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-2019-01893

August 30, 2019

Ms. Alicia Kirchner
Chief, Planning Division
Department of the Army
United States Army Corps of Engineers
Sacramento District
1325 J Street
Sacramento, California 95814-2922

Re: Endangered Species Act Section 7(a)(2) Biological Opinion, Magnuson-Stevens Fishery Conservation and Management Act Essential Fish Habitat Response, and Fish and Wildlife Coordination Act Recommendations for the Sacramento River Bank Protection Project Post Authorization Change Report.

Dear Ms. Kirchner:

Thank you for your letter of July 11, 2019, requesting initiation of consultation with NOAA's National Marine Fisheries Service (NMFS) pursuant to section 7 of the Endangered Species Act of 1973 (ESA) (16 U.S.C. 1531 et seq.) for Sacramento River Bank Protection Project Post Authorization Change Report (SRBPP PACR).

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 (MSA)(16 U.S.C. 1855(b)) for this action. NMFS' review concludes that the program will adversely affect the EFH of Pacific Coast Salmon in the action area, and has included conservation recommendations to minimize these effects.

The enclosed biological opinion (BO) analyzes the effects of the U.S. Army Corps of Engineer's (USACE) SRBPP PACR as a "Framework Programmatic" action. This is considered a Framework Programmatic BO because the biological assessment (BA) included general project details including design, possible locations, effects, and because subsequent bank protection actions are to be developed in the future. Any take of a listed species associated with implementation of SRBPP PACR would be covered under future ESA section 7 consultation (50 CFR Part 402.02) associated with each action. Therefore, an Incidental Take Statement is not included as part of this Framework Programmatic BO. Rather, USACE will request consultation on individual actions or suites of actions under the SRBPP PACR, including a description of the expected effects to species and critical habitat, and any avoidance or minimization measures, in order for NMFS to complete ESA consultation, including exempting incidental take as appropriate.

The enclosed BO, based on the BA and best available scientific and commercial information, concludes that the proposed SRBPP PACR is not likely to jeopardize the continued existence of the federally-listed endangered Sacramento River winter-run Chinook salmon (*Oncorhynchus tshawytscha*) evolutionarily significant unit (ESU), 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.

Because the proposed action will modify a stream or other body of water, NMFS also provides recommendations and comments for the purpose of conserving fish and wildlife resources under the Fish and Wildlife Coordination Act (16 U.S.C. § 662(a)).

Please contact Ally Lane in the NMFS West Coast Region's California Central Valley Office at (916) 930-5617 or via email at Allison.Lane@noaa.gov if you have any questions concerning this section 7 consultation, or if you require additional information.

Sincerely,

Maria Rea
Assistant Regional Administrator
California Central Valley Office

Enclosure

cc: To the file 151422-WCR2017-SA00268
Environmental Planning Section, U.S. Army Corps of Engineers, Sacramento District
Brian Mulvey, Brian.M.Mulvey@usace.army.mil
Patricia Goodman, Patricia.K.Goodman@usace.army.mil

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

Sacramento River Bank Protection Project Post Authorization Change Report

National Marine Fisheries Service Environmental Consultation Organizer Number: WCRO-2019-01893

Action Agency: U.S. Army Corps of Engineers

Affected Species and NMFS' Determinations:

ESA-Listed Species	Status	Is Action Likely to Adversely Affect Species?	Is Action Likely To Jeopardize the Species?	Is Action Likely to Adversely Affect Critical Habitat?	Is Action Likely To Destroy or Adversely Modify Critical Habitat?
Central Valley spring-run Chinook Salmon ESU (*O. tshawytscha*)	Threatened	Yes	No	Yes	No
California Central Valley steelhead Distinct Population Segment (DPS (*O. mykiss*)	Threatened	Yes	No	Yes	No
Southern DPS of North American green sturgeon (*A.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:

Maria Rea
Assistant Regional Administrator

Date: August 30, 2019

LIST OF ACRONYMS

ADCP	acoustic Doppler current profiler
BA	biological assessment
BMP	best management practices
BO	biological opinion
BPM	bank protection measure
CCV	California Central Valley
CCVO	California Central Valley Office
CDFG	California Department of Fish and Game
CDFW	California Department of Fish and Wildlife
CEQA	California Environmental Quality Act
CNFH	Coleman National Fish Hatchery
CRR	cohort replacement rate
CV	Central Valley
CVP	Central Valley Project
CVFPB	Central Valley Flood Protection Board
Delta	Sacramento-San Joaquin Delta
DPS	distinct population segment
DQA	Data Quality Act
DWR	California Department of Water Resources
DWSC	Deep Water Ship Channel
EBMUD	East Bay Municipal Utilities District
EFH	Essential Fish Habitat
EJB	Economically-Justified Basins (*per* USACE connotation)
ERDC	USACE Engineer Research and Development Center
ESA	Endangered Species Act
ESU	Evolutionarily Significant Unit
ETL	Engineering Technical Letter
FWCA	Fish and Wildlife Coordination Act
FRFH	Feather River Fish Hatchery
HMMP	green sturgeon habitat, mitigation, and monitoring plan
ITS	Incidental Take Statement
IWG	Inter-Agency Working Group
IWM	instream woody material
JPE	juvenile production estimate
LF	linear feet
LM	levee mile
LSNFH	Livingston Stone National Fish Hatchery
LWM	large woody material
mm	millimeter
MMP	Mitigation and Monitoring Plan
MSA	Magnuson-Stevens Fishery Conservation and Management Act
NEPA	National Environmental Policy Act
NMFS	National Marine Fisheries Service
NOAA	National Oceanic and Atmospheric Administration

O&M	Operation and Maintenance
PACR	Post Authorization Change Report
PBF	Physical or Biological Feature
PCE	Primary Constituent Element
PDT	Project Development Team
PED	Preconstruction Engineering and Design
PL	Public Law
PVA	Population Viability Analysis
RBDD	Red Bluff Diversion Dam
RD	Reclamation District
Reclamation	United States Department of the Interior, Bureau of Reclamation
RM	River Mile
RPA	Reasonable and Prudent Alternative
RST	rotary screw trap
SAM	Standard Assessment Methodology
sDPS	southern Distinct Population Segment
SJRRP	San Joaquin River Restoration Program
SRA	shaded riverine aquatic
SRBPP	Sacramento River Bank Protection Project
SRFCP	Sacramento River Flood Control Project
SWP	State Water Project
USACE	United State Army Corps of Engineers
USFWS	United States Fish and Wildlife Service
VFZ	vegetation free zone
VSP	Viable Salmonid Populations
WRDA	Water Resources Development Act

NOTE: Throughout this document there are references cited as CDFG, which refers to the California Department of Fish and Game. This name was changed to California Department of Fish and Wildlife (CDFW) on January 1, 2013. However, for consistency on publications, references prior to January 1, 2013, will remain cited as CDFG.

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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) portion 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 Part 402.

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

Because the proposed action would modify a stream or other body of water, NMFS also provides recommendations and comments for the purpose of conserving fish and wildlife resources, and enabling the Federal agency to give equal consideration with other project purposes, as required under the Fish and Wildlife Coordination Act (FWCA) (16 U.S.C. 661 et seq.).

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). A complete record of this consultation is on file at the NMFS California Central Valley Office.

1.2 Proposed Federal Action

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

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

Under the FWCA, an action occurs whenever the waters of any stream or other body of water are proposed or authorized to be impounded, diverted, the channel deepened, or the stream or other body of water otherwise controlled or modified for any purpose whatever, including navigation and drainage, by any department or agency of the United States, or by any public or private agency under Federal permit or license" (16 USC 662(a)).

The U.S. Army Corps of Engineers (USACE) proposes to implement levee protection measures and flood risk management improvements under the authorization of the Sacramento River Bank Protection Project Post Authorization Change Report (SRBPP PACR), a smaller portion of the overall and long running SRBPP. The future actions associated with this programmatic BO include levee bank repair projects that would occur within the SRBPP PACR program area, which encompasses the levees and weirs of various basins within the Sacramento River Flood Control Project (SRFCP). The overall SRBPP PACR program encompasses over 1,000 miles of

levees and weirs. This area extends south-to-north along the Sacramento River, from the Town of Collinsville, river mile (RM) zero, upstream to Chico at RM 184. The SRBPP PACR also includes Cache Creek, the lower reaches of Elder and Deer Creeks, the lower reaches of the American River (RM 0–23), Feather River (RM 0–61), Yuba River (RM 0–11), and Bear River (RM 0–17), portions of Three mile, Steamboat, Sutter, Miner, Georgiana, and Cache Sloughs, as well as a number of flood bypasses and distributaries (Figure 1).

According to the USACE, the Federal government maintains oversight, but has no ownership of, or direct responsibilities for, performing maintenance of the Federal levee system, except for a few select features that continue to be owned and operated by USACE. This should not be confused with the limited maintenance that may occur during site establishment following an erosion repair completed as part of the SRBPP as described in Section 1.3.5. USACE would be responsible for ensuring that conservation measures and environmental standards are clearly stipulated in permits and all required documentation is maintained. USACE would provide the Central Valley Flood Protection Board (CVFPB) with an updated Operations and Maintenance (O&M) manual detailing any changes made to the levee as the result of the repair and any additional long-term maintenance requirements, including vegetation maintenance. A CVFPB Permit is required for every proposal or plan of work, including the placement, construction, reconstruction, removal, or abandonment of any landscaping, culvert, bridge, conduit, fence, projection, fill, embankment, building, structure, obstruction, encroachment or works of any kind, and including the planting, excavation, or removal of vegetation, and any repair or maintenance that involves cutting into the levee, wholly or in part within any area for which there is an Adopted Plan of Flood Control, as defined by California Code of Regulations (CCR) Title 23, Division 1, and must be approved by the CVFPB prior to commencement of work. (CVFPB, 2014)

USACE asserts that they have no discretion in regards to the continuing existence and operation of the flood control structures of the SRFCP. USACE asserts that the responsibility to maintain Civil Works structures, so that they continue to serve their congressionally authorized purposes, is inherent in the authority to construct them and is therefore non-discretionary. Furthermore, USACE asserts that they have a non-discretionary duty to maintain the SRFCP and that perpetuating the project's existence is not an action subject to consultation. USACE maintains that only Congressional actions to de-authorize the structures can alter or terminate this responsibility and thereby allow the maintenance of the structures to cease. Therefore, USACE concludes, that impacts attributable the existence of the levees or to non-discretionary operations are subsumed within the impacts of the environmental baseline rather than the effects attributable to the proposed action.

The proposed action is based on the framework for implementation of the SRBPP PACR. The framework primarily consists of USACE site Selection process, which outlines the steps for implementation from annual inventories of erosion sites all the way through to project construction and site turnover to the local sponsor. This process applies many evaluation steps and considers a variety of site-specific Bank Protection Measures (BPMs) to identified erosion sites within the seven identified economically-justified basins (EJBs). The selection of BPMs for each site will be based on the unique characteristics of each site.

USACE compiled a list of known erosion sites from the latest inventory to show the locations of potential future repairs (Table 2-2). There are a total of 35 erosion sites identified within the

seven EJBs (see Figure 1) with estimated total site length of 20,535 feet. Table 2-1 shows how many erosion sites and total site length are located within each EJB. For the purposes of this consultation, there is no limit to the number of erosion sites, but limiting the linear footage to 30,000 linear feet (LF) within these seven basins to be covered programmatically.

Major considerations of selecting BPMs for each site are avoiding, minimizing, and mitigating negative impacts to fish and wildlife habitat. The process also includes preliminary Standard Assessment Methodology (SAM) evaluations to determine likely losses and necessary gains to habitat, which is described in further detail later in this BO. For some of the sites on this list, there is some preliminary information identified for future repair within the EJBs. These sites were identified in earlier inventories and designs were tentatively developed for economic analysis purposes in 2007. These sites will need to be re-evaluated, and designs will need to be revised under the proposed site selection process, in order to consider and incorporate other opportunities or constraints, most of the sites have not been evaluated yet for developing potential designs.

While attempting to optimize habitat features and function in the designs, fully replacing habitat loss is not always feasible. These deficits may require additional mitigation, either in the form of off-site habitat creation or enhancement, or through the purchase of off-site mitigation credits as appropriate. Off-site mitigation may be acceptable to USACE, CVFPB, and resource agencies on a site-specific basis provided that it compensates for the values being lost, and will be provided within the environmental sub-region of impact (e.g., 1a, 1b, 2 or 3). The proposed action utilizes the approach taken over the last decade, which primarily focused on recreating streambank habitats on-site through the use of constructed benches with riparian vegetation, with adjustments to account for implementation of the *Engineer Pamphlet* (EP) 1110-2-18, Guidelines for Landscape Planting and Vegetation Management at Levees, Floodwalls, Embankment Dams, and Appurtenant Structures (USACE 2019).

Table 1. List of Currently Identified Erosion Sites within the Seven Economically-Justified Basins with Proposed Bank Protection Measures, if Available.

Region	Site Identification				Length (ft.)	BPM	Includes SAM Species?
1a	Cache Creek	LM	2.4	L	218	ND	No
1a	Cache Creek	LM	5.4	L	198	ND	No
1a	Knights Landing Ridge Cut	LM	3.5	R	418	ND	No
1a	Knights Landing Ridge Cut	LM	3.9	R	366	ND	No
1b	Lower American River	RM	1.8	L	190	ND	Yes
1b	Natomas Cross Canal	LM	3.0	R	191	ND	Yes
1b	Sacramento River	RM	50.3	L	89	ND	Yes
1b	Sacramento River	RM	52.4	L	117	ND	Yes
1b	Sacramento River	RM	52.7	L	158	ND	Yes
1b	Sacramento River	RM	53.8	L	155	ND	Yes
1b	Sacramento River	RM	54.8	L	325	ND	Yes
1b	Sacramento River	RM	55.2	L	866	ND	Yes
1b	Sacramento River	RM	55.5	L	384	ND	Yes
1b	Sacramento River	RM	55.7	R	1,150	ND	Yes
1b	Sacramento River	RM	56.5	R	465	4b	Yes
1b	Sacramento River	RM	56.6	L	262	4a	Yes
1b	Sacramento River	RM	56.7	R	662	4b	Yes
1b	Sacramento River	RM	58.5	L	386	5	Yes
1b	Sacramento River	RM	62.9	R	537	4b	Yes
1b	Sacramento River	RM	78.3	L	654	5	Yes
1b	Yankee Slough	LM	1.7	L	147	ND	Yes
2	Bear River	RM	0.8	L	452	5	Yes
2	Bear River	RM	1.9	L	432	ND	Yes
2	Bear River	RM	2.5	L	222	ND	Yes
2	Feather River	RM	0.6	L	901	4a	Yes
2	Feather River	RM	1.0	L	1,054	ND	Yes
2	Feather River	RM	3.8	L	2,094	ND	Yes
2	Feather River	RM	5.0	L	1,666	4a	Yes
2	Feather River	RM	5.8	L	1,030	ND	Yes
2	Feather River	RM	6.0	L	487	ND	Yes
2	Feather River	RM	6.6	L	710	ND	Yes
3	Sacramento River	RM	152.6	L	1,555	ND	Yes
3	Sacramento River	RM	152.8	L	299	4b	Yes
3	Sacramento River	RM	168.3	L	149	4b	Yes
3	Sacramento River	RM	172.0	L	1,546	4b	Yes

Table 1 (continued). List of Currently Identified Erosion Sites within the Seven Economically-Justified Basins with Proposed Bank Protection Measures, if Available.

LM = levee mile; RM = river mile; L = left bank; R = right bank; BPM = bank protection measure; ND = not determined.

Bank Protection Measure Legend

4a: Riparian Bank with Revegetation and Instream Woody Material above Summer/Fall Waterline 4b: Riparian Bench with Revegetation and Instream Woody Material above and below Summer/Fall Waterline

4c: Riparian and Wetland Benches with Revegetation

5: Bank Fill Stone Protection with On-Site Vegetation

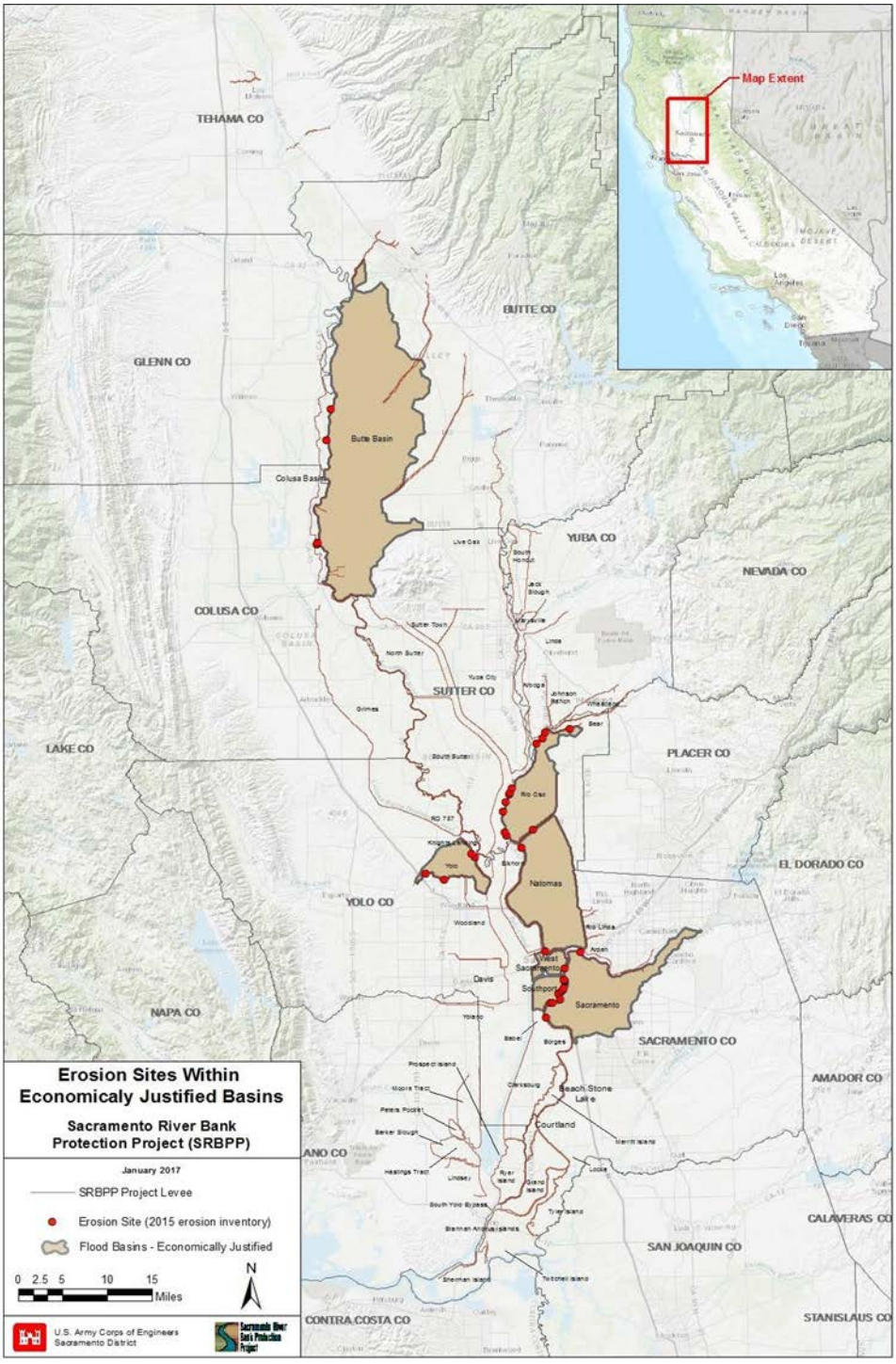

Figure 1. Erosion Sites Identified in Economically Justified Basins.

1.2.1 Site Selection Process

The framework for implementation of this program primarily consists of the Site Selection Process, summarized below, which identifies the steps and pathway from identification of erosion sites to construction and ultimately site turnover to the local sponsor. It includes several steps where project decisions can be influenced to assure environmental effects are appropriately identified, characterized, addressed and mitigated, if needed. Appendix B provides a full description of the Site Selection Process.

The following process will be followed prior to selecting final BPMs for specific erosion sites:

1. **Reconnaissance/Erosion Inventory.** During the reconnaissance trip, a team reviews the existing erosion sites, identifies new sites, and checks the previously repaired sites. This is typically done annually, and it is possible for resource agency staff to participate in these inventories, to help identify potential issues and opportunities.
2. **Critical Site Decision.** This decision step of site selection allows for a fast-track path for critical sites.
3. **Engineering Ranking and Report.** The third step of site selection involves the development of a report and an engineering site ranking based on the information collected during the erosion reconnaissance inventory.
4. **Justification Screening.** This step includes an economic analysis and other work necessary to determine if repairing a site is justified using a risk-based approach. While Step 3 looks only at the likelihood of a breach, this step examines the consequences as well. All sites deemed critical will be recorded in the Critical Site Memorandum. Since critical sites will go through an expedited pathway, this Memorandum serves the purpose of documenting which sites were identified as critical.
5. **Identify Opportunities and Constraints.** During this step of the process, all the potential issues and opportunities associated with each site are identified. This step addresses real estate, environmental resources, constructability, cultural resources, and the grouping of sites. Opportunities and constraints are presented and discussed with the Interagency Working Group (IWG), which includes representatives from NMFS, USFWS, CDFW, project partners, and appropriate stakeholders. This step identifies sites where a variance would be applicable and is when the first steps of the variance request process would be initiated. This is a key opportunity for resource agencies to provide input about listed species concerns and opportunities to avoid/minimize impacts or improve/optimize habitat function.
6. **Conceptual Level Alternatives.** Under this step, the team develops conceptual-level designs and costs. Historically, SRBPP sites have been repaired mostly with riprap. As the SRBPP has progressed, a need has been identified to repair sites with design alternatives that minimize environmental impact while providing bank protection. The PDT is now looking at multiple design alternatives such as planting benches and setback levees. If a site is selected for repair, further analysis and data collection will

occur during the preconstruction engineering and design (PED) phase to verify and refine conceptual alternatives as necessary.

