis on avoidance and fish-friendly designs). Membership in the BPWG will be subject to agency decisions to participate, but should at a minimum include participation from resource agency staff (USFWS, NMFS, CDFW), CVFPB and SAFCA (local sponsors).

    b. The Corps shall coordinate with NMFS during site design as future flood risk reduction actions are designed to ensure conservation measures are incorporated to the extent practicable and feasible and projects are designed to maximize ecological benefits.

    c. The Corps shall ensure the widening of the Sacramento Bypass is designed and constructed to minimize stranding of fish at facilities of the weir and in the depressions of the bypass though grading or construction of drainage channels or other mechanisms as applicable.

    d. The Corps shall minimize the removal of existing riparian vegetation and IWM to the maximum extent practicable, and where appropriate, removed IWM will be anchored back into place or if not feasible, new IWM will be anchored in place.

e. The Corps shall install IWM along all projects associated with the American River Common Features GRR at 40 to 80% shoreline coverage at all seasonal water surface elevations in coordination with the IWG or the BPWG, where site engineering allows for it. The purpose is to maximize the refugia and rearing habitats for juvenile fish.

f. The Corps shall develop a vegetation design deviation for each site in consultation with NMFS to allow for the protection of existing vegetation in place and the planting of new low-risk vegetation on the lower slope of the levee system.

g. The Corps shall use vibratory hammers for pile driving as often as feasible to reduce impacts to aquatic species.

h. The Corps shall use NMFS approved aquatic sound attenuation devices for pile driving to reduce the transmission of sound through water. Attenuation devices can include bubble curtains, dewatered cofferdams, or others as approved by NMFS.

i. The Corps shall consider varying the elevation of planting benches and IWM to accommodate a wide variety of water years and ensure there is ample shoreline habitat in different flow scenarios.

j. The Corps shall monitor turbidity during in-water work activities to ensure levels stay below the allowable thresholds (turbidity measured 1,000 feet downstream of the extent of the site is not to exceed double the upstream of site turbidity measurement).

2. The following terms and conditions implement reasonable and prudent measure 2: "*Measures shall be taken to ensure necessary monitoring and management plans are developed. "*

    a. During design, and in coordination with the local sponsor, the Corps shall coordinate with NMFS to provide a detailed operation plan of the Sacramento Weir, to allow minimal fish stranding risk within the Sacramento Bypass following peak flows.

    b. The Corps shall include as part of the HMMP, a Riparian Corridor Improvement Plan with the overall goal of mitigating for the impacts to the ecological function and value of the existing levee system within the GRR study area. The Corps shall coordinate this plan with NMFS prior to the construction of any projects related to the GRS.

    c. The Corps shall update the O&M manual to incorporate the following measures: (1) an adaptive management plan for operations of the Sacramento Weir that allows for operations of flows in a manner that minimize fish stranding in the Sacramento Bypass, (2) integration of Sacramento Weir operations with the Yolo Bypass.

d. The HMMP measures shall be monitored by the Corps for 10 years following construction and the Corps shall update their O&M manual to ensure the HMMP is adopted by the local sponsor to ensure the goals and objectives of the conservation measures are met for the life of the project.

e. The HMMP shall include specific goals and objectives and a clear, NMFS-approved strategy for achieving full compensation for all project-related impacts on the affected species described above.

f. The HMMP shall include a compensatory mitigation accounting plan to ensure the tracking of compensatory measures associated with future American River Common Features GRR projects as described in the proposed action.

g. The Corps shall continue to coordinate with NMFS during all phases of construction, implementation, and monitoring by hosting annual meetings and issuing annual reports throughout the construction period as described in the HMMP.

h. The Corps shall host an annual meeting and issue annual monitoring reports for five years following completion of project construction. The purpose is to ensure that conservation features of the project are developing consistent with the HMMP.

i. The Corps shall update their O&M Manual to ensure that the mitigation elements are meeting the criteria established in the HMMP with the goal of meeting SAM values.