7. **Site Lock-in Procedure.** Step 7 will select which of the sites will move on to the list for site repairs. Selected sites are generally anticipated to be repaired over a three year period, which makes up a construction cycle. If a site becomes critical (critical only in terms of likelihood of breach and not considering consequences) before the next site selection and implementation cycle, then it may be fast-tracked to Step 8.

8. **Site Selection Lock-in List and Report.** For Step 8, the top sites chosen in Step 7 and the fast-tracked critical sites will be considered the locked-in sites selected for repair in the construction cycles. A report will be written to document how and why the locked-in sites were selected for repair. This report will primarily be for USACE to use and to keep a historical record of the process. The identified sites will be grouped into construction cycle-years, based on the required time needed to acquire real estate and similar construction repair methods or site proximity in order to enhance the value per dollar spent.

9. **Data Collection.** For this step, the PDT will start collecting the data needed to develop the designs. The exact information and the level of detail collected at each site will vary from site to site. Some of the data to be collected includes topographic surveys, geotechnical explorations, tree inventory, potentially impacted endangered species and associated habitat, Hazardous Toxic Radioactive Waste survey, cultural information, and utility survey. Topographical surveys, tree surveys, and bathymetry data will be used to evaluate if a site will require a variance request. After sites have been selected, the PDT will look at the preliminary evaluation results of "unlikely, likely, or unknown" made in Step 1 and compare them with the survey data. Then a determination of "yes or no" will be made to identify which of the selected sites will likely require a variance or design deviation request, based on the chosen design alternative. This step may provide an opportunity for resource agencies to identify data collection to address uncertainties related to impacts to listed species.

10. **Preliminary Designs and Draft Environmental Document.** This step begins the PED process and the drafting of documentation to comply with the National Environmental Policy Act (NEPA) and the California Environmental Quality Act (CEQA), including an Environmental Analysis (EA) and Initial Study (IS) or an EIS/EIR as needed. The designs for each site are confirmed and 30% designs (plans, specifications, and Design Document Report [DDR]) and cost estimates are completed. The cultural resources personnel will consult with the State Historic Preservation Office and the Native American Tribes. USACE will initiate Section 7 consultation during this step, and will include site-specific details and analysis with the request to append this to the programmatic consultation.

11. **Draft Final Design, Final NEPA/CEQA Document, and Pre-Construction Activities.** After an internal review of the plans, the 90% Plans and Specifications are developed,

Section 7 consultation is completed, and the Final NEPA/CEQA decision document is signed.

12. **Review and Final Design.** The official Agency Technical Review and Independent External Peer Review (Type II IEPR, Safety Assurance Review) is performed throughout the development of the plans and specifications and the DDR. Revisions to the designs and contract documents are made based on these reviews, resulting in the 100% DDR and Plans and Specifications for contract advertisement.
13. **Contracting Procedure.** USACE compiles the final plans and specifications, provides the signed "Biddability" (the ability to get a bid), Constructability, Operability and Environmental review, and processes the funding element for construction. Any offsite mitigation is purchased during this time prior to commencement of construction.
14. **Construction.** The contractor constructs the bank repair following the Notice to Proceed.
15. **Mitigation Monitoring.** On-site mitigation requires monitoring to ensure the establishment criteria is met for vegetation growth and survival. The monitoring period must be sufficient to demonstrate that the compensatory mitigation has met performance standards, but not less than five years (see 33 CFR Part 332.6(b)). Monitoring reports are required on a yearly basis. Mitigation monitoring will be planned and coordinated with resource agencies to assure adequacy of monitoring and success of mitigation actions.
16. **Site Turn-over.** Once the construction and mitigation monitoring is complete, USACE turns the site over to the CVFPB, which then turns the site over to the local maintaining agency. USACE provides an amended O&M manual describing any changes made to the levee and new requirements for O&M, including maintenance of any onsite mitigation features in perpetuity.

As described in Section 1.4, "Future Consultation Approach", if the site meets conditions outlined in the Programmatic BO, USACE will provide additional site-specific information and evaluation with a request to have the site appended to the Programmatic BO and covered under the associated incidental take statement. Figure 2-5 shows a flow chart that illustrates the Site Selection Process. For more detail on USACE's site selection process, included is a full description in Appendix B. As identified in steps 1, 5, 6, 9, 10 and 15 above, there are several opportunities for resource agencies to contribute ideas and help guide the decisions for individual erosion site repairs prior to the NEPA and ESA consultation processes. In addition, USACE is committed to regular IWG meetings to regularly discuss project sites as they move through this Site Selection Process.

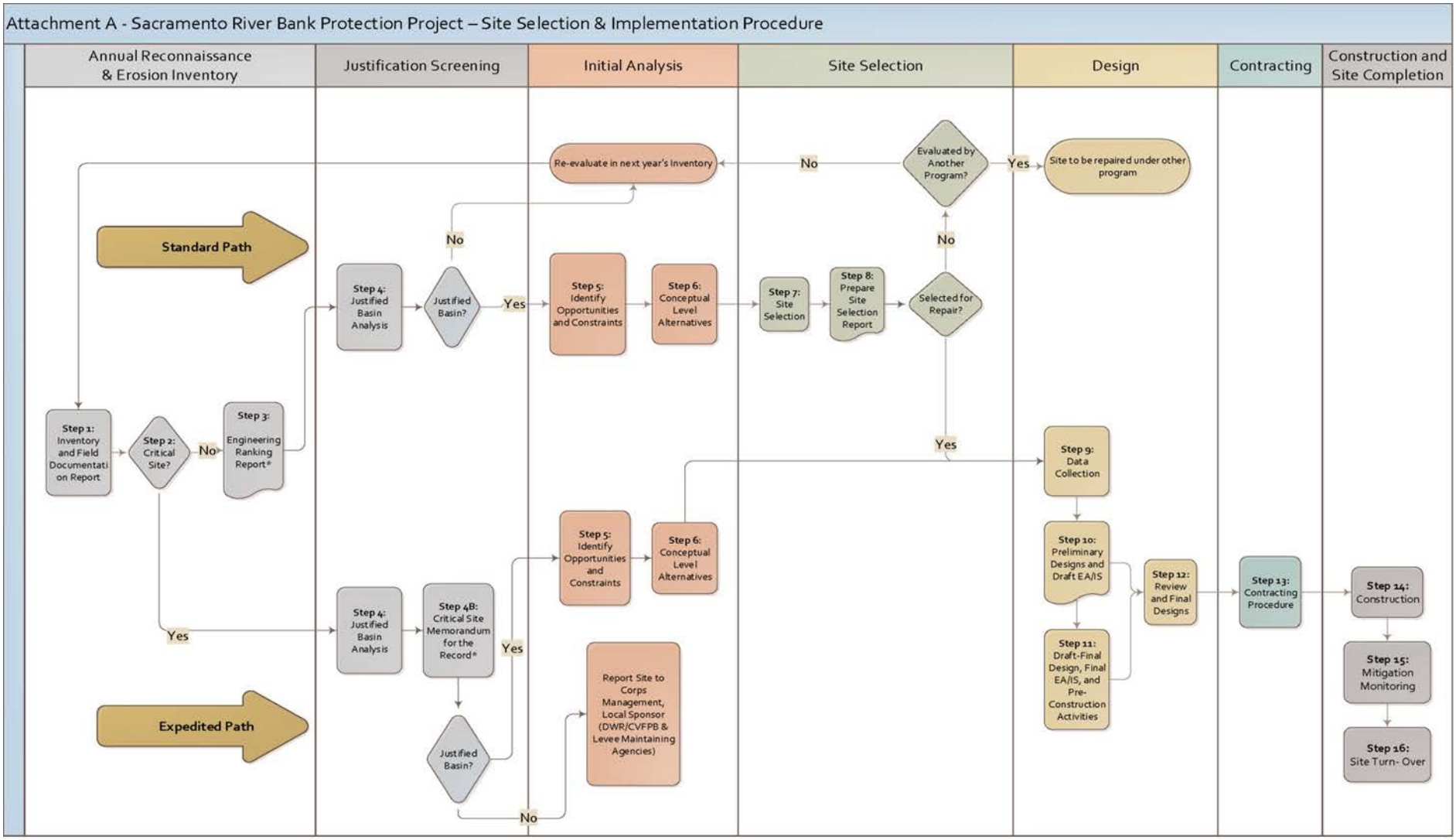

Figure 2. Flow Chart Illustrating the Site Selection Process.

1.2.2 Risk Based Assessment and Requests for Variances

The proposed action includes full compliance with the *EP 1110-2-18* (USACE 2019) and *Implementation Guidance for Section 3013 of the Water Resources Reform and Development Act* [WRRDA] *of 2014, Vegetation Management Policy* (USACE 2017). At many erosion sites, it is likely that there will be limited to minimal on-site design features that may benefit target fish species without securing a variance or design deviation. Requesting a variance or design deviation requires a risk-based assessment that informs decisions more specifically regarding vegetation on levees, and may allow for inclusion of additional features to increase habitat value for various species. This process requires conducting a semi-quantitative risk assessment (SQRA) consisting of the following steps:

1. The facilitator presents an in briefing including a schedule, the objective of the Vegetation Risk Assessment, and a description of the steps in the SQRA process based on the Institute for Water Resources Risk Management Center PowerPoint training presentation for conducting an SQRA.
2. The geotechnical team member presents the Levee Screening Tool (LST) briefing presentation as an introduction to site conditions.
3. The team landscape architect presents information on the trees left in the vegetation free zone as well as the proposed plantings.
4. The team hydraulics engineer presents results of the scour analysis based on a toppled tree.
5. The risk assessment team brainstorms potential failure modes (PFMs) that involve existing or proposed vegetation, and develop short descriptions of each PFM.
6. Non-credible PFMs are eliminated, and the team prepares a short paragraph supporting the non-credible designation.
7. Edited and complete descriptions are prepared for credible PFMs, and the team discusses and develops lists of factors that increase or decrease the likelihood of each PFM.
8. Each team member develops conditional probability estimates for each credible failure mode. Probability estimates are developed for PFMs as a whole, as opposed to developing probability estimates for each node on an event tree. Team members then vote on the likelihood of failure for each PFM. For the first ballot, team members independently evaluate on how to arrive at probability estimates. However, team members typically combine probabilities for several steps in the PFM description to arrive at an overall probability of failure estimate.
9. Results of the first ballot are tabulated and presented to the team. The results are discussed with particular emphasis on the lowest and highest probability estimates for each PFM.
10. The team votes by secret ballot a second time. The results of the first and second ballots are presented in a table for review.

A risk assessment is required to deviate from design standards. No deviations are allowed if there is an increase to incremental life safety risk.

For this action, USACE will seek a variance or design deviation if it is determined to be necessary to maximize on-site features that will adequately offset any losses from the action. During the site selection process, USACE will include additional data collection to support site- specific risk-based assessments and request a variance or design deviation as appropriate.

1.2.3 Current Erosion Sites

USACE Sacramento District and their non-Federal sponsor, CVFPB, conduct annual field reconnaissance reviews of the Sacramento River Flood Control System. Specific criteria are used to identify erosion sites within the system as described in USACE's Field Reconnaissance Report of Bank Erosion Sites and Site Priority Ranking (Ayres Associates 2007). In most cases, the criteria are based on bank and levee conditions that are threatening the function of the flood control system. An erosion site is defined as:

A site that is at risk of erosion during floods and/or normal flow conditions; the term *critical* is used to indicate erosion sites that are an imminent threat to the integrity of the flood control system and of the highest priority for repair.

A site is typically identified as an erosion site if the erosion has encroached into the projected levee prism. The current inventory of erosion sites requiring repair that may be consulted on based on the framework discussed in this Programmatic BA were identified in a field reconnaissance of the Sacramento River Flood Control System conducted by Ayres Associates (2008), which identified 154 erosion sites. Additional erosion sites have been identified in subsequent inventories and, as of 2015, a total of 35 sites were identified within the seven EJBs. Many of these sites are not classified as critical, but they do pose a substantial risk of erosion and threat to the flood control system. As described in Section 1.1.3, the number and extent of documented sites can change from year to year because of various factors. Since streambank erosion is episodic and new erosion sites can appear each year, the analysis is programmatic in nature, focusing on 30,000 LF within the EJBs.

Additional project-level environmental documentation, tiering from this programmatic analysis, will be conducted to address specific sites identified in the future that have been selected for construction through USACE's revised site selection process (Appendix B). As previously described under Section 1.5, "Future Consultation Approach, USACE will prepare site-specific evaluations as described in this framework following the Site Selection Process and adhering to conservation measures and environmental commitments made in their BA.

1.2.4 Bank Protection Measures

The suite of SRBPP PACR site-specific BPMs is described below with figures to support each measure. A BPM is a site-specific design solution to control an existing erosion site while minimizing and/or mitigating environmental impacts.

The following criteria have been developed for bank protection design, consistent with the project purpose and need:

- Restoring the flood damage risk-reduction capability of the originally-constructed levee through the use of structurally reliable erosion-control elements;
- To the extent practicable, maintaining fish and wildlife habitat and scenic and recreational values, and replacing habitat losses through the use of on-site mitigation elements overlying or integrated with erosion-control elements;
- If it is not possible to fully mitigate for fish and wildlife habitat losses on-site, full mitigation of residual habitat losses will occur off-site to the extent justified; and
- Minimizing costs of construction and maintaining both erosion-control and on-site habitat-mitigation elements.

The following measures are intended to meet these criteria while also meeting USACE policy for vegetation management as prescribed in *EP 1110-2-18* (USACE 2019). However, USACE *Implementation Guidance for Section 3013 of WRRDA 2014, Vegetation Management Policy* (USACE 2017) indicates that, until the USACE policy review is completed, trees are not to be removed solely because they are in the vegetation free zone (VFZ) as defined by *EP 1110-2-18*. A risk assessment is required to deviate from design standards. No deviations are allowed if there is an increase to incremental life safety risk (paragraph 4.e). According to the BA (USACE 2017), the VFZ is as defined in *EP 1110-2-18* and thus encompasses the area 15 feet outward of each levee toe that would be restricted to native grass. These measures are conceptual and will be modified to the degree necessary to be suitable for conditions at any given erosion site. As a result, dimensions in the following figures are typical and will vary based on site-specific conditions and designs. The BPMs are described below.

Bank Protection Measure 1—Setback Levee

This measure entails constructing a new levee some distance landward of the existing levee and would avoid or minimize construction in waterside riparian areas (figure 3). The land between the setback and existing levee would act as a floodplain. Land use in the new floodplain would be determined on a site-by-site basis. The old levee could be breached in several locations and/or degraded to allow high flows to inundate the new floodplain. Vegetation on the new setback levee including 15 feet beyond each toe would be restricted to grass, and managed as a VFZ, while vegetation could remain on the existing levee. New vegetation planted in the setback area could serve as mitigation to offset project losses. Additionally, vegetation on the existing levee could become newly available to aquatic species and contribute to a net increase in floodplain vegetation.

Measure 1 would be most applicable in areas where substantial habitat values exist along the channel and land uses in the setback area are not restrictive. Setback levees are recognized for offering opportunities to restore riverine processes and for mitigation of riparian and fish habitat loss at other bank protection sites. Setback levees may also provide other flood control benefits such as addressing seepage issues that other BPMs would not address. Setback levees can be very effective options, but real estate acquisition, existing land use, and technical issues limit opportunities for setback levees in the program area. Due to the typical size of SRBPP proposed actions, often less than 500 linear feet, setback designs may present some hydraulic or other engineering challenges. For their environmental and hydraulic benefits, setback designs remain a preferred option, and are always considered during the Site Selection Process.

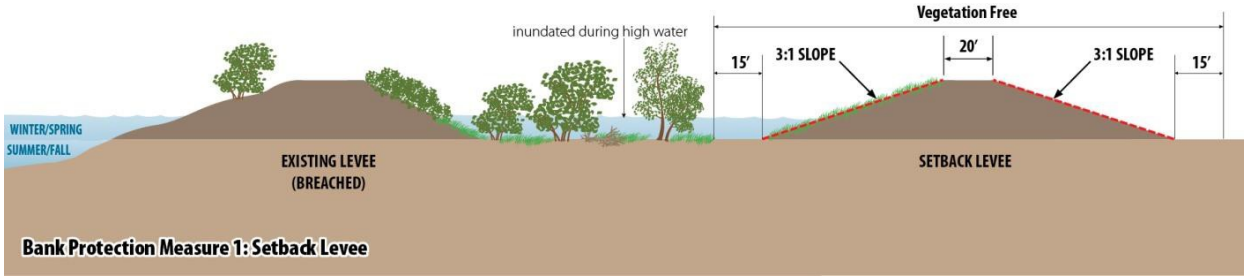

Figure 3. Bank Protection Measure 1: Setback Levee

Bank Protection Measure 2—Bank Fill Stone Protection with No On-Site Woody Vegetation

This measure entails filling the eroded portion of the bank and installing soil-filled revetment along the levee slope (figure 4), and usage will be determined by site-specific analysis. The rock/soil ratio will vary by location and will be determined during site-specific design. Vegetation would be limited to native grass, and existing vegetation would be removed only within the footprint of features to be constructed (e.g., placement of rock or soil). Vegetation within the VFZ but outside of the construction footprint will be left in place. If there is a natural bank distinct from the levee that requires erosion protection, it would be treated with revetment. Measure 2 would be most applicable in areas where there is inadequate space or substantial constraints (e.g., critical infrastructure, homes, roadways, pump facilities, real estate issues, etc.) either landside or waterside, where hydraulic concerns would make it difficult to implement the other measures, or where existing habitat values are very limited.

SRBPP has not implemented this measure since 2005; it was used only rarely prior to that time, but it is included as a low maintenance alternative or in situations with no flexibility of design features. Implementation under the proposed framework will rarely result in selection of this measure for repair of an erosion site.

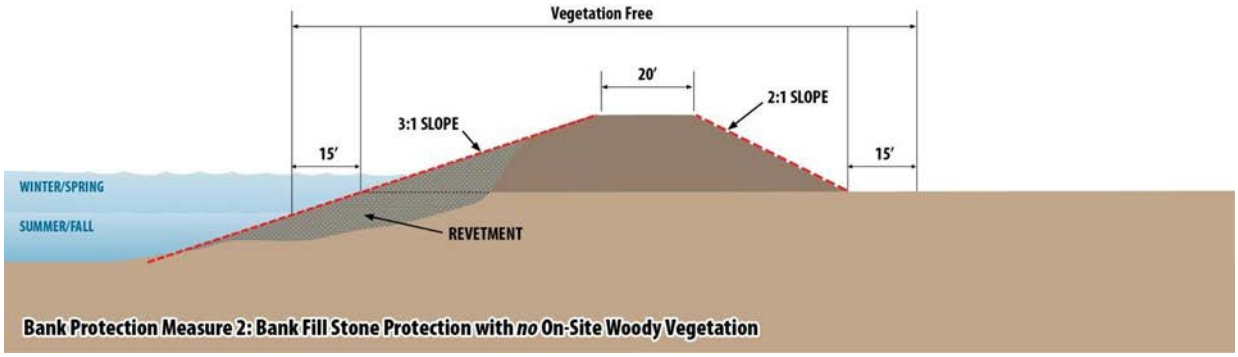

Figure 4. Bank Protection Measure 2: Bank Fill Stone Protection with No On-Site Vegetation.

Bank Protection Measure 3—Adjacent Levee

This measure involves the construction of a new levee embankment adjacent to and landward of the existing levee. The adjacent levee would be constructed to USACE design standards, which require

adjacent levees to be constructed with 3:1 slopes on both the waterside and landside (USACE 2000c). The landward portion of the existing levee would be an integral, structural part of the new levee (figure 5). The waterside portion of the existing levee would remain. Vegetation and instream woody material (IWM) could be placed on the old levee if that portion is outside of the VFZ. However, a variance under the *EP 1110-2-18* may be required if the existing levee is considered to be a waterside planting berm based on its dimensions and proximity to the new levee. The levee may also be degraded to riparian and/or wetland benches that comply with Implementation Guidance for Section 3013 of WRRDA 2014, Vegetation Management Policy (USACE 2017). Vegetation on the landward side of the existing levee and within the footprint of the new adjacent levee would be removed as a part of construction.

Measure 3 would be appropriate at many sites where waterside berms are narrow or non-existent but landside uses would limit the use of setback levees.

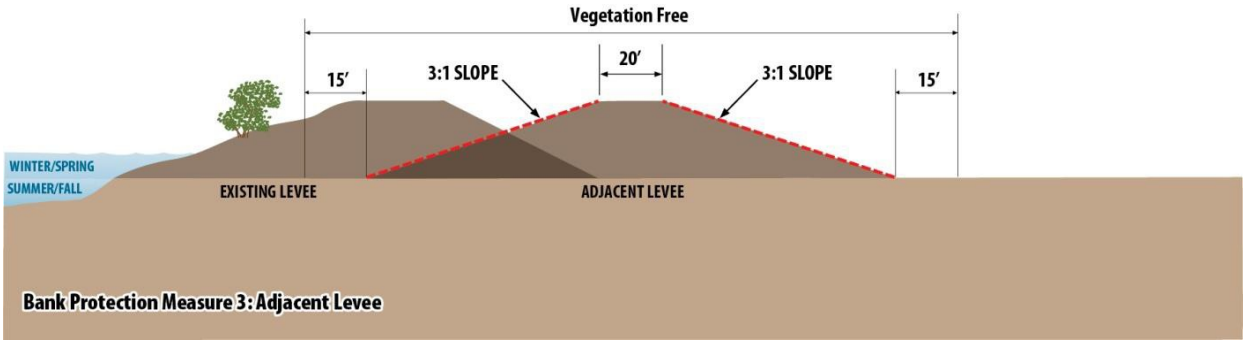

Figure 5. Bank Protection Measure 3: Adjacent Levee.

Bank Protection Measure 4—Riparian and Wetland Benches with Revegetation

Measure 4 consists of three design variations presented as Measures 4a, 4b, and 4c. In general, this measure involves the placement of clean quarry stone from the toe of the bank up to the summer/fall waterline, and placing quarry stone and soil-filled quarry stone on the levee slope above the summer/fall waterline. The rock/soil ratio will vary by location and will be determined during site-specific design. The repairs would involve initial site preparation and construction of levee embankment. Measures 4a, 4b, and 4c would comply with *EP 1110-2-18*, requiring all woody vegetation within the VFZ to be removed.

Measures 4a, 4b, and 4c vary from one another with regard to the placement and extent of environmental features that are intended to increase habitat quality (bank construction, vegetation, and IWM). These variations are driven by a number of factors, most importantly the types of existing resources and the types of species likely to use those resources. For example, if the existing site is downstream of RM 30 and likely to be used by Delta smelt, the new design would not include IWM below the summer/fall waterline, because IWM is not considered optimal habitat for Delta smelt. New IWM would only be installed downstream of RM 30 to replace existing IWM removed during repair of the bank (at a 1:1 ratio). Upstream of RM 30, new IWM is usually incorporated into the design, as Delta smelt are not likely to be present.

In general, plantings consistent with the *EP 1110-2-18* and outside of the VFZ and/or included in the design deviation at each site could include: box elder (*Acer negundo*), white alder (*Alnus rhombifolia*), Oregon ash (*Fraxinus latifolia*), western sycamore (*Platanus racemosa*), Fremont

cottonwood (*Populus fremontii*), valley oak (*Quercus lobata*), Goodding's black willow (*Salix gooddingii*), red willow (*Salix laevigata*), arroyo willow (*Salix lasiolepis*), California wild rose (*Rosa californica*), and narrowleaf willow (*Salix exigua*).

These measures are appropriate where the channel is wide enough to accommodate the installation of the stone and soil structure without substantially affecting the hydraulic capacity of the channel.

Bank Protection Measure 4a—Riparian Bench with Revegetation and Instream Woody Material above Summer/Fall Waterline

The low riparian bench with revegetation and IWM above the summer/fall waterline measure entails installing revetment along the waterside levee slope and/or bank as well as a rock/soil bench to support riparian vegetation and provide a place to anchor IWM. This design provides near-bank, shallow-water habitat and components of shaded riverine aquatic (SRA) habitat for fish and is typically applicable to sites upstream of Sacramento RM 30. This measure includes a riparian bench (figure 6). The bench will be treated with soil-filled quarry stone.

In this design, the riparian bench is intended to be inundated at river stages corresponding to high tide (where tidally influenced) during average winter/spring flows. The riparian bench will be revegetated in a manner similar to recent SRBPP projects with riparian bench designs. Species planted would comply with the *EP 1110-2-18*. Planting plans would describe species to be planted within a specific elevation zone and would detail the number, area and spacing of plants to be installed, and whether the plants are from cuttings or containers.

The riparian bench would be constructed at a slope (between 6:1 and 10:1) and the revetment portion above and below the bench would typically be 3:1 (distance width to distance height, or dW:dH). The width of the bench would be approximately 10 to 30 feet, depending on site conditions. Anchored IWM would be embedded on top of the riparian bench above the summer/fall waterline. The IWM would be available as accessible habitat along the banks only during winter/spring flows when the bench is inundated. Individual pieces of IWM would be placed to fit the project site's hydraulic conditions and other applicable guidance. The SAM assumes 60% shoreline coverage and a high level of complexity. Exact shoreline coverage amounts and complexity components will be determined during site-specific design.

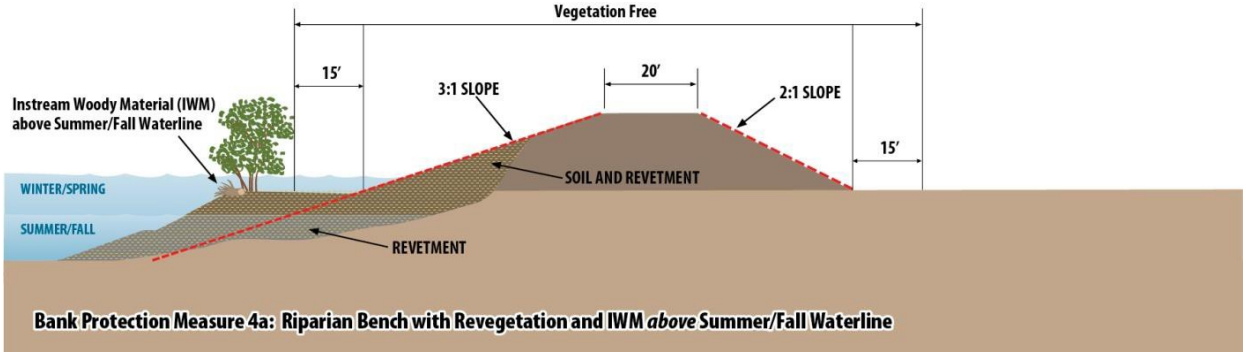

Figure 6. Bank Protection Measure 4a: Riparian Bench with Revegetation and Instream Woody Material above Summer/Fall Waterline.

Bank Protection Measure 4b—Riparian Bench with Revegetation and Instream Woody Material above and below Summer/Fall Waterline

The low riparian bench with revegetation and IWM above and below the summer/fall waterline measure entails installing revetment along the waterside levee slope and/or bank as well as a rock/soil bench (as described for Measure 4a) to support riparian vegetation and provide a place to anchor IWM. In addition to the placement of IWM above the summer/fall waterline as described for Measure 4a, IWM also would be placed beyond the bench below the summer/fall waterline (figure 7), thereby increasing the types and extent of mitigation for shallow-water fish habitat, providing year-round instream habitat for targeted fish species. This design is typically applicable to sites upstream of Sacramento River RM 30. Installation of soil-filled quarry stone and riparian bench would be similar to Measure 4a.

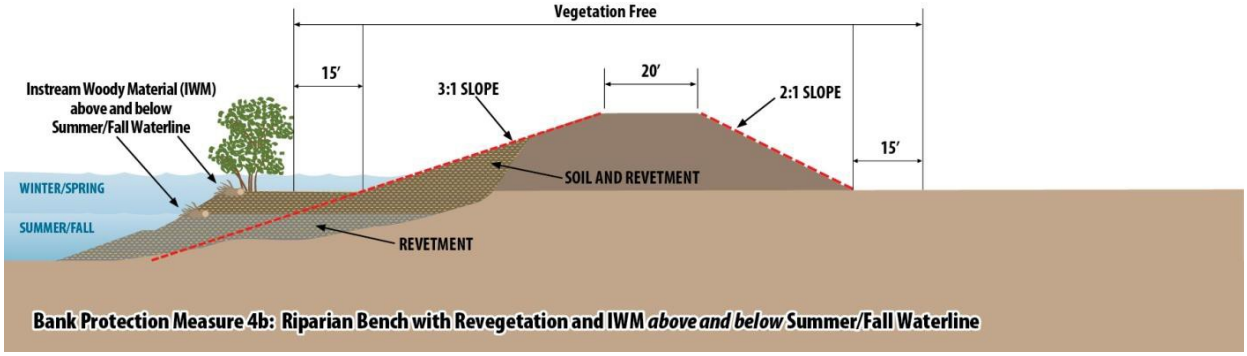

Figure 7. Bank Protection Measure 4b: Riparian Bench with Revegetation and Instream Woody Material above and below Summer/Fall Waterline.

Bank Protection Measure 4c—Riparian and Wetland Benches with Revegetation

Measure 4c (figure 8) entails installing revetment along the waterside levee slope and/or bank as well as a rock/soil bench to support riparian vegetation and provide a place to anchor IWM. Bench slopes would be the same as those described for Measure 4a. The design also includes a wetland bench below the summer/fall waterline to further increase habitat quality. This design is intended for sites downstream of Sacramento RM 30 and targets mitigation of impacts on Delta smelt habitat. Existing vegetation would be removed only within the footprint of features to be constructed (e.g., placement of rock or soil). Grass would be allowed in this area. Vegetation within the VFZ, but outside of the construction footprint will be left in place. Because IWM might increase habitat suitability of ambush predators, new IWM would only be installed to replace existing IWM removed during project repair (at a 1:1 ratio).

The riparian and wetland benches are intended to flood at river stages corresponding to winter/spring (high) flows and summer/fall (low) flows, respectively. Both benches would be revegetated in compliance with the *EP 1110-2-18* and in accordance with appropriate planting plans. The wetland bench would typically be planted with hardstem bulrush (*Scirpus acutus*), California bulrush (*S. californicus*), and/or giant bur-reed (*Sparganium eurycarpum* ssp. *eurycarpum*).

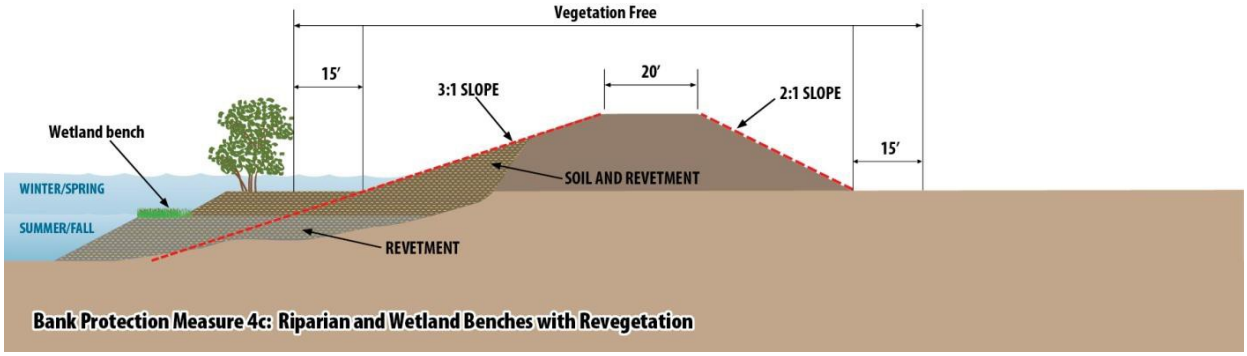

Figure 8. Bank Protection Measure 4c: Riparian and Wetland Benches with Revegetation.

Bank Protection Measure 5—Bank Fill Stone Protection with On-Site Vegetation

Measure 5 (figure 9) entails filling the eroded portion of the bank and installing revetment along the waterside levee slope and streambank from the streambed to a height determined by site-specific analysis. The revetment would be placed at a slope of 3:1. All IWM would be removed from the bank; following construction, it would not be replaced on the bank fill stone protection.

Existing vegetation would be removed only within the footprint of features to be constructed (e.g., placement of rock or soil). Vegetation within the VFZ but outside of the construction footprint would be left in place. The actual amount of retained vegetation could vary substantially from site to site during implementation. New vegetation would be limited to native grasses within the VFZ, while woody vegetation could be replaced by planting outside of the VFZ, and within the project footprint, as allowed by the design deviation and site-specific conditions. The long-term goal of vegetation planting is to provide riparian and SRA cover habitat as defined by USFWS. Planting plans would describe species to be planted within a specific elevation zone and would detail the number, area and spacing of plants to be installed, and whether the plants are from cuttings or containers. Six inches of soil cover would be placed on the revetment to support on-site vegetation. If there is a natural bank distinct from the levee that requires erosion protection, it would be treated with revetment.

Similar to Measure 2, Measure 5 would be most applicable in areas where there is inadequate space or substantial constraints that would limit the applicability of the other measures. However, some amount of space is necessary to allow for the planting of vegetation.

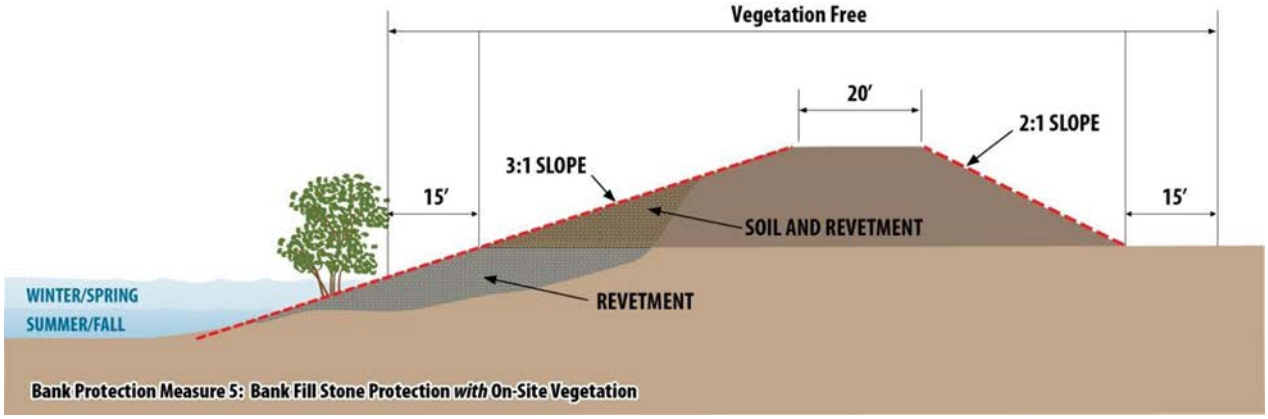

Figure 9. Bank Protection Measure 5: Bank Fill Stone Protection with On-Site Vegetation.

Additional Measures

Additional measures may be considered and found to be appropriate during the implementation of site-specific repairs. 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 (e.g., impermeable groins) and alternative materials in place of riprap. These measures are not included in the proposed action identified in Section 2.4. These and other measures, which may be developed in the future, would be included in the tiered site-specific consultations, if proposed.

Recently Completed Repair Sites Representing Likely Future Condition

To illustrate the outcome of this Site Selection Process for implementation, USACE has compiled information from 25 sites within the EJBs that were constructed under the SRBPP Phase II Authorization since 2005 (Table 2-3). For these previously constructed sites, a similar process was used for determining the best design for construction. The best design was determined using engineering, economics and environmental considerations. During implementation of this authorization, the Site Selection Process will be followed, which is used to develop the actual designs selected for construction. This will be done in a manner similar to the process used to determine the designs of this suite of previously constructed sites. Since these sites have extensive available data and demonstrate implementation similar to this proposed action, this approach provides the best opportunity to visualize implementation of this authorization using this programmatic framework process. This is presented as part of the effects analysis in Chapter 5 of the (USACE, 2019).

As previously stated, SRBPP has not implemented this measure as of 2005; it was used only rarely prior to that time, but it is included as a low maintenance alternative or in situations with no flexibility of design features, and is a component of USACE's analysis of potential repairs, although implementation under the proposed framework is unlikely to result in selection of this measure for repair of an erosion site. It should be noted that there was no implementation of Measure 2 on the 25 historic repair sites analyzed between 2005 and 2018.

Table 2. List of Erosion Repair Sites within EJBs Constructed Since 2005.

	System	Location (River Mile)	Bank	SRBPP SAM Region	Design Type	Site Length (LF)
1	Sacramento R.	47	L	1B	BPM 4B	1156
2		49.6	L	1B	BPM 5	298
3		49.7	L	1B	BPM 4A	280
4		49.9	L	1B	BPM 5	268
5		50.2	L	1B	BPM 5	1473
6		50.4	L	1B	BPM 5	288
7		50.8	L	1B	BPM 5	894
8		51.5	L	1B	BPM 5	888
9		52.3	L	1B	BPM 4C	1320
10		52.4	L	1B	BPM 5	166
11		53.1	L	1B	BPM 5	120
12		53.5	R	1B	BPM 4A	430
13		56.7	L	1B	BPM 4D WT	1600
14		57.2	R	1B	SETBACK	1200
15		62.5	R	1B	BPM 4B	255
16		68.9	L	1B	BPM 4B	786
17		73.5	L	1B	BPM 4A	1050
18		77.2	L	1B	BPM 4A	600
19		78	L	1B	BPM 4B	1058
20	Feather R.	5.5	L	2	BPM 4A	832
21		7	L	2	BPM 4A	520
22	American R.	0.3	L	1B	BPM 4A	520
23		2.8	L	1B	BPM 4A	470
24		10	L	1B	BPM 4A	740
25		10.6	L	1B	BPM 4A	670
					Total linear feet	17882

	# Sites	Total LF
Sacramento R.	19	14130
Feather R.	2	1352
American R.	4	2400

1.2.5 Operations and Maintenance

Once repairs are complete, a project site may require limited maintenance to ensure establishment of on-site mitigative features. During the initial establishment period, maintenance activities are anticipated to be required for three to five years; these activities may include removing invasive vegetation detrimental to project success, pruning and watering planted vegetation to promote optimal growth, replacing plantings, monitoring navigational hazards, and placing fill and rock revetment if the site is damaged during high flow events or by vandalism.

Once established, the riparian vegetation should be self-maintaining. Maintenance activities conducted during the initial establishment period are not to be confused with long-term O&M activities, which are the responsibility of the local maintaining agency. Following site turn-over, responsibility for long-term O&M activities rests with the local maintaining agency. USACE will provide the CVFPB with an updated O&M manual detailing any changes made to the levee as the result of the repair and any additional long-term maintenance requirements, including annual maintenance limits to placement of no more than 600 cubic yards of material, which corresponds to a disturbance length of less than 300 feet; should more material be required in any year, the operating and maintaining agency (i.e., CVFPB) will obtain the necessary permits from the regulatory agencies. USACE will be responsible for ensuring that conservation measures and environmental standards stipulated in permits and all required documentation are maintained. If outside alterations of a project site are proposed by other agencies or private entities, USACE will work with USFWS and NMFS to ensure that environmental features at the project sites are maintained or that off-site compensation is implemented to make up for any deficits.

Any needed in-water maintenance work will be conducted during periods that minimize adverse effects on listed fish species. Unless approved otherwise by NMFS, in-water maintenance will be conducted between July 1 and November 30 of each year for sites above RM 60, and between August 1 and November 30 for sites below RM 60.

1.2.6 Proposed Compensation Strategy

Off-Site Compensation for Chinook salmon, Steelhead, and Green Sturgeon

If bank repair actions are not fully self-mitigating, off-site compensation measures will be implemented after either project completion or concurrent with site construction using conservation measures/banks. Whether constructed as part of a suite of bank protection sites or established independent of a project site in coordination with California Department of Water Resources (DWR), USFWS, and NMFS, off-site compensation will focus on replacing and enhancing habitat values for the listed species addressed in this BO. The SAM model, which was specifically created to assist with determining and quantifying effects and compensation amounts, will be utilized to the extent practicable.

However, other evaluation tools recognized by the resource agencies and acceptable to USACE may also be utilized. Possible off-site compensation could include the use of one or more of the following elements:

- Setback levees to reestablish natural bank conditions along the channel, provide a seasonally inundated floodplain, and increase overhead riparian cover with structural

diversity (Figure 2-6). Under these conditions, active channel migration could resume and would be subject to the natural cycles of habitat disturbance and renewal.

- Construction of in-channel and off-channel wetland benches or less steeply sloping banks to provide juvenile rearing habitat.
- Planting riparian trees for bank shading and long-term production of IWM for aquatic habitat.
- Installation of IWM for the creation of instream cover and feeding areas.
- Removal of rock revetment, which would allow the river to reclaim its natural geomorphic processes and move freely throughout the floodplain.

Similar compensation values may also be obtained through the purchase of third party mitigation bank credits.

The 2007 Programmatic BA prepared for the SRBPP (Stillwater Sciences 2007) estimated necessary off-site compensation lengths of setback levees, instream benches, and IWM to offset SAM deficits related to construction of 24,000 LF of BPMs. The study demonstrated that these types of off-site compensation measures are capable of addressing deficits that, in this case, were determined through the SAM. However, actual lengths and locations of off-site compensation for future repair sites would be calculated on a site-specific basis.

Off-Site Compensation Process

Sections 7(a)(1) and 7(a)(2) of the ESA, 16 U.S.C. Sections 1636(a)(1) and (2), require all Federal agencies to utilize their authorities to support and implement programs for the conservation of listed species, and to ensure that designated critical habitat will not be destroyed or adversely modified. Impacts to listed species are minimized by including conservation measures in the Federal agency's project description. These conservation measures may include off-site enhancement of listed species habitat as an individual project action. The general off-site compensation process is outlined below.