j. The Corps, in coordination with the local sponsor, shall ensure that the mitigation and monitoring plan for the Sacramento Bypass includes post-project monitoring of fish stranding. The monitoring plan shall be developed in coordination with NMFS.

k. USACE shall provide NMFS a detailed O&M plan for the Sacramento Weir and new Adult Fish Passage Facility. The O&M plan shall include instructions that minimize stranding and passage delays of fish. The plan shall also include maintenance to address scour and erosion within the new widened bypass in order to reduce fish stranding. The plan shall also include monitoring for any potential disconnected pools after water recedes from the bypass.

l. USACE shall provide NMFS a detailed O&M plan for all aspects of the proposed action, to ensure all sites are properly managed and the Design Deviation allowing vegetation to remain is followed. This plan shall be incorporated into the O&M manual for each site to ensure vegetation removal does not occur in the future.

m. USACE shall provide NMFS a Long Term Management Plan outlining the maintenance of all on-site and off-site mitigation. The plan shall include performance goals, monitoring plans, replanting plans, and an adaptive management plan for how mitigation will be addressed if the mitigation site fails.

3. The following terms and conditions implement reasonable and prudent measure 3: "*Measures shall be taken to ensure that contractors, construction workers, and all other parties involved with these projects implement the projects as proposed in the biological assessment and this BO*."

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

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

4. The following terms and conditions implement reasonable and prudent measure 4: *"Measures shall be taken to present NMFS with further information on launchable flood features and their effects on ESA listed species and their habitat."*

    a. USACE shall initiate discussions to evaluate the durability of planting benches built on top of launchable flood features. If sites are demonstrated to have a likelihood to be lost during the life of the project, and appropriate mitigation plan will be proposed to rectify the loss of the mitigation. A decision will be presented to NMFS no later than December 31, 2021, or the effects will fall back to the uncertainty of the mitigation being durable and not count towards offsetting the effects of the project.

    b. USACE shall evaluate the probability of the launchable rock trenches launching. If fish habitat is deemed likely to be lost during the life of the project, an appropriate mitigation plan will be proposed to rectify the loss of the habitat. A decision will be presented to NMFS no later than December 31, 2021, or the effects will fall back to the worst-case scenario and assume that all launchable trenches will launch during the life of the project.

5. The following terms and conditions implement reasonable and prudent measure 5: *"Measures shall be taken to monitor incidental take of listed fish and the survival of on-*

site plantings, reporting of annual repair status, purchase of mitigation credits, and submissions of site-specific designs."

a. USACE shall incorporate appropriate monitoring technology into the fish passage facility to ensure passage of all species during a variety of hydrologic conditions. Appropriate monitoring technology shall be determined in discussion with NMFS, CDFW, and other resource agencies as appropriate to determine what technology will best provide data needed to demonstrate successful passage. This technology shall include PIT tag arrays, acoustic receivers, and other monitoring devices, such as VAKI, DIDSON, or AERIS.

b. USACE shall monitor conditions in each side of the new Adult Fish Passage Facility (both the channel and the ladder) to ensure NMFS passage criteria are being met.

c. The Corps shall initiate an interagency PIT Tag collaborative meeting. The goal of this meeting will be to establish a group where collected PIT tag data may be shared. This meeting shall commence prior to the first operation of the new Sacramento Weir Fish Passage Facility. The planning of the initial meeting shall be coordinated with CDFW and NMFS.

d. The Corps shall ensure the Sacramento Bypass is surveyed every year after overtopping events and maintain any large scour holes or erosion that may cause stranding risk or increase the likelihood of stranding within the expanded Sacramento Bypass.

e. USACE shall provide NMFS with a site-specific project description prior to advertising for construction contracts of any sites. The project description shall include a design at or beyond the 65% level, anticipated impacts, and proposed mitigation ratios for the site. NMFS must provide written approval that the site is consistent with this opinion prior to construction, NMFS will respond within 14 days of receiving site-specific documents.