1. Off-site compensation requirements for one or more individual project sites will be determined using the SAM or other assessment tools recognized by the resource agencies. A combination of pre-construction survey data, SRA habitat modeling, or post- construction survey data will be used to verify assumptions used in the SAM model or other assessment tools.
2. Proposed compensation sites will be surveyed for SRA and other attributes using established methods and recommended compensation measures will be submitted for approval by the resource agencies. If a significant setback levee action (or other significant restorative action) is designed and developed with the intent of offsetting future SRBPP PACR bank protection impacts, the action will be subject to the appropriate advance mitigation guidance, including the requirements of 33 CFR Part 332, Compensatory Mitigation for Losses of Aquatic Resources, the USACE

Implementation Guidance for WRDA 2007 – Section 2036(c) Wetlands Mitigation, and Appendix C of *ER 1105-2-100*.

3. The functional equivalence of the project and compensation sites will be determined by site locations (e.g., compensation sites located where they can be colonized by the affected life stages of the focus fish species), site attributes (e.g., potential exchanges between one or more SRA attributes such as IWM, substrate, shade, etc.), relative sizes of the sites, and compensation timing using the SAM or other assessment tools.
4. Timing of project site construction, compensation site construction, and SRA habitat evolution will be evaluated using the SAM or other assessment tools; the goal is to achieve net positive SAM results for the project and compensation sites at all times. This will require a balance between compensation sites and construction sites at any given time.
5. Compensation requirements are to be met within the SAM-recommended timelines and will be on a bank length basis of 1:1 (project site length to compensation site length) or area basis of 1:1 (project area to compensation site area) using the SAM or other approved methodology. Compensation requirements that remain unmet for periods longer than recommended will be subject to additional accumulated habitat compensation requirements under the framework established by the SAM or other approved methodology.

Location of Compensation

There is a history of policy positions favoring local or on-site mitigation over more distant compensation. Prior policy positions of NMFS have stated that the use of distant sites (>50 miles) is unacceptable because it does not ensure “in-kind” compensation, or that local populations which have been affected by the project benefit from the habitat enhancement (NMFS 2001). 33 CFR Part 332 establishes compensatory mitigation standards and criteria for projects permitted by USACE pursuant to Section 404 of the Clean Water Act, 33 U.S.C. Section 1344. In general, 33 CFR Part 332.3(b)(1) states that compensation sites should be located within the same watershed as the impact site, and should be located where it is most likely to successfully replace lost functions and services. Watershed scale features such as aquatic habitat diversity, habitat connectivity, relationships to hydrologic sources, trends in land use, ecological benefits, and compatibility with adjacent land uses are to be taken into account.

For the purposes of the proposed action, compensation requirements will generally be determined within each of the four EJB regions (Figure 1) with the intent of completing the proposed conservation measures at sites selected as close as practicable to the bank protection project sites. Whether two potential project and compensation sites are ecologically interchangeable can primarily be assessed by determining whether fish species or specific life stages could inhabit the two sites at the same time of year. In select situations, compensation

sites may be acceptable if fish species utilize the two sites at various times or during different life stages.
Two potential compensation sites have been identified at the time of this Programmatic BA: the 1992 SRBPP Cache Slough/Yolo Bypass Cross-Levee Project in Region 1a, and rock removal at Kopta Slough in Region 3. Additional compensation sites within these regions and in Regions 1b and 2, will address the needs of the proposed action. Final compensation site locations may be constrained by: (1) limited potential for habitat benefits to listed species from planned acquisition or enhancement; (2) location of the property relative to site(s) requiring off-site compensation; (3) compatibility of nearby land uses with the proposed land use at the compensation site; (4) available funding; and (5) the willingness of landowners to sell their properties. Due to the unique qualities of some mitigation opportunities or sites (e.g., rock removal at Kopta Slough), it may be appropriate to mitigate for impacts in one region with compensation in another.

Compensation Timing

Compensation timing refers to the time between the initiation of bank repairs at a particular site and the attainment of the habitat benefits to protected species from designated compensation sites. In general, compensation time is the time required for on-site plantings to provide significant amounts of shade or structural complexity from IWM recruitment. Significant long-term benefits have often been considered as appropriate to offset small short-term losses in habitat for listed species in the past, as long as the overall action contributes to recovery of the listed species. The authority to compensate prior to or concurrent with project construction is given under the WRDA of 1986 (33 U.S.C. Sections 2201–2330); however, long-term compensation to offset short-term losses is generally not an option for the loss of critical habitats under the ESA (USFWS 1998).

Guidelines for Off-Site Compensation

Protection of listed species habitat through habitat enhancement actions at sites constructed by USACE or CVFPB may be considered as one means to satisfy off-site compensation requirements once all available on-site mitigation alternatives have been exhausted. For compensation sites constructed to cover compensation needs of multiple proposed bank repair sites, the compensation action may be completed prior to some of the erosion repairs covered, and medium-term to long-term habitat benefits will potentially accumulate for use in offsetting habitat impacts. Within the SRBPP context, the goal of combining compensation actions would be to optimize offsetting adverse impacts to the Federally listed fish species addressed in this Programmatic BO. Combining or “pooling” these compensation actions can reduce costs and provide more productive benefits for listed species. The purchase of mitigation credits from third-party mitigation banks may also be considered as a strategy for off- site habitat compensation.

The use of advance mitigation strategies for the SRBPP PACR might be considered, and would be accomplished through the Section 7 consultation process, with advance mitigation agreements that would be consistent with established criteria and guidelines of the involved agencies. As described in Section 2.6.4.3, *Location of Compensation Sites*, 33 CFR Part 332

establishes compensatory mitigation standards and criteria for projects permitted by USACE. In addition, USACE's *Implementation Guidance for WRDA 2007 – Section 2036(c) Wetlands Mitigation* and *ER 1105-2-100,* Appendix C, will be followed for SRBPP PACR compensatory mitigation actions to the extent practicable, and will be consistent with USFWS and NMFS fulfilling their statutory obligations under Section 7 of the ESA. As advance mitigation is similar in concept to mitigation banking, USFWS will also be directed by its *Guidance for the Establishment, Use, and Operation of Conservation Banks*, as finalized in May 2003 (USFWS 2003b), and NMFS will also be directed by its West Coast Region Conservation Banking Guidance, as finalized in August 2015 (NMFS 2015). Additional guidance for State agencies may be found in *Official Policy on Conservation Banks*, issued in April 1995 (Wheeler and Strock 1995).

Although these relevant Federal and State guidance documents for conservation and mitigation banking provide the fundamental precepts under which advance mitigation for the SRBPP PACR will be undertaken, advance mitigation actions and proposals will be unique and variable. Therefore, some of the more important additional guidelines that would also apply to advance mitigation relative to the SRBPP PACR are as follows:

- A setback levee (or other significant restorative action) for compensation that is part of a suite of discrete bank protection sites analyzed and evaluated together as one SRBPP PACR project, may not need the coverage of a formal advance mitigation agreement, provided USACE and the State of California have addressed the relevant advance mitigation issues in their environmental documentation for the overall programmatic action;
- The IWG will support an independent re-analysis of the 1992 SRBPP Cache Slough/Yolo Bypass Cross-Levee Project in Solano County, California to determine how many excess conservation credits may be applied to future SRBPP compensation needs. Application and use of such credits will be subject to appropriate conservation and advance mitigation agreements;
- On-site compensation efforts that create substantially more compensation than necessary to fully offset on-site impacts may have the excess compensation credited, accounted for, and used through appropriate consultation processes, or under appropriate conservation and advance mitigation agreements;
- The project service area for each advance mitigation site may vary and will be defined at the time each site is established;
- Advance mitigation credits may either be withdrawn directly by USACE and the State of California (in the case of advance mitigation sites the State may choose to operate), or conservation bank credits may be purchased from an intermediate, private seller/bank operator. However, all accounting, regardless of credits originating from a government project or private bank, will be based on the SAM (USACE 2012) or other methodology approved by the resource agencies;

- Each IWG agency will be given an opportunity to participate in the development of, and to become a party to any advance mitigation or conservation bank agreements which are developed;
- USACE and the State of California, in coordination with the IWG agencies, will first consider the purchase of credits in a mitigation or conservation bank. In this instance, the mitigation bank sponsor will be responsible for: (1) preparing and seeking approval of mitigation and/or conservation bank agreements, and (2) conducting operations, maintenance, monitoring, and accounting for mitigation bank sites and/or conservation banks; and
- USACE and the State of California may also develop advance mitigation sites in accordance with applicable Federal and State laws, regulations, and policies. The protections and management of advance mitigation sites will be established in perpetuity. Management measures will be implemented to ensure adequate control of undesirable activities (e.g., trash dumping, tree cutting, off-road vehicle use, and invasion by exotic vegetation). Management elements that maintain the habitat for the various listed species will also be included, as necessary. However, for the management and maintenance of all advance mitigation sites, the guiding principle would be to achieve to the extent feasible, a largely unmanaged operation based on natural river functions and processes.

1.2.7 Conservation Measures

Conservation measures have been developed to help identify, avoid, minimize and compensate for potential adverse effects to listed fish species. These measures implemented USACE will include the following mitigation monitoring, site evaluation, and construction-related measures.

Mitigation Monitoring and Site Evaluation

USACE will submit a detailed monitoring plan for on- and off-site habitat mitigation for each individual site as part of the consistency determination with the Programmatic BO. All mitigation sites will be monitored for a period of at least five years to ensure the successful establishment of planted vegetation. Plantings will be monitored to ensure they have a minimum of 70% canopy cover after three years, and 80% planted acreage survival and 75% canopy cover at the end of five years. Remediation will occur if these survival and cover goals are not met. As stated above in Section 1.4 “Proposed Federal Action,” an annual monitoring report for each site that evaluates how the site meets the mitigation success criteria will be submitted to the resource agencies by December of each year. Multiple sites may be bundled into one report. NMFS will not review additional bank repair sites under the SRBPP PACR until USACE is up to date on their purchasing of off-site mitigation credits if applicable, and yearly monitoring reporting for all sites under the SRBPP PACR program.

Validation of SAM Model Performance

USACE will evaluate whether sites meet the compensation criteria of the SAM model (USACE 2012). Post-construction vegetation and habitat monitoring will be used to validate previous SAM model outputs, which were used to determine the extent of physical habitat mitigation.

This information may be used to improve the SAM model in the future, and to more accurately mitigate for future loss of riparian physical habitat associated with flood control projects. The monitoring of physical habitat attributes will use passive measurement techniques that are not expected to adversely affect listed fish or critical habitat, and do not require further consultation.

Fisheries and Aquatic Habitat Monitoring

USACE will develop a biological monitoring plan describing the goals and methods of fisheries monitoring under the SRBPP PACR program. This plan will be submitted and approved by NMFS prior to the implementation of any biological monitoring. Any biological monitoring that requires the take of listed salmonids or green sturgeon will require consultation with NMFS. The specific types of fishery monitoring techniques are to be developed by USACE, with consultation and coordination of the Engineer Research and Development Center (ERDC).

Fishery monitoring is expected to include techniques involving sampling at selected program locations in the action area throughout juvenile migration period using electrofishing or other similar methods. If turbidity is low, passive techniques, such as underwater observation may also be used. Passive techniques may also include sonar imaging cameras (e.g., ARIS or DIDSON) or other sonar technology to detect fish use at different reference sites. Monitoring sites within the action area may be used to determine fish presence under different conditions, including during periods of no bench inundation, partial bench inundation, and full bench inundation. Monitoring may include physical characteristics, and benthic biological communities.

Develop Monitoring Plans Utilizing Appropriate Criteria

In developing the detailed biological and vegetation monitoring plans described above, USACE will use the “SMART” criteria, which refers to an acronym used to set project objectives. SMART objectives are Specific, Measurable, Achievable, Realistic, and Timely. Monitoring would be designed with the following goals in mind:

a. *Rationale* - The rationale, or underlying reason for implementing the monitoring plan is to ensure that compensation and mitigation measures historically and

currently implemented are resulting in the intended effect on listed species and critical habitat. In recent years, USACE and NMFS have worked together to carefully design levees that include benefits to listed fish species and designated critical habitat. Some of these features include setback levees, vegetated benches with SRA habitat, installation of IWM, and limiting the amount of rock placement on levees. It would now be timely to test the effectiveness of alternative designs, as opposed to traditionally riprapped levees. The biological portion of this monitoring plan is being implemented to determine the extent of fish use of alternative levee designs. The vegetation portion of this monitoring plan is being implemented to measure the extent of riparian habitat available in alternative levee designs post-construction. As a whole, the monitoring is being implemented in order to guide future implementation of mitigation and conservation measures, and the implementation of alternative levee designs.

b. *Goals* - The goal of the monitoring program is to evaluate fishery and vegetation responses to a range of critical levee repair projects and designs. This includes evaluating how critical levee repair projects and designs are contributing to the recovery of listed fishes in the Central Valley, and to designated critical habitat uplift.

c. *Objectives* - The objective of the monitoring plan is to inform future conservation and mitigation actions related to flood control projects, and to guide the implementation of future levee designs in the Central Valley.

SAM Update

USACE, subject to availability of funds and with the assistance and consultation of the IWG, will develop a strategy to compile recent data and initiate updates or revisions to the SAM model to improve accuracy for project planning. In updating the SAM model, USACE will work with the IWG and ERDC to revisit curves and assumptions used in the model to assure that these accurately reflect potential riparian habitat change inputs, e.g. evaluating impacts to SR winter- run Chinook salmon, CV spring-run Chinook salmon, CCV steelhead and their designated critical habitat related to the placement of rock at elevations below the seasonal water surface elevations, and making updates as needed. Any monitoring data from previous SRBPP sites used to validate SAM assumptions would be used as part of this evaluation process. USACE will seek concurrence from NMFS prior to its application in future ESA Section 7 consultations for actions implemented pursuant to the SRBPP PACR.

Additional Green Sturgeon Conservation Measures

The following actions were recommended by NMFS to minimize and mitigate possible impacts to sDPS green sturgeon. USACE proposes to implement these conservation measures for the SRBPP PACR to identify and help reduce impacts to sDPS green sturgeon and their critical habitat.

a. USACE will update the implementation strategy for the sDPS green sturgeon Habitat Mitigation and Monitoring Plan (HMMP), which includes the specific elements that are described below. The goal of developing the HMMP is to ensure that adverse impacts of future SRBPP PACR projects on sDPS green sturgeon are sufficiently mitigated in order to allow for the growth, survival, and recovery of the species in the study area.

b. USACE will then develop an sDPS green sturgeon HMMP in consultation with NMFS and in coordination with the Interagency Ecological Program (IEP) green sturgeon project work team, or another NMFS-approved technical panel of green sturgeon experts. This will happen prior to the construction of any work under the SRBPP PACR within the designated critical habitat of sDPS green sturgeon. The HMMP would focus on filling important data gaps on green sturgeon life history, and micro- and macro-habitat ecology in both the Sacramento River and the Delta within the project action area. This data will look at how bank stabilization measures proposed in the SRBPP PACR affect sturgeon ecology and survival. The goal of this conservation measure is to leverage the resources of the IEP to help develop an HMMP that utilizes and applies the best available scientific expertise and information.

c. USACE will either refine the SAM or develop an alternative sDPS green sturgeon survival and growth response model. The model may be based on using and updating the existing Hydrologic Engineering Center Ecosystem Function Model that reflects sDPS green sturgeon's preference for benthic habitat, or some other model modified for use and approved by NMFS. These new/modified models would account 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 intersection of seasonal water surface elevations and the levee bank. Any proposed model(s) must be capable of evaluating green sturgeon survival in response to levee repair projects as part of the SRBPP, and the effects on all relevant habitat conditions, not exclusively flow changes. Development of the model will be initiated at the start of the first Preconstruction Engineering and Design (PED) Phase in consultation with NMFS and in coordination with the appropriate sturgeon experts on the IEP, or another independent expert panel with sturgeon expertise. The goal of this measure is to develop a functional assessment methodology, using the best available scientific expertise and information, to predict the effects of future SRBPP actions and to evaluate the performance of mitigative actions relative to the survival and growth of sDPS green sturgeon.

d. The HMMP will also identify measures to restore or compensate for the area and ecological function of soft-bottom benthic substrate for sDPS green sturgeon permanently lost to project construction. Any subsequent actions to restore or compensate for impacts to sDPS green sturgeon will be coordinated with the IWG or a Bank Protection Working Group, and must be implemented within the lower Sacramento River/Delta in order to offset any adverse effects to designated critical

habitat. The restored habitat must be capable of providing appropriate types and quantities of benthic prey, freshwater or estuarine areas with adequate flow, depth, water quality, temperature, salinity, oxygen content, and other chemical characteristics necessary for normal behavior, growth, and viability of all life stages. It should also provide safe and unobstructed migratory pathways necessary for timely passage of adult, sub-adult, and juvenile fish within the region's different estuarine habitats and between the upstream riverine habitat and the marine habitats. The restoration/compensation will be initiated prior to commencement of each construction cycle within the designated critical habitat of sDPS green sturgeon for the SRBPP, and the updated model should be used to evaluate performance. The restoration site and plan will be developed in consultation with NMFS and in coordination with the IEP or another designated scientific expert panel. The goal is to ensure that the spatial and temporal ecological impacts from project-related permanent loss of critical habitat for sDPS green sturgeon are fully compensated

e. The sDPS green sturgeon HMMP will be developed with measurable objectives for completely offsetting all identified adverse impacts to all life stages of sDPS green sturgeon (as modeled using refined approaches described in Measure C, and considering design refinements that occur in the PED Phase of project implementation). The goal of this measure is to develop SMART objectives for mitigation: Specific (target a specific area for improvement), Measurable (quantify or suggest an indicator of progress), Attainable (specify who will do the work and if possible how), Realistic (state what results can realistically be achieved, given available resources), and Timely (specify when the results can be achieved) habitat performance objectives for green sturgeon mitigation.

f. Mitigation actions will be initiated prior to the construction activities (within each construction cycle) affecting sDPS green sturgeon and their critical habitat. Specific mitigation plans may be developed during PED to reduce the specific impacts of levee bank construction actions. The goal of this measure is to ensure that mitigation coincides with project implementation and minimizes, to the maximum extent possible, extended temporal effects.

g. The sDPS green sturgeon HMMP will include measurable performance standards at agreed upon intervals, and will be monitored for a period of up to ten years following construction. If additional monitoring is necessary, the monitoring will be included in the project O&M plan, and carried out by the non-Federal sponsor. The HMMP will include adaptive management strategies for correcting any mitigation measures that do not meet performance standards. The goal of this measure it to provide a reasonable amount of time to measure performance standards after mitigation occurs to ensure that it meets the objectives of the HMMP.

Construction-Related Conservation Measures

USACE will implement additional measures, consistent with earlier BOs (USFWS 2001, 2004, 2006a, 2007, 2008a, 2008b, 2009a, 2009b, 2010, 2014; NMFS 2001, 2004, 2006a, 2006b, 2008a, 2008b, 2009, 2014, 2016) for the SRBPP, to help conserve and minimize impacts on listed species, including:

- Where feasible, preventative measures to treat failure mechanisms that minimize project size.
- Stockpiling of construction materials such as portable equipment, vehicles, and supplies, including chemicals, at designated construction staging areas and barges, exclusive of any riparian and wetlands areas.
- Erosion control measures (Best Management Practices [BMPs]) that minimize soil or sediment from entering the river. BMPs will be installed, monitored for effectiveness, and maintained throughout construction operations.
- Limiting site access to the smallest area possible in order to minimize disturbance.
- Daily removal of all litter, debris, unused materials, equipment, and supplies from the project area. Such materials or waste will be deposited at an appropriate disposal or storage site.
- Immediate (within 24 hours) cleanup and reporting of any spills of hazardous materials to the resource agencies. Any such spills and the success of the cleanup efforts will also be reported in post-construction compliance reports.
- Designating a USACE-appointed representative 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 conducted by USACE.
- An on-site inspection tour, led by a USACE biologist/environmental manager or contractor, if requested by USFWS or NMFS personnel or other resource agencies, during or upon completion of construction activities.
- Screening any water pump intakes as specified by NMFS and USFWS screening specifications. Water pumps will maintain an approach velocity of 0.2 feet per second or less when working in areas that may support Delta smelt.
- A USACE representative will be assigned to work closely with the contractor(s) through all construction stages, and to ensure that any living riparian vegetation or IWM within vegetation clearing zones is avoided and left undisturbed to the extent feasible.

Furthermore, USACE will seek to avoid and minimize construction effects on listed species and their critical habitat to the extent feasible. A number of avoidance measures will be applied to the entire project or specific actions, and other measures may be appropriate at specific locations within the action area. Avoidance activities to be implemented during the final design and construction are not limited to, but may include:

- Identifying all habitats containing, or with a substantial possibility of containing, listed terrestrial, wetland, and plant species in the potentially affected project areas.
- Minimizing effects by modifying engineering design to avoid potential direct and indirect effects.
- Incorporating sensitive habitat information into project bid specifications.
- Incorporating requirements for contractors to avoid identified sensitive habitats into project bid specifications.
- Minimizing vegetation removal to the extent feasible.
- Minimizing, to the extent possible, grubbing and contouring activities.
- Whenever possible, placing fill materials with no excavation or movement of existing materials on-site.
- A qualified biologist will supervise all construction activities, including clearing, pruning, and trimming of vegetation, to ensure these activities have a minimal effect on natural resources.
- If a cofferdam is needed during construction, constructing it by placing the sheet piles sequentially from the upstream to the downstream limits of the construction area. If substrate, cover, and water depths allow, seining would be conducted within the cofferdam with a small-mesh seine to remove as many fish as possible before the cofferdam is closed; upon completion of seining, exclusionary nets would be placed in the river to prevent fish from re-entering the dammed area. Once the cofferdam is closed the area will be partially dewatered, and a final seining and dip netting effort will be conducted to capture any remaining fish. Only low-flow pumps with screened intakes will be used during dewatering operations. Any captured fish would be released downstream of the construction area

Summary of Conservation Measures

Table 3 presents a general summary of environmental commitments that USACE will adhere to as part of the SRBPP PACR.