f. USACE shall provide to NMFS (at the address below) a vegetation monitoring report at years 1, 2, 3, 5, and 8 post-construction no later than December 31st of each reporting cycle. This report shall provide information as to the success of the revegetation program and whether the conservation goals are being met at each site. If goals are not being met, then the report shall indicate what actions are being implemented to meet those goals.

g. USACE shall submit a report to NMFS of any incidental take that occurs as part of the project. This report shall be submitted no later than December 31 of each reporting cycle.

h. USACE shall contact NMFS within 24 hours of the new expanded Sacramento Weir overtopping for the first 5 years.

i. USACE shall ensure that the NMFS Central Valley Office is involved with the discussions, development, and tracking of the SAM model development and the proposed Green Sturgeon research.

j. All reports for NMFS shall be sent to:

Cathy Marcinkevage
California Central Valley Office
National Marine Fisheries Service
650 Capitol Mall, Suite 5-100
Sacramento California 95814
FAX: (916) 930-3629
Phone: (916) 930-3600
ccvo.consultationrequests@noaa.gov

2.10. Conservation Recommendations

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

1. The Corps should integrate the 2017 California Central Valley Flood Protection Plan's Conservation Strategy into all flood risk reduction projects they authorize, fund, or carry out.

2. The Corps should prioritize and continue to support flood management actions that set levees back from rivers and in places where this is not technically feasible, repair in place actions should pursue landside levee repairs instead of waterside repairs.

3. The Corps should consult with NMFS in the review of ETL variances for future projects that require ETL compliance.

4. The Corps should develop ETL vegetation variances for all flood management actions that are adjacent to any Central Valley anadromous fish habitat.

5. The Corps should use all of their authorities, to the maximum extent feasible to implement high priority actions in the NMFS Central Valley Salmon and Steelhead Recovery Plan. High priority actions related to flood management include setting levees back from riverbanks, increasing the amount and extent of riparian vegetation along reaches of the Sacramento River Flood Control Project.

6. The Corps should encourage cost-share sponsors and applicants to develop floodplain and riparian corridor enhancement plans as part of their projects.

7. The Corps should continue to work with NMFS and other agencies and interests to support the improved growth, survival and recovery of native fish species in the Yolo

Bypass and other bypasses within the Sacramento River Flood Control Project, including restoring/improving fish passage.

8. The Corps should consider implementing post-construction bathymetry to monitor changes in benthic habitat.

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

2.11. Reinitiation of Consultation

This concludes formal consultation for American River Watershed Common Features General Reevaluation Report Reinitiation 2020.

As 50 CFR 402.16 states, reinitiation of consultation is required and shall be requested by the Federal agency or by the Service where discretionary Federal agency involvement or control over the action has been retained or is authorized by law and if: (1) The amount or extent of incidental taking specified in the ITS is exceeded, (2) new information reveals effects of the agency action that may affect listed species or critical habitat in a manner or to an extent not considered in this opinion, (3) the identified action is subsequently modified in a manner that causes an effect to the listed species or critical habitat that was not considered in the biological opinion, or (4) a new species is listed or critical habitat designated that may be affected by the action.

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

Section 305(b) of the MSA directs Federal agencies to consult with NMFS on all actions or proposed actions that may adversely affect EFH. Under the MSA, this consultation is intended to promote the conservation of EFH as necessary to support sustainable fisheries and the managed species' contribution to a healthy ecosystem. For the purposes of the MSA , EFH means "those waters and substrate necessary to fish for spawning, breeding, feeding, or growth to maturity", and includes the physical, biological, and chemical properties that are used by fish (50 CFR 600.10). Adverse effect means any impact that reduces quality or quantity of EFH, and may include direct or indirect physical, chemical, or biological alteration of the waters or substrate and loss of (or injury to) benthic organisms, prey species and their habitat, and other ecosystem components, if such modifications reduce the quality or quantity of EFH. Adverse effects on EFH may result from actions occurring within EFH or outside of it and may include site-specific or EFH-wide impacts, including individual, cumulative, or synergistic consequences of actions (50 CFR 600.810). Section 305(b) of the MSA also requires NMFS to recommend measures that can be taken by the action agency to conserve EFH. Such recommendations may include measures to avoid, minimize, mitigate, or otherwise offset the adverse effects of the action on EFH [CFR 600.905(b)]

This analysis is based, in part, on the EFH assessment provided by the United States Army Corps of Engineers and descriptions of EFH for Pacific Coast salmon (PFMC 2014) contained in the fishery management plans developed by the Pacific Fisheries Management Council and approved by the Secretary of Commerce.