Table 3. Summary of Conservation Measures.

Environmental Commitment	Description
Chinook salmon, steelhead, and green sturgeon	One or more of the following measures will be initiated if bank repair actions are not fully self-mitigating for protected fish species: Creation of setback levees Construction of in-channel or off-channel wetland benches or less-steep bank slopes

	Planting of riparian vegetation Placement of IWM Rock removal Purchase of credits from third-party mitigation banks Additional conservation measures will be implemented to reduce programmatic effects to green sturgeon, including: Develop and implement an HMMP • Refine SAM or develop new model to evaluate effects to green sturgeon
Standard Assessment Methodology (SAM) Revisions	Develop strategy to compile recent data and initiate updates or revisions to the SAM model to improve accuracy for project planning.
Monitoring	USACE will conduct the following monitoring: Vegetation establishment at repair sites up to 3-5 years post-construction Aquatic Habitat – Physical structure and biological communities to help validate SAM assumptions and repair site performance Fisheries monitoring utilization by site and project reaches Annual monitoring reports will be prepared and submitted
Construction BMPs	USACE will implement several measures including erosion control, monitoring, limiting vegetation removal, and screening intake pumps to minimize adverse environmental effects during construction.

"Interrelated actions" are those that are part of a larger action and depend on the larger action for their justification. "Interdependent actions" are those that have no independent utility apart from the action under consideration (50 CFR Part 402.02). There are no interdependent or interrelated activities associated with the proposed action.

1.3 Consultation History

- **7 May 2014 –** NMFS received an initial request for formal consultation from the United States Army Corps of Engineers (USACE) for the Sacramento River Bank Protection Project Post Authorization Change Report program (SRBPP PACR), which would install 80,000 LF of bank protection under the Sacramento River Bank Protection Project (SRBPP) Phase II Supplemental Authority. This version is superseded by the most current version of the biological assessment (BA) (revised January 2017).

- **3 November 2014 –** NMFS sent USACE a formal letter requesting additional information on this program.

- **4 December 2014 –** USACE sent NMFS a revised BA. This version is superseded by the most current version of the BA (revised January 2017).

- **22 January 2016 –** In response to comments on the BA provided by the United States Fish and Wildlife Service (USFWS) on 19 March 2015, the USACE provided a revised BA to USFWS *only*. Regarding this, NMFS expressed concerns over potential inconsistencies in the description of the programmatic BA provided to NMFS and USFWS and requested a copy of the BA be provided to NMFS as well. Shortly after this request was made, USACE reevaluated the economic feasibility of the program and determined that the scope of the program was to be greatly reduced to 30,000 LF of bank protection, and a new program description would be provided to both agencies.

- **25 January 2016 –** NMFS received supplemental information from USACE including: additional information for the southern Distinct Population Segment (sDPS) of green sturgeon; clarifications of the Standard Assessment Methodology (SAM) results and graphic representations of SAM results generated for Chinook salmon and steelhead; and omission of SAM results for adult Chinook salmon, which NMFS and USACE found to be inconsistent with the reasonably anticipated response to program actions.

- **22 July 2016** – USACE provided a rough draft of the revised program description section of the BA to NMFS and USFWS via email.

- **9 August 2016 –** NMFS responded with comments to the draft of the revised program description section to USACE via email.

- **10 November 2016 –** NMFS sent a letter to USACE with guidance on potential actions that could mitigate for the impacts of the SRBPP PACR bank stabilization program.

- **27 January 2017 –** NMFS received a revised BA from USACE. The BA was revised in response to comments provided by NMFS and USFWS, including a more limited scope of the program.

- **16 May 2016 –** NMFS requested more information from USACE regarding the critical habitat impacts analysis in the BA

- **16 June 2017 –** USACE provided a response to NMFS regarding the critical habitat impacts analysis.

- **8 June 2017 –** NMFS sent a list of additional questions and comments to USACE concerning the BA via email.

- **21 June 2017 –** NMFS and USACE met in person to discuss these comments.

- **11 July 2017** – USACE responded to NMFS via email regarding the comments that were generated during the meeting on 21 June 2017. NMFS requested that the USACE provide additional information clarifying the SRBPP PACR repair sites.

- **7 September 2017 –** USACE responded with clarification on the SRBPP PACR repair sites.

- **12 September 2017 –** USACE requested that long-term fisheries monitoring for the SRBPP PACR sites be added to this consultation.

- **16 November 2017 –**NMFS requested more information about some inconsistencies in the BA regarding the rate of construction.

- **5 December 2017 –** USACE provided information on the proposed rate of construction and NMFS initiated consultation.

- **3 May 2019 –** NMFS transmitted a draft BO to USACE for review. The draft BO concluded that the proposed action is likely to jeopardize the continued existence of the Sacramento River winter-run Chinook salmon evolutionarily significant unit (ESU), Central Valley spring-run Chinook salmon ESU, and California Central Valley steelhead DPS, and destroy or adversely modify their designated critical habitat.

- **23 May 2019 –** NMFS and USACE personnel met to discuss USACE comments on the draft BO. The discussions focused on the draft project description and assumptions on repair design, environmental baseline, Reasonable and Prudent Alternative, and Terms and Conditions. USACE provided a draft response letter to NMFS.

- **29 May 2019 –** USACE received comments from NMFS staff regarding the bank protection designs, clarifying how the site selection process would occur, running the SAM analysis for each future site once a design is selected, ensuring the BA is more of a framework programmatic as the USACE had intended, incorporating bioengineered BPMs when possible, and including NMFS on technical teams for the design process.

- **24 June 2019 –** USACE submitted updated BA and initiation package requesting formal consultation.

- **27 June 2019 –** NMFS and USACE met to discuss comments to BA. The USACE indicated their initial BA (and draft BO) did not accurately represent the proportion of expected levee repair designs to be used and discussed intended changes/updates to the BA.

- **7 July 2019** – NMFS requested further information from USACE

- **11 July 2019 –** NMFS received new BA from USACE, and initiated consultation.

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 provides an opinion stating how the agency's actions would affect listed species and their critical habitats. If incidental take is reasonably certain to occur, section 7(b)(4) requires NMFS to provide an ITS that specifies the impact of any incidental taking and includes non-discretionary reasonable and prudent measures (RPMs) and terms and conditions to minimize such impacts.

2.1 Analytical Approach

This BO includes both a jeopardy analysis and/or an adverse modification analysis. The jeopardy analysis relies upon the regulatory definition of "to jeopardize the continued existence of" a listed species, which is "to engage in an action that 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 Part 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 for the conservation of a listed species. Such alterations may include, but are not limited to, those that alter the physical or biological features essential to the conservation of a species or that preclude or significantly delay development of such features" (81 FR 7214).

The designation(s) of critical habitat for (species) use(s) the term primary constituent element (PCE) or essential features. The new critical habitat regulations (81 FR 7414) replace 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.

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

- Identify the rangewide status of the species and critical habitat expected to be adversely affected by the proposed action.
- Describe the environmental baseline in the action area.
- Analyze the effects of the proposed action on both species and their habitat using an "exposure-response-risk" approach.

- Describe any cumulative effects in the action area.

- Integrate and synthesize the above factors by: (1) Reviewing the status of the species and critical habitat; and (2) adding the effects of the action, the environmental baseline, and cumulative effects to assess the risk that the proposed action poses to species and critical habitat.

- Reach a conclusion about whether species are jeopardized or critical habitat is adversely modified.

- If necessary, suggest a RPA to the proposed action.

2.1.1 Use of Analytical Surrogates

Standard Assessment Methodology Analysis

SAM is a computational modeling and tracking tool developed by Stillwater Sciences with USACE, DWR, and fishery resource agencies (California Department of Fish and Wildlife [CDFW], NMFS, and USFWS). 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 in the Sacramento River. SAM allows agencies to quantitatively assess the potential effects of bank protection and stream restoration projects and inform them of compensation requirements to offset impacts and ensure that these activities do not jeopardize Chinook salmon, steelhead, and green sturgeon or destroy or adversely modify their critical habitat. SAM was applied to previously repaired SRBPP sites to demonstrate the future project impacts while recognizing that more refined SAM analyses would be undertaken to determine project-level effects at individual sites in the future.

SAM evaluates habitat modification impacts and bank protection alternatives by taking into account several key factors affecting listed species relevant to this consultation. A major advantage of the SAM is that it integrates species life history and seasonal flow-related variability in habitat quality and availability to generate species responses to project actions over time. By identifying and quantifying the response of focal species to changing habitat conditions over time, project managers, biologists and design engineers can make changes to project designs to avoid, minimize, or provide on- or off-site compensatory mitigation for impacts to habitat parameters that influence the growth and survival of target fish species by life stage and season (*http://www.stillwatersci.com/tools.php?tid=26*).

The SAM model is used to assess species responses as a result of changes to habitat conditions by direct quantification of bank stabilization design parameters (*e.g.*, bank slope, substrate). Consistent with Fish and Wildlife Mitigation Policy, the USACE proposes to follow as preferred hierarchy for mitigation: avoid, minimize, compensate on-site, and compensate off-site (46 FR 7644, 1981). In the case of most levee projects, most or all of these mitigation strategies are applied due to their large size. Challenges associated with completely avoiding and minimizing impacts, temporal delays in habitat function of on-site compensatory mitigation, and limitations

of being able to provide full compensation at project sites, generally warrant the need for some form of off-site compensation.

In general, the SAM quantifies habitat values in terms of bankline weighted or area weighted species responses. These responses are calculated by combining indices of habitat quality (*i.e.*, fish response indices) with quantity (bank length or wetted area) for each season, target year, and relevant species/life stage. The SAM conceptual model assesses changes to the quality and extent of the following six near-shore and floodplain habitat variables (*i.e.*, fish response indices), taking into account habitat utilization and impacts to the growth and survival by life stage and season (USACE 2012):

1. **Bank slope** — average bank slope of each average seasonal water surface elevation;
2. **Floodplain availability** — ratio of wetted channel and floodplain area during the 2-year flood to the wetted channel area during average winter and spring flows;
3. **Bank substrate size** — the median particle diameter on the bank (i.e., D50) along each average seasonal water surface elevation;
4. **Instream structure** — percent of shoreline coverage of IWM along each average seasonal water surface elevation;
5. **Aquatic vegetation** — percent of shoreline coverage of aquatic or riparian vegetation along each average seasonal water surface elevation; and
6. **Overhanging shade** — percent of the shoreline coverage of shade.

The SAM does not directly model changes in the above variables. Instead, habitat changes are estimated separately by the user and entered into an input data file to an Electronic Calculation Template (ECT) developed within a Microsoft Access database to track species responses to program actions over time. Changes in habitat variables may be fixed in time, such as installation of revetment at a particular slope and substrate size. In other circumstances, habitat evolution over time may be represented by more gradual changes in variables such as changes in floodplain inundation due to meander migration or changes in shade due to growth of planted vegetation. Typically, habitat evolution modeling is restricted to shade estimates from riparian growth models, but the SAM accommodates any number of other habitat modeling approaches such as meander migration modeling or IWM recruitment modeling.

Once a particular time series of habitat variable estimates is developed and entered into an ECT input file, fish responses are calculated using previously developed relationships between habitat variables and species/life stage responses (USACE 2012). The 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 (e.g., with-program or without-program) the ECT uses these relationships to determine the responses of individual species and life stages to the measured or predicted values of each variable, for each season and target year; the ECT then multiplies these values together to generate an overall species response index. This index is then multiplied by the linear distance or area of bank to which it applies; the product is then integrated through time, generating a weighted species response index (expressed as feet or square feet) in each year of the analysis. The weighted species response index provides a

common metric that can be used to quantify habitat values over time and evaluate the effectiveness of on-site and off-site habitat compensation actions.

Following the procedures outlined in the SAM User's Manual (USACE 2012), the electronic calculation template (ECT version 4.0) was used to quantify the responses of the focus fish species and life stages to with-program conditions over 50 years. The SAM model utilizes water years (WY) rather than traditional calendar years; SAM WY also differ from traditional hydrologic water years. SAM WY are as follows: fall (September – November), winter (December – February), spring (March – May), summer (June – August). The current application of the SAM has been simplified by assuming two key water surface elevations for habitat analysis: summer/fall and winter/spring. The ECT was used to calculate a time series of the relative response indices for each pre-program and with-program scenario developed below. Biological responses of each focus fish species life stage were predicted within each habitat unit and for each time step, based on habitat variable values and fish residency determined from region-specific timing tables (USACE 2012). In general, as calculated using the ECT, positive differences between the existing and with-program responses are assessed as a net benefit for the focus fish species (i.e., the bank repair action produced superior conditions than pre-program conditions). Negative differences indicate the bank repair actions produced inferior conditions that will require additional habitat compensation.

The SAM evaluates the response of focus fish species and their critical life-stages to BPMs over a 50-year period of analysis. Results are output as either bankline or wetted area Weighted Response Indices (WRI). The maximum negative wetted area WRI for a juvenile life stage are identified and can be used as a proxy for offsetting program effects. Although the SAM results can be presented as bankline weighted and wetted area weighted WRIs, this analysis will focus on bankline weighted because sufficient information was not available to calculate wetted area weighted WRIs.

The SAM incorporates the value of on-site mitigative features; therefore, the maximum negative wetted area WRI can be interpreted as the remaining potential effect that must be mitigated through additional on-site or off-site features, or through the purchase of off-site mitigative credits. Identifying the maximum negative WRI over the 50-year period of analysis ensures that potential temporal losses are sufficiently considered. The site-specific timing by water year and season of installed bank protection features, including rock placement, soil and IWM installation, and vegetation plantings, were considered in this analysis for the with-program conditions. Descriptions of the habitat variables used in the analysis are discussed below.

The following describes how input values for each of the habitat attributes were derived for existing conditions in the SRBPP PACR SAM assessment.

1. **Bank Slope:** Existing bank slopes (run-over-rise ratio) were developed in GIS using seasonal water surface elevation and bathymetric and topographic survey data.
2. **Floodplain Availability:** The SAM attribute of floodplain inundation ratio, which represents floodplain availability, was assumed to have a value of 1, reflecting the absence of significant floodplain habitat above the winter-spring shoreline under existing conditions. These attributes were developed in GIS using seasonal water surface elevation and bathymetric and topographic survey data.
3. **Bank Substrate Size:** The median substrate sizes along the summer-fall and winter-spring shorelines of the program reaches were determined in the field by following the data collection protocol from the USACE riprap database (USFWS 2002) (USACE 2007)

4. **Instream Structure:** The shoreline coverage of IWM along the average summer-fall and winter-spring shorelines of the program reach were determined using field data collected by USACE.
5. **Overhanging Shade:** The extent of overhanging shade along the summer-fall and winter-spring shorelines was determined through from GIS analysis using digitized canopy overlaying seasonal shoreline positions.

Biological responses of each focal species life stage will be modeled within each habitat unit for each season. In general, as calculated, positive differences between the existing and with-program responses are considered to result in improved growth and survival for the focus fish species, and negative values indicate the bank repair actions produced inferior conditions when compared to pre-program conditions and reduced growth and survival; over a 30-day exposure period.

Analytical Surrogates for Green Sturgeon

Critical habitat for green sturgeon in the action is designated in the Sacramento River. Impacts to the southern DPS of North American green sturgeon are also estimated using an analytical surrogate; however, there is a lack of suitable data available to determine precise program impacts on green sturgeon. Although the SAM model does have a green sturgeon component, the model may not have the precision to accurately index green sturgeon responses to changes in modeled habitat attributes and a more rigorous modeling approach needs development. USACE and NMFS have been in close discussion regarding previous requirements to develop a green sturgeon HMMP, with specific elements described in several previously issued BOs (see *Section 1.8.7* above). The HMMP directive included in past BOs also required USACE to either refine the SAM, or develop an alternative green sturgeon survival and growth response model.

No benthic surveys were conducted due to high water levels in the winter of 2016/2017. However, USACE has purchased a standard Ponar sampler and other equipment to proceed with a benthic community sampling study to determine forage organisms that may inhabit the project areas and relate physical habitat characteristics that may determine forage opportunities. Following initial testing of sampling gear, USACE will develop a stratified sampling plan using bathymetry and hydraulic model outputs to identify and select appropriate sampling sites with similar flow and depth characteristics. This will allow them to determine whether there are key habitat features, which may provide suitable production or presence of prey organisms and understand how SRBPP PACR project actions may be affecting forage opportunities for green sturgeon. As of April 4, 2019, USACE plans to conduct pilot sampling to inform plan development as soon as water elevations drop enough to safely commence. Once flows subside USACE plans to sample throughout the year.

For this BO, NMFS has determined that the spatial extent of critical habitat below the ordinary high water mark (OHWM) which will be covered by bare rock revetment (*i.e.*, where there is not soil mixed in and the surface is not planted) would serve as the best analytical surrogate for impacts to all life stages of green sturgeon.

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 Part 402.02. The BO also examines the condition of critical habitat throughout the designated area, evaluates the conservation value of the various watersheds and coastal and marine environments that make up the designated area, and discusses the current function of the essential PBFs that help to form that conservation value.

Table 4. Description of species, current ESA listing classification and summary of species status.

Species	Listing Classification and Federal Register Notice	Status Summary
Sacramento River winter-run Chinook salmon (*Oncorhynchus tshawytscha*)	Endangered 6/28/2005 70 FR 37160	According to the NMFS 2016, 5-year species status review, the overall status of Sacramento River winter-run Chinook salmon has declined since the 2010 status review, with the single spawning population on the mainstem Sacramento River no longer at a low risk of extinction. New information indicates an increased extinction risk to winter-run Chinook salmon. The larger influence of the hatchery broodstock in addition to the rate of decline in abundance over the past decade has placed the population at a moderate risk of extinction and because there is only one remaining population, the extinction risk for the ESU has increased from moderate risk to high risk of extinction.
Central Valley spring-run Chinook salmon (*O. tshawytscha*)	Threatened 9/2/2005 70 FR 52488	According to the NMFS 2016, 5-year species status review, 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, Clear creeks) trending in the positive direction. Recent declines of many of the dependent populations, high pre-spawn and egg mortality during the 2012 to 2015 drought, uncertain juvenile survival during the drought are likely increasing the ESU's extinction risk.
California Central Valley Steelhead (*O. mykiss*)	Threatened 9/2/2005 70 FR 52488	According to the NMFS 2016, 5-year species status review, the status of CCV steelhead appears to have changed little since the 2011 status review that concluded that the DPS was in danger of extinction. Most wild CCV populations are very small, are not monitored, and may lack the resiliency to persist for protracted periods if subjected to additional stressors, particularly widespread stressors such as climate change. The genetic diversity of CCV steelhead has likely been impacted by low population sizes and high numbers of hatchery fish relative to wild fish. The life-history diversity of the DPS is mostly unknown, as very few studies have been published on traits such as age structure, size at age, or growth rates in CCV steelhead.
Green sturgeon (*Acipenser medirostris*)	Threatened 8/9/2009 74 FR 52300	According to the NMFS 2015, 5-year species status review, some threats to the species have recently been eliminated, such as take from commercial fisheries and removal of some passage barrier, but the species viability continues to be constrained by factors such as a small population size, lack of multiple populations, and concentration of spawning sites into just a few locations. The species continues to face a moderate risk of extinction.

Table 5. Description of critical habitat, designation details and status summary.

Species	Designation Date and Federal Register Notice	Status Summary
Sacramento River Winter-run Chinook ESU	6/16/1993 58 FR 33212	Designated critical habitat includes the Sacramento River from Keswick Dam (river mile (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. Physical and biological features 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.
Central Valley Spring-run Chinook salmon ESU	9/2/2005 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 line. In areas where the ordinary high-water line has not been defined, the lateral extent will be defined by the bankfull elevation. Physical and biological features considered essential to the conservation of the species include: spawning habitat; freshwater rearing habitat; freshwater migration corridors; and estuarine areas.
California Central Valley Steelhead	9/2/2005 70 FR 52488	Critical habitat for CCV steelhead includes stream reaches of the Feather, Yuba, and American rivers, Big Chico, Butte, Deer, Mill, Battle, Antelope, and Clear creeks, the Sacramento River, as well as portions of the northern Delta. Critical habitat includes the stream channels in the designated stream reaches and the lateral extent as defined by the ordinary high-water line. In areas where the ordinary high-water line has not been defined, the lateral extent will be defined by the bankfull elevation. Physical and biological features considered essential to the conservation of the species include spawning habitat; freshwater rearing habitat; freshwater migration corridors; and estuarine areas.

Species	Designation Date and Federal Register Notice	Status Summary
Southern Distinct Population Segment (sDPS) of North American Green Sturgeon	8/9/2009, 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. 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 also included as critical habitat for sDPS green sturgeon. Physical and biological features 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.

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 Part 402.02). The action area is not the same as the program boundary area because the action area must delineate all areas where federally listed populations of salmon, steelhead, and green sturgeon may be affected by the implementation of the proposed action.

The action area includes all the waterbodies where work will occur (listed in Table 6 and Table **7**), as well as all additional areas that may be affected by the action. These include mitigation banks, where credits may be purchased, and areas downstream of the repairs that may experience increased turbidity during the repairs. The action area includes perennial waters of the Sacramento River, American River, Feather River and certain tributaries, extending 200 feet perpendicular from the average summer-fall shoreline and up to 400 feet downstream from proposed in-water construction areas. This estimation is based on previous turbidity monitoring efforts at other SRBPP PACR sites, which found that the level of turbidity 300 feet downstream from construction resembled baseline conditions (USACE 2015).

Table 6. Approximate Location of SRBPP PACR, by River Mile.

Sacramento River	Right	51-63
	Left	45-80, 138-176
Feather River	Left	0-12
American River	Right	0-2
	Left	0-12

Table 7. Range Where Repairs May Occur Each Basin and Each Waterbody.

Econ. Justified Basin	Related Waterbodies	Downstream	Upstream
Butte Basin	Butte Creek	2mi SE of Seven Mile Rd and Goodspeed Rd	1mi SE of Midway Rd
Butte Basin	Butte Slough	~ Sac River Mile (RM) 138	1mi East on Marty Rd
Butte Basin	Cherokee Canal	1mi SW Colusa Hwy	>2mi NE Colusa Hwy
Butte Basin	Colusa Bypass	Sac RM 146 L*	Sac RM 146 L*
Butte Basin	Moulton Weir	Sac RM 158 L*	Sac RM 159 L*
Butte Basin	Mud Creek	River Road	Nord Avenue
Butte Basin	Sacramento River	Sac RM 138 L*	Sac RM 176 L*
Natomas Basin	Lower American River	American RM 0 R*	American RM 2 R*
Natomas Basin	Natomas Cross Canal	Sac RM 79 L	Pacific Ave
Natomas Basin	Natomas East Main Drainage Canal (NEMDC)	Northgate Blvd	Sankey Rd
Natomas Basin	Pleasant Grove Canal	Sankey Rd	Howsley Rd
Natomas Basin	Sacramento River	Sac RM 60 L*	Sac RM 79 L*
Rio Oso	Bear River	Bear RM 0	Bear RM 3
Rio Oso	Coon Creek Intercept	Pacific Ave	Coon Creek
Rio Oso	Feather River	Feather RM 0 L*	Feather RM 12 L*
Rio Oso	Natomas Cross Canal	Sac RM 79 L*	Pacific Ave
Rio Oso	Sacramento River	Sac RM 79 L*	Sac RM 80 L*
Rio Oso	Yankee Slough	Hwy 70	Jackson Rd
Sacramento	Sacramento River	Sac RM 45 L*	Sac RM 60 L*
Sacramento	Lower American River	American RM 0 L*	American RM 12 L*
Southport	Sacramento River	Sac RM 51 R*	Sac RM 58 R*
Southport	Sac River Deep Water Ship Channel (DWSC)	Fisher Ave	Solomon Island Rd
West Sacramento	Yolo Bypass	Sac River DWSC	County Rd 127
West Sacramento	Sacramento River	Sac RM 57 R*	Sac RM 63 R*
Yolo	Cache Creek	Yolo Bypass	County Rd 96B
Yolo	Knights Landing Ridge Cut	Yolo Bypass	Knights Landing
Yolo	Yolo Bypass	Cache Creek	Knights Landing Ridge Cut

**"L" refers to the levee on the left side of the river when looking downstream.*
**"R" refers to the levee on the right side of the river when looking downstream.*

Since the USACE may also purchase mitigation credits from one or more conservation bank over the course of the program, the action area also includes the three mitigation banks that have service areas within the potential program area. These include the Fremont Landing Conservation Bank, which is a 100-acre floodplain site along the Sacramento River (Sacramento RM 80); Bullock Bend Mitigation Bank, a 119.65-acre floodplain site along the Sacramento

River at the confluence of the Feather River (Sacramento RM 106); and Liberty Island Conservation Bank within the north Delta.

2.4 Environmental Baseline

The "environmental baseline" includes the past and present impacts of all Federal, State, or private actions and other human activities in the action area, the anticipated impacts of all proposed Federal projects in the action area that have already undergone formal or early section 7 consultation, and the impact of state or private actions which are contemporaneous with the consultation in process (50 CFR Part 402.02).

Most impacts on listed species occurred prior to the SRBPP PACR and are the result of development of the basin-wide flood control system, the SRFCP, 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, it had major effect on regeneration of riparian woodland communities, recruitment of large woody debris to the river system, spawning and rearing of fish in floodplain and floodplain functions, and allochthonous inputs of nutrients and food to the aquatic system. It 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. 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 SRBPP PACR is occurring in the Sacramento River, American River, Feather River, and other tributaries, bypasses and sloughs in the Sacramento River watershed, most of which serve as rearing habitat and migratory corridors for listed Sacramento River winter-run Chinook salmon, CV spring-run Chinook salmon, CCV steelhead, and sDPS green sturgeon. As mentioned above, much of the Sacramento River watershed has been substantially altered from human activities, and this has dramatically reduced the habitat value of the watershed 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 an important migratory corridor for SR winter-run Chinook salmon, CV spring-run Chinook salmon, CCV steelhead, and sDPS 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 can be attributed to the lower American River for CV spring-run, CCV steelhead, and sDPS green sturgeon.

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.

Anticipated climate change may affect spatial and temporal precipitation patterns along with the intensity and duration of precipitation with the Sacramento and American River watersheds. The effect of climate change is anticipated to be more winter and less spring and summer run-off within the watershed. In addition, expected run-off is anticipated to be warmer, possibly affecting the ability to meet downstream water temperature objectives to protect salmon, steelhead, and green sturgeon. This, combined with more precipitation as rain, will affect future operations of all reservoirs within the California Central Valley. A change in the run-off pattern within the Sacramento and American River watersheds will likely affect reservoir storage and downstream river flows due to more frequent spillway releases.

The Sacramento River Flood Protection Project impacts the natural meander and ecosystem of the Sacramento and American Rivers, included in the SRBPP PACR action area. Downstream from the American River confluence, the Sacramento River is moderately sinuous, with the channel confined on both sides by man-made levees enhanced and repaired over the decades. The channel in this reach is 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 and Nimbus Dams.

USACE proposes to use the Interagency Working Group (IWG) to support an independent re-analysis of the 1992 SRBPP Cache Slough/Yolo Bypass Cross-Levee Project in Solano County, California to determine how many excess conservation credits may be applied to future SRBPP PACR compensation needs. The Cache Slough, built in 1992, provides in-kind mitigation for adverse impacts to Delta smelt habitat. The site is comprises 176 acres, with 12,000 LF of exterior bank line and 138 acres of wetted area. It is located within designated Delta smelt critical habitat on Cache Slough in the northern Sacramento-San Joaquin Delta, west of the Sacramento River, approximately eight miles north of Rio Vista. The site is owned and maintained by DWR, with the purpose of supplying advanced mitigation credits to address off-site mitigation requirements for SRBPP actions where compensation for habitat loss cannot be completed on-site. However, there exists no formal agreement between NMFS, USACE and DWR regarding the disposition of “credits” for NMFS-listed species and this analysis considers the beneficial effects of the 1992 SRBPP Cache Slough/Yolo Bypass Cross-Levee Project to reside in the Environmental Baseline. As such, the NMFS will not support or engage in an effort to analyze the applicability of credits toward future SRBPP PACR actions.

2.4.1 Land Cover

The Sacramento River watershed historically supported an extensive range of riparian habitat and marshes. Today, the Sacramento River Basin includes several distinct ecosystems, including wetlands, riparian habitats, irrigated agriculture, annual grasslands, and valley oak woodland.

Eight land cover types were identified in the SRBPP PACR program area: riparian forest (35%), riparian scrub-shrub (7%), riparian herbaceous (18%), emergent marsh (5%), bare ground (2%), agricultural (31%), ruderal vegetation (0%), and urban (3%).

Riparian forest typically has a dominant overstory of cottonwood, California sycamore (*Platanus racemosa*), and valley oak (*Quercus lobata*). Species found in the scrub-shrub will make up the sub canopy and could also include white alder 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 are also found in riparian communities.

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 USACE, 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-natives 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 SRBPP PACR 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).

Riparian recruitment and establishment models (Mahoney 1998); (Bradley 1986) and empirical field studies (Scott 1997); (Scott 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 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.

2.4.2 Previous SRBPP Flood Management Actions

The environmental baseline also includes past and present flood management actions within the SRBPP action area.

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. Construction for Phase II started in 1976 and is on-going. An additional 80,000 LF was added to Phase II by the Water Resources Development Act (WRDA) of 2007, and is the authorization for the proposed action that is the subject of this consultation. A third phase may continue bank protection after the completion of Phase II, but currently, the scope of Phase III is being determined by USACE and the CVFPB.

SRBPP Phase I

Construction for the SRBPP Phase I included 11 rivers and waterways: 1) 3-Mile Slough; 2) American River; 3) Bear River; 4) Elder Creek; 5) Feather River; 6) Georgiana Slough; 7) Miner Slough; 8) Sacramento River; 9) South Dry Creek; 10) Steamboat Slough; and 11) Sutter Slough. These are described in greater detail below.

1. **3-Mile Slough** – Repairs at this location took place starting in 1963 and concluded by 1970. The repairs primarily took place at 8 sites on approximately 4,500 non-contiguous LF on the left bank of the waterway. The areas repaired began at approximately RM 1.07 and included locations to RM 1.7. Repairs consisted of quarry stone bank revetment.
2. **American River** – Repairs on the American River took place starting in 1965 and concluding by 1970. The repairs took place at 3 sites on approximately 3,000 non-contiguous LF on the right and left banks of the waterway. The areas repaired began at approximately RM 4.8 and included locations to RM 5.84. Repairs consisted of quarry stone bank revetment.
3. **Bear River** – Repairs at this location took place starting in 1965 and concluded by 1967. The repairs took place at 9 sites on approximately 8,000 non-contiguous LF on the right and left banks of the waterway. The areas repaired began at approximately RM 1.76 and included locations to RM 11.6.
4. **Elder Creek** – Repairs on Elder Creek took place starting in 1965 and concluding by 1969. The repairs took place at 13 sites on approximately 14,000 non-

contiguous LF on the right and left banks of the waterway. The areas repaired began at approximately RM 0.2 and included locations to RM 1.85.

5. **Feather River** – Repairs at this location took place starting in 1965 and concluded by 1968. The repairs took place at 13 sites on approximately 14,000 non-contiguous LF on the right and left banks of the waterway. The areas repaired began at approximately RM 1.9 and included locations to RM 49.6. Repairs consisted of cobble and quarry stone bank revetment.
6. **Georgiana Slough** – Repairs on Georgiana Slough took place starting in 1965 and concluded by 1974. The repairs took place at 12 sites on approximately 7,000 non-contiguous LF on the right and left banks of the waterway. The areas repaired began at approximately RM 4.0 and included locations to RM 10.1. Repairs consisted of quarry stone bank revetment.
7. **Miner Slough** – Repairs at this location took place starting in 1966 and concluded by 1974. The repairs took place at 12 sites on approximately 10,000 non-contiguous LF on the left bank of the waterway. The areas repaired began at approximately RM 0.6 and included locations to RM 5.2. Repairs consisted of quarry stone bank revetment.
8. **Sacramento River** – Repairs on the Sacramento River took place starting in 1963 and concluded by 1975. The repairs took place at 280 sites on approximately 332,000 non-contiguous LF on the right and left banks of the waterway. The areas repaired began at approximately RM 12.4 and included locations to RM 165.1. Repairs on sites from RM 77.6L and down consisted of quarry stone riprap whereas repairs on sites from RM 77.6L and up consisted of quarry stone riprap or cobble stone bank revetment.
9. **South Dry Creek** – Repairs at this location took place at 3 sites on approximately 4,000 non-contiguous LF on the left bank of the waterway. The areas repaired began at approximately RM 1.3 and included locations to RM 3.5.
10. **Steamboat Slough** – Repairs on Steamboat Slough took place at 41 sites starting in 1966 and concluded by 1974. The repairs took place on approximately 29,000 non-contiguous LF on the right and left banks of the waterway. The areas repaired began at approximately RM 15.3 and included locations to RM 25.0. Repairs consisted of quarry stone bank revetment.
11. **Sutter Slough** – Repairs at this location took place at 18 sites starting in 1963 and concluded by 1974. The repairs took place on approximately 10,000 non-contiguous LF on the right and left banks of the waterway. The areas repaired began at approximately RM 22.0 and included locations to RM 28.1. Repairs consisted of quarry stone bank revetment.

In Phase I of SRBPP, repairs of about 430,000 LF of levee consisted mainly of quarry stone and bank revetment, and no mitigation was provided for fish and wildlife habitat losses from the construction of bank protection.

SRBPP Phase II

In 1974, repair of 405,000 LF was authorized for SRBPP Phase II. Construction began in 1976 and, as of December 2011, through multiple construction and multiple design contracts, 404,367 LF has been repaired, leaving 633 LF remaining out of the authorized 405,000 LF. Table 8 is a summary of linear feet of bank protection constructed annually. The overall SRBPP program, area is the same for Phase I and Phase II. However, Phase II site locations vary from the Phase I site locations because erosion problems occurred at different locations throughout the program area.

Table 8. Linear Feet of Bank Protection Constructed Annually under the SRBPP.

Year	Bank Protection Constructed	Total Bank Protection Constructed	Bank Protection Remaining
1975	0	0	405,000
1976	54,955	54,955	350,045
1977	11,955	66,910	338,090
1978	21,802	88,712	316,288
1979	35,519	124,231	280,769
1980	5,745	129,976	275,024
1981	18,763	148,739	256,261
1982	32,458	181,197	223,803
1983	0	181,197	223,803
1984	3,100	184,297	220,703
1985	43,683	227,980	177,020
1986	0	227,980	177,020
1987	31,222	259,202	145,798
1988	11,161	270,363	134,637
1989	42,431	312,794	92,206
1990	0	312,794	92,206
1991	0	312,794	92,206
1992	529	313,323	91,677
1993	0	313,323	91,677
1994	0	313,323	91,677
1995	6,855	320,178	84,822
1996	0	320,178	84,822
1997	689	320,867	84,133
1998	0	320,867	84,133
1999	11,044	331,911	73,089
2000	0	331,911	73,089
2001	9,800	341,711	63,289
2002	700	342,411	62,589
2003	16,500	358,911	46,089
2004	0	358,911	46,089
2005	0	358,911	46,089
2006	13,664	372,575	32,425

Year	Bank Protection Constructed	Total Bank Protection Constructed	Bank Protection Remaining
2007	11,300	383,875	21,125
2008	5,734	389,609	15,391
2009	8,203	397,812	7,188
2010	1,200	399,012	5,988
2011	2,607	401,619	3,381
2012	0	401,619	3,381
2013	0	401,619	3,381
2014	0	401,619	3,381
2015	1,546	403,165	1,835
2016	687	403,852	1148
2017	515	404,367	633
Total:	404,367		
Authorized:	405,000		

Construction for the SRBPP Phase II included 15 rivers and waterways: 1) American River; 2) Bear River; 3) Cache Creek; 4) Cache Slough; 5) Colusa Basin; 6) Elder Creek; 7) Elk Slough; 8) Feather River; 9) Georgiana Slough; 10) Miner Slough; 11) Murphy's Slough; 12) Sacramento River; 13) Steamboat Slough; 14) Sutter Bypass; and 15) Sutter Slough. These are each described in greater detail below.

1. **Lower American River** – Repairs on the American River took place starting in 1996 and concluded by 2012. The repairs took place at 9 sites on approximately 12,000 non-contiguous LF on the waterway. The sections of the Lower American River repaired were: RM 0.3L, 2.0L, 2.8L, 3.7L, 4.5L, 6.8L, 8.7R, 10.0L, and 10.6L.
2. **Bear River** – Repairs at this location took place in 1976. The repairs took place at 1 site on approximately 650 non-contiguous LF on the left bank of the waterway. The areas repaired began at approximately RM 0.3.
3. **Cache Creek** – Repairs on Cache Creek took place in 2006. The repairs took place at 3 critical emergency erosion sites on approximately 2,720 non-contiguous LF on the left bank of the waterway. Three setback levees were constructed at levee mile (LM) 0.8, LM 1.1 and LM 2.4.
4. **Cache Slough** – Repairs at RM 21.8 were completed in 2008. The site is approximately 1,040 LF on the right bank of the waterway on Hastings Island.
5. **Colusa Basin** – Repairs at this location took place starting in 2001 and concluded by 2003. The repairs took place at 1 site on approximately 26,000 non-contiguous LF on the waterway.
6. **Elder Creek** – Repairs on Elder Creek took place in 1976. The repairs took place at 2 sites on approximately 1,600 non-contiguous LF on the right bank of the waterway. The areas repaired began at approximately RM 2.09 and included locations to RM 3.83.
7. **Elk Slough** – Repairs on Elk Slough took place in 1982. The repair took place at 1 site on approximately 300 LF on the left bank of the waterway near RM 2.1.

8. **Feather River** – Repairs at this location took place starting in 1977 and concluded by 2012. The repairs took place at sites approximately 19,000 non-contiguous LF mostly on the left bank of the waterway. Three sections recently repaired were: RM 5.5L, 7.0L, and 28.5R.
9. **Georgiana Slough** – Repairs on Georgiana Slough took place starting in 1978 and concluded by 1985. The repairs took place at 13 sites on approximately 17,000 non-contiguous LF on the right and left banks of the waterway. The areas repaired began at approximately RM 1.3 and included locations to RM 12.3. Repairs consisted of quarry stone riprap.
10. **Miner Slough** – Repairs at this location took place starting in 1983 and concluded by 1997. The repairs took place at 11 sites on approximately 7,000 non-contiguous LF on the right and left banks of the waterway. The areas repaired began at approximately RM 1.0 and included locations to RM 7.6. Repairs consisted of quarry stone riprap.
11. **Murphy's Slough** – Repairs on Murphy's Slough were completed at one location in 1976. The repair area was approximately 300 LF on the left bank of the waterway.
12. **Sacramento River** – Repairs on the Sacramento River took place starting in 1976 and the most recent repairs continuing into 2017. The repairs took place at approximately 300 sites on approximately 260,000 non-contiguous LF on the right and left banks of the waterway. The areas repaired began at approximately RM 8.5 and included locations to RM 191.6. Repairs consisted of stone riprap covered with soil filled quarry stone and planted with native riparian species. Sites completed as of 2017 include: RM 16.8L,16.9L, 26.9L, 33.0R, 33.3R, 34.5R, 42.7R, 43.7R, 44.7R, 47.0L, 47.9R, 48.2R, 49.6L, 49.7L, 49.9L, 50.2L, 50.4L, 50.8L, 51.5L, 52.3L, 52.4L, 53.1L, 53.5R, 56.7L, 62.5R, 68.9L, 71.3R, 72.2R, 73.5L, 78.0L, 87.0L, 93.7L, 99.3R, 114.5R, 123.5L, 136.7R, 136.9R, 149.0L, and 177.8R.
13. **Steamboat Slough** – Repairs at this location took place starting in 1976 and concluded by 2009. The repairs took place at 41 sites on approximately 33,000 non-contiguous LF on the right and left banks of the waterway. The areas repaired began at approximately RM 15.7 and included locations to RM 26.0R. Sites recently completed were: 16.6R, 19.0R, 19.4R and 22.7R. Repairs consisted of stone riprap covered with soil filled quarry stone and planted with native riparian species.
14. **Sutter Bypass** – Repairs at RM 0.4.E took place in 2009. The site is approximately 365 LF on the left bank of the waterway.
15. **Sutter Slough** – Repairs at this location took place starting in 1983 and concluded by 1997. The repairs took place at 36 sites on approximately 22,000 non-contiguous LF on the right and left banks of the waterway. The areas repaired began at approximately RM 21.9 and included locations to RM 28. Repairs consisted of quarry stone riprap.

Mitigation for Phase II bank protection is an improvement over Phase I. In order to address impacts to species listed under the ESA and impacts to their designated critical habitat, Phase II bank protection has attempted preservation of riparian and riverine habitat through avoidance

and on-site mitigation. Although this approach was applied for several years, the ETL has affected the ability for USACE to preserve onsite vegetation and reduced the amount of on-site mitigation.

Most recently, the 2008 programmatic BO consulted on and authorized BPMs for a list of sites shown below in Table 9. These recently constructed sites will further inform the understanding of the environmental baseline in the program action area. The sites located within the EJB, and thus directly within the program action area, are in bold font.

Table 9. Sites Consulted on under the 2008 Programmatic Biological Opinions.