3.1. Essential Fish Habitat Affected by the Project

The geographic extent of freshwater EFH is identified as all water bodies currently or historically occupied by Council-managed salmon as described in Amendment 18 of the Pacific Coast Salmon Plan (PFMC 2014). In the estuarine and marine areas, salmon EFH extends from the extreme high tide line in nearshore and tidal submerged environments within state territorial waters out to the full extent of the Exclusive Economic Zone (EEZ) (200 nautical miles or 370.4 km) offshore of Washington, Oregon, and California north of Point Conception. The proposed project occurs in the area identified as "freshwater EFH", as it is above the tidal influence where the salinity is below 0.5 parts per thousand.

The implementing regulations for the EFH provisions of the MSA (50 CFR part 600) recommend that the FMPs include specific types or areas of habitat within EFH as "habitat areas of particular concern" (HAPC) based on one or more of the following considerations: (1) the importance of the ecological function provided by the habitat; (2) the extent to which the habitat is sensitive to human-induced environmental degradation; (3) whether, and to what extent, development activities are, or will be, stressing the habitat type; and (4) the rarity of the habitat type. Based on these considerations, the Council designated five HAPCs: (1) complex channels and floodplain habitats; (2) thermal refugia; (3) spawning habitat; (4) estuaries; and (5) marine and estuarine SAV. HAPCs that occur within the proposed project area are (1) complex channels and floodplains, and (2) thermal refugia.

3.2. Adverse Effects on Essential Fish Habitat

The proposed action is considered to have multiple activities that affect EFH for Pacific salmon as described in Amendment 18 to the Pacific Coast Salmon FMP (PFMC 2014). The following aspects of the proposed action are expected to have adverse effects on the freshwater EFH in the Action Area of the project:

1) Bank Stabilization and Protection – The proposed project has components that will entail bank stabilization and protection activities in the Action Area which includes freshwater EFH. These activities include placement of rock armoring and removal of riparian vegetation. The alteration of riverine and estuarine habitat from bank and shoreline stabilization, and protection from flooding events can result in varying degrees of change in the physical, chemical, and biological characteristics of existing shoreline and riparian habitat. Human activities removing riparian vegetation, armoring, relocating, straightening and confining stream channels and along tidal and estuarine shorelines influences the extent and magnitude of stream bank erosion and down cutting in the channel. In addition, these actions have reduced hydrological connectivity and availability of off-channel habitat and floodplain interaction. Armoring of shorelines to prevent erosion and maintain or create shoreline real estate simplifies habitats, reduces the amount of intertidal habitat, and affects nearshore processes and the ecology of a myriad of species (Williams and Thom 2001). As described in

Amendment 18 in PFMC 2014, a river confined by adjacent development and/or flood control and erosion control structures can no longer move across the floodplain and support the natural processes that: 1) maintain floodplain connectivity and fish access that provide velocity refugia for juvenile salmon during high flows; 2) reduce flow velocities that reduce streambed erosion, channel incision, and spawning redd scour; 3) create side channels and off-channel areas that shelter rearing juvenile salmon; 4) allow fine sediment deposition on the floodplain and sediment sorting in the channel that enhance the substrate suitability for spawning salmon; 5) maintain riparian vegetation patterns that provide shade, large wood, and prey items to the channel; 6) provide the recruitment of large wood and spawning gravels to the channel; 7) create conditions that support hyporheic flow pathways that provide thermal refugia during low water periods; and 8) contribute to the nutrient regime and food web that support rearing and migrating juvenile salmon in the associated mainstem river channels. These activities are expected to adversely affect HAPCs for (1) complex channels and floodplains, and (2) thermal refugia.

2) Flood Control Maintenance – The proposed project will continue to prevent access to historic floodplain habitat by maintaining the levees constructed for flood protection. The protection of housing communities from flooding events can result in varying degrees of change in the physical, chemical, and biological characteristics of existing shoreline and riparian habitats. Maintaining the flood control levees results in the addition of rock armoring after any erosion event, regular (sometimes yearly) herbicide application, removal of riparian vegetation from the shoreline (also sometimes yearly), and other potentially harmful maintenance activities. Managing flood flows with flood control structures such as levees can disconnect a river from its floodplain eliminating off-channel habitat important for salmonids. Floodplains serve as a natural buffer to changes in water flow: retaining water during periods of higher flow and releasing it from the water table during reduced flows. These areas are typically well vegetated, lowering water temperatures, regulating nutrient flow and removing toxins. Juvenile salmon use these off channel areas because their reduced flows, greater habitat complexity, increased food availability, and shelter from predators may increase growth rates and their chance of survival. Artificial flood control structures have similar effects on aquatic habitat as does the efforts to stabilize banks and remove woody debris. The function of natural stream channels and associated riparian areas and the effects of flood control structures such as levees has been discussed in section 2.4.1 of this opinion. The HAPCs adversely affected include (1) complex channels and floodplains, and (2) thermal refugia.

3.3. Essential Fish Habitat Conservation Recommendations

The Corps should implement the following conservation measures to minimize the adverse effects described in section 3.2 above. In order to avoid or minimize the effects to HAPCs (1) and (2) described above, NMFS recommends the following conservation measures described in Amendment 18 to the Pacific Coast Salmon FMP:

1) *Bank Stabilization and Protection*

- Minimize the loss of riparian habitats as much as possible.

- Bank erosion control should use vegetation methods or “soft” approaches (such as beach nourishment, vegetative plantings, and placement of IWM) to shoreline modifications whenever feasible. Hard bank protection should be a last resort and the following options should be explored (tree revetments, stream flow deflectors, and vegetative riprap).

- Re-vegetate sites to resemble the natural ecosystem community.
- Replace in-stream fish habitat by providing root wads, deflector logs, boulders, rock weirs and by planting shaded riverine aquatic cover vegetation.
- Use an adaptive management plan with ecological indicators to oversee monitoring and ensure mitigation objectives are met. Take corrective action as needed.
- Implement term and conditions 1(a-d), from the section 7 Opinion for this project.
- Minimize alteration of floodplains and wetlands in areas of salmon EFH.
- Determine cumulative effects of all past and current floodplain and wetland alterations before planning activities that further alter wetlands and floodplains.
- Promote awareness and use of the United States Department of Agriculture (USDA)'s wetland and conservation reserve programs to conserve and restore wetland and floodplain habitat.
- Promote restoration of degraded floodplains and wetlands, including in part reconnecting rivers with their associated floodplains and wetlands and invasive species management.

2) *Flood Control Maintenance*

- Retain trees and other shaded vegetation along earthen levees and outside levee toe.
- Ensure adequate inundation time for floodplain habitat that activates and enhances near-shore habitat for juvenile salmon.
- Reconnect wetlands and floodplains to channel/tides.

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

3.4. Statutory Response Requirement

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

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

3.5. Supplemental Consultation

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

4. Data Quality Act Documentation and Pre-Dissemination Review

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

4.1. Utility

Utility principally refers to ensuring that the information contained in this consultation is helpful, serviceable, and beneficial to the intended users. The intended users of this opinion are the Corps. Other interested users could include the California Department of Water Resources (DWR) and Sacramento Area Flood Control District (SAFCA). Individual copies of this opinion were provided to the Corps, DWR, and SAFCA. The document will be available within two weeks at the NOAA Library Institutional Repository https://repository.library.noaa.gov/welcome. The format and naming adheres to conventional standards for style.

4.2. Integrity

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

4.3. Objectivity

Information Product Category: Natural Resource Plan

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

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

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

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

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