	RM	Bank	LF	BO (#sites)	Year Constructed	Post Con Report
Sacramento River	16.8	L	650	2008-13 sites	2015	NA
	26.0	L	1546	Solo	2016	NA
	35.4	L	1070	2009-12 sites	Not Started	NA
	42.7	R	198	2008-13 sites	2009-10	2009
	49.7	**L**	**285**	**2008-13 sites**	**2008-9**	**2009**
	52.3	**L**	**1320**	**2008-13 sites**	**2008-9**	**2008**
	53.5	**R**	**322**	**2008-13 sites**	**2008-9**	**2008**
	55.2	**L**	**730**	**2008-13 sites**	**Not Started**	**NA**
	57.2	**R**	**1200**	**Solo**	**2012-2013**	**NA**
	71.3	**L**	**515**	**Solo**	**2017**	**NA**
	73.5	**L**	**1088**	**2009-12 sites**	**2009-10**	**2009**
	77.2	**L**	**607**	**2008-13 sites**	**2011**	**2011**
	87.0	L	750	2009-12 sites	2009-10	2009
	93.7	L	1050	2009-12 sites	2009-10	2009
	114.5	R	1500	2009-12 sites	2009-10	2009
	136.7	R	300	2009-12 sites	2009-10	2009
	136.9	R	900	2009-12 sites	2009-10	2009
	177.8	R	1068	2008-13 sites	2008-9	2008
Feather River	**5.5**	**L**	**833**	**2009-12 sites**	**2009-10**	**2009**
	7.0	**L**	**887**	**2009-12 sites**	**2011**	**2011**
	28.5	R	1219	2008-13 sites	2009-10	2009
American River	**0.3**	**L**	**517**	**2008-13 sites**	**2008-9**	**2008**
	2.8	**L**	**472**	**2008-13 sites**	**2008-9**	**2008**
	10.0	**L**	**502**	**2009-12 sites**	**2011**	**2011**
	10.6	**L**	**611**	**2009-12 sites**	**2011**	**2011**
Steamboat Slough	16.6	R	708	2008-13 sites	2008-9	2008
Cache Slough	21.8	R	1042	2008-13 sites	2008-9	2008
Sutter Bypass	0.4	R	365	2009-12 sites	2009-10	2009
	Total LF		**22255**		**EJB LF**	**9889**

SRBPP Environmental Impacts and Mitigation

Mitigation for environmental impacts of bank protection has improved with SRBPP Phase II, reflecting the developing understanding of the status and survival requirements of listed fish species. However, to date, compensatory mitigation has been directed solely at site-level impacts. The Sacramento River is highly fragmented and disconnected from ecological processes, and much of this is the result from river erosion and meandering being halted by rock riprap bank protection (USFWS 2004). As of 2004, of the lower 194 miles of the Sacramento River, over half of the river's banks have been riprapped (*i.e.*, covered with bare rock), and this is mainly due to four decades of work under the SRBPP (USFWS 2004). Note that this figure was taken from a 2004 report, and more riprap has been installed since then, causing further harm to listed species and impacts to their critical habitat.

Although site-level impacts have been addressed from compensatory mitigation associated with the SRBPP, 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 percent, or more, compared to pre-SRBPP conditions" (USFWS 2004).

Loss of IWM negatively impacts salmonids through multiple phases of their life history. Schaffter, Jones 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 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 & 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, Bilby 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 & 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. Sacramento River winter-run

Chinook salmon, CV spring-run Chinook salmon, CCV steelhead, and sDPS 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.

In addition to impacts associated with ecosystem-wide loss of IWM, there are additional ecosystem-wide impacts associated with large-scale riprapping from the SRBPP. Riprapping has been shown to reduce recruitment of spawning gravel for salmonids, which was especially impactful during SRBPP phases upstream under the Sacramento River, Chico Landing to Red Bluff Project (USFWS 2004). 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 (Welcomme 1979, USFWS 2004). 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 USACE Vegetation Policy

The continuation of the USACE 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 SRBPP program action 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 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.*

FER-1.8 (Priority 1): *Implement the lower Feather River Corridor Management Plan and other projects that promote natural river processes (e.g., floodplain and riparian restoration). Federal, State and local agencies should use their authorities to develop and implement programs and projects that focus on retaining, restoring and creating active floodplain and riparian corridors within their jurisdiction in the Feather River watershed.*

FER-1.9 (Priority 2): *Implement projects to improve near shore refuge cover for salmonids in the Feather River to minimize predatory opportunities for striped bass and other non-native predators.*

FER-2.6 (Priority 2): *Utilize fish friendly designs (e.g., levee setbacks, inclusion of riparian vegetation) for levee construction and maintenance.*

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.

2.4.3 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 0 to RM 184, and the lower reaches 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 CV spring-run Chinook salmon, Sacramento River winter-run Chinook salmon, CCV steelhead, and sDPS 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. 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 for by NMFS 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. Only a few of the Core 1 populations meet the long-term objective of low extinction risk; the remaining Core 1 populations have the potential to do so.

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 and the Northern Sierra Nevada Diversity group. Within the action area, there are both "Core 1" and "Core 2" populations of CV spring-run Chinook salmon, as designated for by NMFS recovery plan for the species (NMFS 2014). Core 1 populations were described above. Core 2 populations meet, or have the potential to meet, the biological recovery standard for moderate risk of extinction. 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.

Presence of CCV 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 SRBPP PACR 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 CCV 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 CCV 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 CCV steelhead DPS occurs in both the Sacramento River and the surrounding watersheds.

The action area contains CCV steelhead from the Basalt and Porous Lava Diversity group and the Northern Sierra Nevada Diversity group (*i.e.*, American and Feather Rivers). Within the action area, there are both "Core 2" and "Core 3" populations of steelhead, as designated by NMFS Recovery Plan for the species (NMFS 2014). Core 2 populations were described above. Core 3 watersheds have populations that are present on an intermittent basis and require straying from other nearby populations for their existence. 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 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 from the sDPS 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.

2.4.4 Status of Critical Habitat within the Action Area

The SRBPP PACR encompasses areas within the SRBPP program area, which includes over 1,000 miles of levees and weirs. This area extends south-to-north along the Sacramento River, from the Town of Collinsville (RM 0) upstream to Chico at RM 184. The SRBPP also includes Cache Creek, the lower reaches of Elder and Deer Creeks, the lower reaches of the American River (RM 0-23), Feather River (RM 0-61), Yuba River (RM 0-11), and Bear River (RM 0-17), portions of Three mile, Steamboat, Sutter, Miner, Georgiana, and Cache Sloughs, as well as a number of flood bypasses and distributaries. The SRBPP PACR action area occurs within this program area, and includes the mainstem Sacramento River (as far south as Collinsville up to Chico), Yolo and Sacramento Bypasses, the lower American River, and numerous tributaries (for a full visual representation of the program vicinity, see Figures 1, 2, and 3). Designated critical habitat for Sacramento River winter-run Chinook salmon (June 16, 1993, 58 FR 33212), CV

spring-run Chinook salmon (September 2, 2005, 70 FR 52488), CCV steelhead (September 2, 2005, 70 FR 52488) and the sDPS of green sturgeon (October 9, 2009, 74 FR 52300) occur in the SRBPP PACR action area.

The PBFs essential to the conservation of Sacramento River winter-run Chinook salmon, CV spring-run Chinook salmon, and CCV 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 features of the PBFs essential to the conservation of Sacramento River winter-run Chinook salmon, CV spring-run Chinook salmon, and the CCV steelhead DPS 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. CCV 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 habitat 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 Sacramento River winter-run Chinook salmon, CV spring-run Chinook salmon, CCV steelhead, and sDPS 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 SRBPP PARC program. The SRBPP PACR action area encompasses a large 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 72^{o}F (22.2^{o}C), and create a thermal barrier to the migration of adult and juvenile salmonids (Kjelson 1982). In addition, water diversions at the dams (*e.g.*, Friant, Goodwin, La Grange, Folsom, Nimbus, and other dams) 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 sites 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, such as migration barriers, water conveyance factors, water quality, *etc.*, 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 sDPS green sturgeon. In addition, channelization and removal of riparian vegetation and IWM have greatly reduced access to floodplain and off-channel rearing habitat, 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 sDPS 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).

2.4.5 Mitigation Banks and the Environmental Baseline

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 Sacramento River winter-run Chinook salmon, CV spring-run Chinook salmon, and CCV steelhead. 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 68 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 sDPS 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.

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 Sacramento River winter-run Chinook salmon, CV spring-run Chinook salmon, and CCV steelhead. There are off-channel shaded aquatic habitat credits, SRA habitat credits, and floodplain credits available. To date, there have been less than 25 percent of the 100 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.

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 Sacramento River winter-run Chinook salmon, CV spring-run Chinook salmon, and CCV steelhead. There are salmonid floodplain restoration, salmonid floodplain enhancement, and salmonid riparian forest credits available. To date, there have been approximately 10 percent of 119.65 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" means the direct and indirect effects of an action on the species or critical habitat, together with the effects of other activities that are interrelated or interdependent with that action, that will be added to the environmental baseline (50 CFR Part 402.02). Indirect effects are those that are caused by the Proposed Action and are later in time, but still are reasonably certain to occur.

To evaluate the effects of the SRBPP PACR programmatic, NMFS examined the proposed BPM designs, the site selection process, and the possible locations. We also reviewed and considered the USACE's proposed conservation measures. This assessment relied heavily on the information from the USACE's BA. As a framework programmatic consultation, without exact sites or designs within the action area, NMFS assumed SAM outputs that were analyzed for previously repaired sites of the Phase I repair program, were a good representation to extrapolate to the total proposed program impact length. A more detailed description of this analysis can be found below in the section entitled *Use of Representative Sites to Estimate Effects*.

The assessment will consider the nature, duration, and extent of the potential actions relative to the migration timing, behavior, and habitat requirements of federally-listed Sacramento River winter-run Chinook salmon, CV spring-run Chinook salmon, CCV steelhead, and sDPS of North American green sturgeon. Specifically, this assessment will consider the potential impacts

resulting from the construction and subsequent O&M activites at a framework level. Effects of the SRBPP PACR on aquatic resources include both short- and long-term impacts. Short-term effects, which are related primarily to construction activities, may last several hours to several weeks. Some long-term effects are expected to last years to decades, and generally involve physical alteration of the riverbank and riparian vegetation adjacent to the water's edge, while other long-term effects are expected to continue indefinitely, including the continued blockage to floodplain habitat.

The SAM model has previously been used to quantify impacts to the green sturgeon, but its utility is limited to assessing nearshore habitat. There is currently no model that can evaluate the effects of bank stabilization projects on habitats below seasonal water surface elevations or on the benthic habitat that green sturgeon utilize. As part of the HMMP, USACE will either refine the SAM to evaluate impacts to benthic habitat, or develop a new model that will evaluate the effect of levee repair projects on green sturgeon. Similarly, the effects of bank armoring below seasonal water surface elevations on salmon and steelhead are not well captured by the SAM.

Further bank armoring and levee repairs will contribute to the continued confinement of the riverine system, blocking rearing juveniles from the floodplain, which in turn negatively affects listed fish species and their designated critical habitat.

2.5.1 Program Effects for Salmonids and Green Sturgeon

NMFS expects that juvenile winter-run Chinook salmon, juvenile spring-run Chinook salmon, adult and juvenile CCV steelhead, and adult and juvenile green sturgeon will be present in the action area during construction activities, although in low numbers because the construction window avoids periods of peak abundance. No spawning habitat for winter-run Chinook salmon, spring-run Chinook salmon, or green sturgeon is present in the action area and, therefore no adverse effects to spawning adults or incubating eggs are expected. The action area overlaps with potential spawning habitat for steelhead in the American River from RM 0-12, however, spawning in this area is considered rare and the construction window avoids spawning season.

Direct effects of the proposed action associated with in-river construction work will involve equipment and activities that will produce sound pressure waves, and create underwater noise and vibration, thereby temporarily altering in-river conditions. Hydroacoustic pressure impulses can affect behavior of fish and may result in physical injury such as tissue damage, hearing loss, or death (Popper and Hastings 2009). Any alteration in behavior or physical injury can increase the chance of predation due to disorientation, the ability to feed, or migrate. Only those fish that are holding adjacent to or migrating past the levee repair site will be directly exposed or affected by construction activities. Those fish that are exposed to the effects of construction activities will encounter short-term (i.e., minutes to hours) construction-related noise and physical disturbance. Construction disturbance can cause injury or harm by increasing the susceptibility of some individuals to predation by temporarily disrupting normal sheltering behaviors. These changes can also impair feeding behaviors, which in turn impact their ability to grow and survive. Juvenile fish are the most vulnerable to these changes, since adults are better able to quickly swim away from the construction sites and escape injury. Any fishes that do not avoid the worksite during construction could potentially be crushed or injured by construction equipment or personnel.

Toxic substances used at construction sites, including gasoline, lubricants, and other petroleum-based products could enter the waterway as a result of spills or leakage from machinery and injure listed salmonids and green sturgeon. Petroleum products also tend to form oily films on the water surface that can reduce dissolved oxygen available to aquatic organisms. The exposure to these substances can kill fishes directly in high enough concentrations through acute toxicity or suffocation from lack of oxygen. These chemicals may also kill the prey of listed fish species, reducing their ability to feed and therefore grow and survive. However, due to adherence to proposed project BMPs that dictate the use, containment, and cleanup of contaminants, there is very low risk of toxic substances affecting fishes at the construction site.

Turbidity and sedimentation events are not expected to affect visual feeding success of green sturgeon, as they are not believed to utilize visual cues (Sillman et al. 2005). Green sturgeon, which can occupy waters containing variable levels of suspended sediment and thus turbidity, are not expected to be impacted by the slight increase in the turbidity levels anticipated from the proposed program activities. Increases in turbidity can harm salmonids by temporarily burying submerged aquatic vegetation that supports invertebrates for feeding juvenile fishes, leading to reduced growth and survival. High turbidity can also damage a fish's gills, interfere with cues necessary for orientation in homing and migration, and reduce available spawning habitat (Bash et al. 2001). However, BMPs in place for the SRBPP PACR program are expected to greatly reduce the severity and duration of increased turbidity caused by program activities, such that turbidity levels are expected to have minor effects to listed fish species, primarily resulting in behavioral modifications.

NMFS expects that actual physical damage or harassment may occur to listed fish species, but will be low due to the timing of the construction. Impacts to adults due to construction are expected to be especially minor because their size, preference for deep water, and their crepuscular migratory behavior will enable them to avoid most temporary, nearshore disturbance that occurs during typical daylight construction hours.

Ecological Effects Related to Ecological Changes to Riparian Habitat and Function

Loss of riparian habitat is a key driver to many of the negative short- and long-term impacts of the SRBPP PACR. The existence and continual establishment of vegetation in proximity to streams and rivers is essential to maintain functioning riparian habitats (Boyer *et al.* 2003). Intact riparian habitat performs many functions essential to fish growth and productivity, and is critical in supporting suitable instream conditions necessary for the survival and recovery of imperiled native salmonid stocks. Vegetated riparian areas provide the following ecosystem services:

- Shade channels maintaining cool water temperatures and retaining dissolved oxygen levels.
- Stabilize channel banks and control bank erosion and sedimentation.
- Provide overhead cover and refuge for juvenile salmonids that reduce predation.
- Reduce velocities along channel margins preferred by newly emerged fry and yearling salmonids.

- Contribute small organic matter (*e.g.*, leaves, twigs, grasses, and insects) to channels and support primary and secondary production.
- Capture organic matter and wood from upstream sources, increasing surface areas for primary and secondary production.
- Provide trees that fall into channels and influence river geomorphology, creating complex habitats, including pools, riffles, debris collections, backwater, and off-channel habitat that are necessary to fish for cover, holding, spawning, rearing, and protection from predators.
- Filter stormwater runoff, capturing sediments and pollutants from upslope areas and thereby assisting in water quality maintenance.
- Provide low velocity areas that allow deposition of fine sediments during overbank flows.
- Reduce flood flow velocities and create micro-currents that provide fish near-channel holding areas to rest and maintain their position in a stream reach during flooding.

Each of these functions support the ability of a reach to contribute to the salmonid life histories expressed in those reaches. A diverse assemblage of native riparian vegetation can appreciably increase instream habitat conditions, and enhance bank integrity (Shields 1991). Riparian vegetation has a profound effect on the stability of both cohesive and non-cohesive soils. Wynn *et al.* (2004) found that at sites where banks are nearly vertical, woody vegetation may provide better protection against scour of the bank toe. Woody vegetation also provides greater geotechnical reinforcement of stream banks by serving as an effective buffer between the water and the underlying soil. It increases flow resistance, which reduces flow velocity, thereby greatly reducing erosion (Fischenich 2001).

Streamside vegetation is an important source of energy for the maintenance of invertebrates and fish. Instream communities are highly dependent on leaf litter from streamside forests for maintaining metabolism and ecosystem structure. Robust vegetation along the water's edge dramatically increases the input of terrestrial invertebrates into aquatic systems (Fischenich 2001, Florsheim *et al.* 2008). Roots uptake elements from the soil and bedrock, then deliver them to the stream through the process of decay (Fischenich & Copeland 2001). Roots, stems, logs, and organic debris such as leaves provide colonization sites through increased surface area, and velocity refuge for algae and macro invertebrates (Fischenich 2001, Florsheim *et al.* 2008).

Aquatic macroinvertebrate diversity and density are higher in streams with wider riparian areas (Newbold *et al.* 1980, as cited in Florsheim *et al*. 2008). Organic matter delivered from site-level riparian areas, or accumulated within edge habitat from upstream sources, is a food source for macro-invertebrates (Fischenich 2001). In floodplain channels, which frequently have a high fluvial transport potential, floodplain forests are an important source of immobile wood that provide, among other functions, forage species colonization sites. Riparian vegetation is a vital source of energy for invertebrates and fishes (Fischenich 2001).

Standard Assessment Methodology Analysis

The SAM provides a framework to quantitatively assess both short and longer-term impacts of the SRBPP PACR proposed actions. See Section 2.1.1 *Use of Analytical Surrogates* for an in-depth description of SAM analysis. Due to the programmatic nature of the SRBPP PACR, the

final type and location of BPMs cannot be determined in advance, which creates a challenge in describing the potential effects. In an effort to evaluate project effects, the results of previous Phase I SRBPP repair sites was provided as a representation of the more recent designs being utilized by the SRBPP (See Appendix A SRBPP PACR 2019 BA). Each site will have a separate SAM analysis performed once a more detailed design is presented, and effects will be consulted on through this programmatic on a site-by-site basis.

2.5.2 Program Effects on Critical Habitat

A majority of the action area overlaps with designated critical habitat for all of the following listed fish species: winter-run Chinook salmon, CV spring-run Chinook salmon, CCV steelhead, and sDPS green sturgeon. Therefore, usage of most of the BPMs presented can cause significant effects on PBFs of critical habitat. However, without prior knowledge of what Measures will be selected the full extent of these impacts cannot be determined in advance.

Impacts due to construction are expected to temporarily impact PBFs of critical habitat including rearing and migratory corridor from potential releases of toxic substances, increases in turbidity, and increases in underwater noise. Described above in the Section 2.5.1 *Construction Impact Analysis for Salmonids and Green Sturgeon*, the BMPs utilized by the SRBPP PACR program are expected to prevent these impacts from permanently degrading the PBFs of critical habitat for winter-run Chinook salmon, CV spring-run Chinook salmon, CCV steelhead, and sDPS green sturgeon. Further analysis of long-term impacts to critical habitat described below, include the removal of SRA habitat, removal of IWM, and installation of rock revetment.

Critical Habitat for Sacramento River Winter-Run Chinook, CV Spring-Chinook Salmon, and CCV Steelhead

SAM results of the previously repaired sites under this program demonstrate short-term effects to PBFs, with many effects not persisting for greater than 10 years. This analysis of previous sites can only be looked at as a potential outcome for future sites, and still demonstrates significant short-term effects on the following PBFs. For all salmonid species, habitat deficits are greater in the fall and summer than in winter and spring due to greater shade reductions. Habitat deficits for fry/juvenile rearing and juvenile (smolt) migration will occur in all seasons due to reductions of instream, shoreline vegetation, and overhead cover. Habitat deficits for juvenile migration will generally persist beyond project construction in all regions. For winter-run Chinook, habitat deficits for fry/juvenile rearing will generally result in short-term and longer-term habitat deficits in all seasons in Regions 1B and 3. Winter-run Chinook are not expected to occur at any of the representative erosion sites in the analysis within Region 2, so no results were calculated for winter-run Chinook in Region 2. For CV spring-run Chinook and CCV steelhead, habitat deficits for fry/juvenile rearing will generally persist in Regions 1B, 2, and 3.

The proposed SRBPP PACR is expected to significantly impact several of the essential features (PBFs) of critical habitat for winter-run Chinook salmon, CV spring-run Chinook salmon, and CCV steelhead, particularly freshwater rearing habitat and migration corridors for juvenile salmon and steelhead. The PBF of freshwater rearing habitat refers to water quantity and floodplain connectivity that supports juvenile growth and mobility; water quality and forage supporting juvenile development; and natural cover such as shade, large wood, and aquatic

vegetation, and undercut banks. Similarly, The PBF of migratory corridors refers to rivers and creeks that are free from obstruction and excessive predation with natural cover such as large wood, aquatic vegetation, and undercut banks that support juvenile survival (NMFS 2014).

The SRBPP PACR program as described will remove some portion of riparian habitat and IWM, depending on the site-specific details and designs chosen. With NMFS involvement in the PDT and PED design process, impacts are expected to be minimized to the extent possible, and unavoidable impacts will be mitigated, as described in the mitigation process outlined in the proposed action. Riparian habitat, especially the SRA component, is important for rearing and out-migrating juvenile salmonids because it enhances the aquatic food webs and provides high-value feeding areas. Once in the river channel, stems, trunks, and branches become very important structural habitat components for aquatic life. Many of the aquatic invertebrates that are primary food sources for juvenile salmon and steelhead live on woody debris. In some cases, the reproductive cycles of macroinvertebrates rely on IWM, as their eggs are laid and develop inside fallen logs and are eventually available to be eaten by fishes. The removal of riparian habitat will greatly degrade these habitat attributes, leading to a reduction of food, and thereby a reduction in growth and survival for juvenile salmon and steelhead.

Riparian shade can be critical in preventing diurnal thermal maxima from reaching dangerous levels, thereby extending the usable season for small streams (Maslin, Lennon et al. 1997). Trees and shrubs growing along riverbanks provide microclimates of cooler water temperatures during the hot summer months where many fishes will congregate to feed and seek cover. Therefore, the removal of riparian habitat will degrade the PBFs of freshwater rearing and migratory corridors by increasing temperatures to harmful and potential lethal levels. The SRBPP PACR program will also lead to an increase in predation of juvenile salmonids through both the removal of IWM, which serves as cover from predation, and the installation of rock revetment, the preferred habitat of ambush predators of salmonids. The program will also perpetuate the confinement of rivers within their banks, reducing connectivity with adjacent floodplains that could serve as rearing habitat.

The PBF of migratory corridors for adults is not expected to be impacted, as migrating adult Chinook and steelhead prefer deeper water and are unlikely to use the nearshore habitat that will be affected by this program. Furthermore, the site will not install any features that are expected to block or impede juvenile or adult migration. There is no spawning habitat for winter-run Chinook salmon or spring-run Chinook salmon in the action area. Although steelhead spawning has been documented in a reach of the American River that overlaps with the action area, spawning in this area is considered uncommon, as the potential spawning area is very small and the channel areas immediately adjacent to erosion sites do not support spawning riffles. The work window for the SRBPP PACR program also avoids the peak spawning time for steelhead. Therefore, the program is not expect to degrade the quality of PBFs for Chinook salmon and steelhead spawning adults or incubating eggs.

Critical Habitat for the Southern DPS of the North American Green Sturgeon

Critical habitat for green sturgeon is present within the program area. The PBFs essential to the conservation of green sturgeon include physical habitat, water, river flow, and salinity

concentrations required to maintain green sturgeon habitat for spawning, larval and juvenile transport, rearing, and adult migration. Of these, the PBFs that may be adversely affected by the program action include food resources and substrate type or size.

The PBF of food resources, which refers to the availability of prey items for juvenile, sub-adult, and adult life stages, is expected be adversely affected by the installation of up to 30,000 linear feet of rock revetment. In all repairs, the rock revetment is assumed to extend below ordinary high water and cover benthic habitat. The replacement of soft benthic substrate with rocks will impair green sturgeon foraging habitat, thereby reducing the availability of prey. Similarly, the PBF of substrate type and size will also be adversely affected, as part of the natural riverbed will be permanently covered with large rocks and will no longer be available as foraging habitat.

The SRBPP PACR program is not expected to permanently impact the PBFs of water flow or water quality, migration corridors (*i.e.*, pathways necessary for the safe and timely passage of all life stages), or depth (*i.e.*, availability of deep pools for use as holding habitat), since the program will not install any features that are expected to block or impede juvenile or adult migration, alter any deep pools, or permanently alter water quality. In addition, green sturgeon PBFs for egg deposition and development, and larval development are not expected to be affected since no spawning occurs in the action area.

As discussed above, the SAM can provide some information about the impacts to green sturgeon critical habitat, although these are limited to near-shore changes. Because green sturgeon are primarily a benthic rather than nearshore dwelling species, SAM results for green sturgeon should be interpreted within that context. The SAM results will likely indicate habitat deficits for adult residence in all regions in all seasons due to potential reduction in slope, low replacement of instream structure (LWM recruitment), and due to rock revetment and little replacement of habitat features.

Proposed Mitigation and Conservation Measures

Section 1.2.7 of the Proposed Action describes the additional minimization and conservation measures (*i.e.,* mitigation measures) that USACE proposes to offset the unavoidable and residual adverse effects of the proposed levee repair actions. After discussion with NMFS during earlier drafts of this program, USACE developed a much more robust Compensation Strategy to incorporate more alternatives. As each site will be consulted on separately, mitigation and compensation measures will be evaluated on a project-by-project basis in technical assistance with NMFS to determine the best suited compensation plan.

If bank repair actions are not fully self-mitigating, off-site compensation measures will be implemented after project completion or concurrent with site construction using conservation measures/banks. Whether constructed as part of a suite of bank protection sites or established independent of a project site in coordination with DWR, USFWS, and NMFS, off-site compensation will focus on replacing and enhancing habitat values for the listed species addressed in this BO. The SAM model, which was specifically created to assist with determining and quantifying effects and compensation amounts, will be utilized to the extent practicable.

Program Influence on Very Highly Rated Stressors

Implementation of actions under the SRBPP PACR could exacerbate several of the most highly rated stressors affecting Sacramento River winter-run Chinook salmon, CV spring-run Chinook salmon and CCV steelhead identified in the recovery plan (NMFS 2014). These very high stressors were previously described in Section 2.4 *Environmental Baseline*. The tables below identify the Very Highly Ranked Stressors, by species, which could be exacerbated by the proposed action. Table 13 identifies Very Highly Ranked Stressors specific to the green sturgeon in the action area that were identified in the Recovery Plan for the Southern Distinct Population Segment of North American Green Sturgeon (NMFS 2018).

Table 10. Very Highly Ranked Threats to Sacramento River Winter-run Chinook salmon in the Action Area.

Life Stage	Primary Stressor Category	Specific Stressor	Exacerbated by the Proposed Action
Juvenile Rearing and Outmigration	Loss of Natural Morphologic Function	Loss of Natural Morphologic Function in the Delta	Yes
Juvenile Rearing and Outmigration	Loss of Natural Morphologic Function	Loss of Natural Morphologic Function in the lower Sacramento River	Yes
Juvenile Rearing and Outmigration	Loss of Riparian Habitat and Instream Cover	Loss of Riparian Habitat and Instream Cover in the Delta	Yes
Juvenile Rearing and Outmigration	Loss of Riparian Habitat and Instream Cover	Loss of Riparian Habitat and Instream Cover in the lower Sacramento River	Yes
Juvenile Rearing and Outmigration	Predation	Predation in the Delta	Yes
Juvenile Rearing and Outmigration	Predation	Predation in the lower Sacramento River	Yes
Juvenile Rearing and Outmigration	Predation	Predation in the middle Sacramento River with emphasis on anthropogenically-created predation opportunities at GCID, RBDD and other structures	Yes
Juvenile Rearing and Outmigration	Predation	Predation in the upper Sacramento River with emphasis on anthropogenically-created predation opportunities at ACID and other structures	Yes
Juvenile Rearing and Outmigration	Loss of Natural Morphologic Function	Loss of Natural Morphologic Function in the upper Sacramento River	Yes

Table 11. Very Highly Ranked Threats to Central Valley Spring-run Chinook salmon in the Action Area.

Life Stage	Primary Stressor Category	Specific Stressor	Exacerbated by the Proposed Action
Juvenile Rearing and Outmigration	Loss of Floodplain Habitat	Lower and Middle Sacramento River	Yes
Juvenile Rearing and Outmigration	Loss of Natural River Morphology	Lower and Middle Sacramento River	Yes
Juvenile Rearing and Outmigration	Loss of Riparian Habitat and Instream Cover	Lower and Middle Sacramento River	Yes
Juvenile Rearing and Outmigration	Loss of Floodplain Habitat	Delta	Yes
Juvenile Rearing and Outmigration	Predation	Predation in the Delta	Yes
Juvenile Rearing and Outmigration	Predation	Predation in the middle and lower Sacramento River	Yes
Juvenile Rearing and Outmigration	Loss of Riparian Habitat and Instream Cover	Delta	Yes
Juvenile Rearing and Outmigration	Loss of Natural River Morphology	Delta	Yes

Table 12. Very Highly Ranked Threats to California Central Valley Steelhead in the Action Area.

Life Stage	Primary Stressor Category	Specific Stressor	Exacerbated by the Proposed Action
Juvenile Rearing and Outmigration	Loss of Floodplain Habitat	Lower and Middle Sacramento River	Yes
Juvenile Rearing and Outmigration	Loss of Natural River Morphology	Lower and Middle Sacramento River	Yes
Juvenile Rearing and Outmigration	Loss of Riparian Habitat and Instream Cover	Lower and Middle Sacramento River	Yes
Juvenile Rearing and Outmigration	Loss of Floodplain Habitat	Delta	Yes
Juvenile Rearing and Outmigration	Predation	Predation in the Delta	Yes
Juvenile Rearing and Outmigration	Predation	Predation in the middle and lower Sacramento River	Yes
Juvenile Rearing and Outmigration	Loss of Riparian Habitat and Instream Cover	Delta	Yes
Juvenile Rearing and Outmigration	Loss of Natural River Morphology	Delta	Yes

Table 13. Very Highly Ranked Threats to the sDPS of North American Green Sturgeon in the Action Area.

Life Stage	Primary Stressor Category	Specific Stressor	Exacerbated by the Proposed Action
Larvae/Juveniles	Altered Prey Base	Non-native species	Yes
Larvae/Juveniles	Altered Prey Base	Global climate change	Yes
Larvae/Juveniles & Adults	Altered Water Temperature	Global climate change	Yes
Eggs	Disease and Predation	Non-native species	Yes

Larvae/Juveniles	Competition for Habitat	Native and non-native species	Yes

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 Part 402.02). Future Federal actions that are unrelated to the proposed action are not considered in this section because they require separate consultation pursuant to section 7 of the ESA.

Some continuing non-Federal activities are reasonably certain to contribute to 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 Agricultural Practices

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 sDPS green sturgeon reproductive success and survival rates (Dubrovsky 1998, Daughton 2002).

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 habits 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, Welch 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 which 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.

2.7 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 BO 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 diminishes the value of designated or proposed critical habitat for the conservation of the species.

2.7.1 Status of 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.

2.7.2 Status of the CV Spring-Run Chinook salmon ESU

In the 2016 status review, NMFS found, with a few exceptions, CV spring-run Chinook salmon populations have increased through 2014 returns since the last status review (2010/2011), which moved the Mill and Deer creek populations from the high extinction risk category, to moderate, and Butte Creek remaining in the low risk of extinction category. Additionally, the Battle Creek and Clear Creek populations continued to show stable or increasing numbers in that period, putting them at moderate risk of extinction based on abundance. Overall, the Southwest Fisheries Science Center concluded in their viability report that the status of CV spring-run Chinook salmon (through 2014) had probably improved since the 2010/2011 status review and that the ESU's extinction risk may have decreased. However, fish returns in 2015 were extremely low (1,488 adults) (CDFW GrandTab). For the fourth consecutive year, CDFW has documented critically low returns for Butte, Deer, and Mill creeks which hold the only wild, independent populations of CV spring-run Chinook salmon (CDFW GrandTab). The effects of the December 2011 to March 2017 drought have resulted in severe rates of decline and a trend toward extirpation.

2.7.3 Status of the CCV Steelhead DPS

The 2016 status review (NMFS 2016c) concluded that overall, the status of CCV steelhead appears to have changed little since the 2011 status review and should remain as a threatened species. Although there is still a general lack of data on the status of wild populations, there are some encouraging signs, as several hatcheries in the Central Valley have experienced increased returns of steelhead over recent years. There has also been a slight increase in the percentage of wild steelhead in salvage at the south Delta fish facilities, and the percentage of wild fish in those data remains much higher than at Chipps Island. The new video counts at Ward Dam show that Mill Creek likely supports one of the best wild steelhead populations in the Central Valley,

though at much reduced levels from the 1950's and 60's. Restoration efforts in Clear Creek continue to benefit CCV steelhead. However, the catch of unmarked (wild) steelhead at Chipps Island is still less than 5 percent of the total smolt catch, which indicates that natural production of steelhead throughout the Central Valley remains at very low levels. Despite the positive trend on Clear Creek and encouraging signs from Mill Creek, all other concerns raised in the current status review remain.

2.7.4 Status of the Green Sturgeon southern DPS

The viability of sDPS green sturgeon is constrained by factors such as a small population size, lack of multiple populations, and concentration of spawning sites into just a few locations. The risk of extinction is believed to be moderate because, although threats due to habitat alteration are thought to be high and indirect evidence suggests a decline in abundance, there is much uncertainty regarding the scope of threats and the viability of population abundance indices (NMFS 2015). The recovery potential for this species is likely high, however, if sources of mortality and activities that decrease habitat quality and quantity, particularly in spawning and rearing habitat, are limited (NMFS 2018).

Although the population structure of sDPS green sturgeon is still being refined, it is currently believed that only one population of sDPS green sturgeon exists. Lindley, Schick et al. (2007), in discussing winter-run Chinook salmon, states that an ESU represented by a single population at moderate risk of extinction is at high risk of extinction over the long run. This concern applies to any DPS or ESU represented by a single population, and if this were to be applied to sDPS green sturgeon directly, it could be said that sDPS green sturgeon face a high extinction risk. However, the position of NMFS, upon weighing all available information (and lack of information) has stated the extinction risk to be moderate (NMFS 2015).

There is a strong need for additional information about sDPS green sturgeon, especially with regards to a robust abundance estimate, a greater understanding of their biology, and further information about their micro- and macro-habitat ecology.

2.7.5 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 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 describe 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 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. Long-term impacts include the permanent physical alteration of the riverbank and riparian vegetation, as well as continued blockage to the floodplain, which will last for many years.

1. Construction-related Effects

Direct effects associated with in-river construction work will involve equipment and activities that will produce pressure waves, and create underwater noise and vibration, thereby temporarily altering in-river conditions. Any fishes that do not relocate during construction can be crushed or injured by construction equipment or 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 in the SRBPP PACR 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 to Sacramento River winter-run Chinook salmon, CV spring-run Chinook salmon and CCV steelhead, and sDPS green sturgeon. Considering that site-specific actions will occur along primary migratory corridors of the Sacramento River, the Delta, and some of the larger tributary reaches 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. Program implementation using the Site Selection Process will result in identifying BPMs optimized to include greater plantable areas, which will allow for substantial on-site compensation of the impacts. However, site-specific considerations, such as design configuration and planting densities, will determine the actual amount of on-site compensation that can be provided. As previously stated, and demonstrated by the historic constructed sites evaluation, the USACE future implementation will likely consist of primarily BPM 4 (a, b, or c) or BPM 5 designs, which will include replacement 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. The overall effects are not able to be determined fully with the programmatic approach, but will be further evaluated for each site.

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 USACE proposes to offset the unavoidable and residual adverse effects of the proposed levee repair actions. The USACE's Compensation Strategy incorporates alternatives; through site-specific consultations including mitigation and compensation measures, which will be evaluated on a project-by-project basis in technical assistance with NMFS to determine the best suited compensation plan.

If impacts of bank repair actions cannot be fully mitigated on-site, off-site compensation measures will be implemented after project completion or concurrent with site construction using conservation measures/banks. Whether constructed as part of a suite of bank protection sites or established independent of a project site in coordination with DWR, USFWS, and NMFS, off-site compensation will focus on replacing and enhancing habitat values for the listed species addressed in this BO. The SAM model, which was specifically created to assist with determining and quantifying effects and compensation amounts, will be utilized to the extent practicable.

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 ETL and riprap placement are clearly driving these effects. Other effects to all species are not measured by the SAM such as short- and long-term effects to species associated with changes in substrate size and related increases in predation below seasonal water surface elevations. These "unmeasured" effects represent an inherent shortfall of the SAM approach to measuring effects to the focus species and represent a level of uncertainty that is difficult to address in this BO.

Depending on design, the effects of the proposed programmatic action could exacerbate stressors/threats to Sacramento River winter-run Chinook salmon, CV spring-run Chinook salmon,CCV steelhead, and sDPS green sturgeon. Through conscientious design in coordination with NMFS and the mitigation procedures included in the program, these impacts are expected to be minimized to the maximum extent possible, with unavoidable impacts mitigated. Considering that site-specific actions will occur along primary migratory corridors of the Sacramento River, the Delta, and some of the larger tributary reaches 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, CV Spring-run Chinook Salmon, CCV Steelhead and sDPS Green Sturgeon Critical Habitat

Within the action area, the general relevant PBFs of the designated critical habitat for listed salmonids are 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 BPMs, which involve vegetation removal, bank fill stone protection installation of rock revetment, and 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, provide high-value feeding areas for juvenile salmonids. Removal of SRA habitat and IWM associated with the SRBPP PACR program 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 SRBPP PACR 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 SRBPP PACR 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 BPM chosen for repairs 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. This plan will be in place before the commencement of project construction.

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, any effects of interrelated and interdependent activities, and cumulative effects, it is NMFS' BO that the proposed action is not likely to jeopardize the continued existence of the Sacramento River winter-run Chinook salmon ESU, the Central Valley spring-run Chinook salmon ESU, the California Central Valley steelhead DPS, and the Southern DPS of North American green sturgeon, or to 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 Part 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 Part 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.

For a framework programmatic action, an incidental take statement is not required at the programmatic level; any incidental take resulting from any action subsequently authorized, funded, or carried out under the program will be addressed in subsequent section 7 consultation, as appropriate [50 CFR Part 402.14(i)(6)].

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 Part 402.02).

1. The USACE should complete a study of potential rock revetment removal sites on the Sacramento River where rock revetment does not serve a flood risk reduction benefit and can be removed for the purpose of enhancing green sturgeon (if applicable) and salmonid

shoreline habitat. The USACE should consider remediating one of these sites as mitigation for subsequent consultations to be completed under the SRBPP PACR programmatic.

2. The USACE should make set-back levees integral components of their authorized bank protection or ecosystem restoration efforts.
3. USACE should engage with NMFS on opportunities for implementing actions under the SRBPP PACR that avoid, minimize and effectively offset impacts to fish species and critical habitat. USACE should collaborate with NMFS to develop a prioritization framework that identifies and implements site-level and system improvements that avoid in-water work to the maximum extent practicable. This should include the following, but not necessarily limited to:
    a. Developing a prioritization framework for the SRBPP PACR with a project design hierarchy that starts with set-back levees and landside levee repairs.
    b. Proactively conducting real-estate investigations for landside work before consultation requests and/or program planning and implementation.
    c. Proactively investigating and identifying riparian corridor enhancement opportunities that could be implemented in the vicinity of future projects that impact fish species and critical habitat.
    d. Proactively investigating and planning rock removal projects to mitigate future placement of revetment in critical habitat. For example, the USACE has legacy rock placement areas along the Upper Sacramento River reach from Red Bluff to Chico Landing near Hamilton City that do not serve any purpose toward protecting human safety and could be removed to facilitate riverine function such as side channel and floodplain inundation.

7. USACE 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.
8. USACE should develop an institutional mechanism for including NMFS in the review and approval of ETL variances for future projects that require ETL compliance.
9. USACE 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 (NMFS 2014). High priority actions related to flood management include setting levees back from riverbanks, and increasing the amount and extent of riparian vegetation along reaches of the Sacramento River Flood Control Project.
10. USACE should encourage cost share sponsors and applicants to develop floodplain and riparian corridor enhancement plans as part of their projects.
11. USACE should support and promote aquatic and riparian habitat restoration within the Sacramento River and other watersheds, especially those with listed aquatic species. Practices that avoid or minimize negative impacts to listed species should be encouraged.
12. USACE should continue to work cooperatively with other State and Federal agencies, private landowners, governments, and local watershed groups to identify opportunities for cooperative analysis and funding to support salmonid habitat restoration projects.
13. USACE should continue to work with NMFS and other agencies and interests to restore fish passage 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.

14. USACE should work with NMFS to implement bio-technical designs when possible to incorporate both bank protection and fish habitat measures into designs.
15. USACE should avoid designing any sites using BPM 2 unless all other options are deemed infeasible at that location.

NMFS requests notification of the implementation of any conservation recommendations.

2.11 Reinitiation of Consultation

This concludes formal consultation for Sacramento River Bank Protection Project Post Authorization Change Report.

As 50 CFR Part 402.16 states, reinitiation of formal consultation is required 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 BO, (3) the agency action is subsequently modified in a manner that causes an effect on the listed species or critical habitat that was not considered in this BO, 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. The MSA (section 3) defines EFH as "those waters and substrate necessary to fish for spawning, breeding, feeding, or growth to maturity." 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 Part 600.810). Section 305(b) also requires NMFS to recommend measures that can be taken by the Action Agency to conserve EFH.

This analysis is based, in part, on the EFH assessment provided by the USACE and descriptions of EFH for Pacific Coast salmon (PFMC 2014) contained in the fishery management plans (FMP) developed by the PFMC and approved by the Secretary of Commerce.

3.1 Essential Fish Habitat Affected by the Project

EFH designated under the Pacific Coast Salmon FMP may be affected by the proposed action. Species that utilize EFH designated under this FMP within the action area include fall-run/late fall-run Chinook salmon. Habitat Areas of Particular Concern (HAPCs) that may be either directly or indirectly adversely affected include (1) complex channels and floodplain habitats, (2) thermal refugia, and (3) spawning habitat.

3.2 Adverse Effects on Essential Fish Habitat

Consistent with the ESA portion of this document which determined that aspects of the proposed action will result in impacts to Pacific Coast salmon and critical habitat, we conclude that aspects of the proposed action would also adversely affect EFH for these species. Adverse effects to ESA-listed critical habitat and EFH HAPCs are appreciably similar, therefore no additional discussion is included. Listed below are the adverse effects on EFH reasonably certain to occur. Affected HAPCs are indicated by number, corresponding to the list in Section 3.1.

Sedimentation and Turbidity

- Reduced habitat complexity (1)
- Degraded water quality (1, 2, 3)
- Reduction in aquatic macroinvertebrate production (1)

Contaminants and Pollution-related Effects

- Degraded water quality (1, 2)
- Reduction in aquatic macroinvertebrate production (1)

Installation of Revetment

- Permanent loss of natural substrate at levee toe (1, 2, 3)
- Reduced habitat complexity (1, 2)
- Increased bank substrate size (1, 3)
- Increased predator habitat (1)

Removal of Riparian Vegetation

- Reduced shade (1, 2)
- Reduced supply of terrestrial food resources (1)
- Reduced supply of IWM (1, 2)

3.3 Essential Fish Habitat Conservation Recommendations

NMFS recommends the following EFH conservation recommendations:

1. Measures shall be taken to maintain, monitor, and adaptively manage all conservation measures throughout the life of the proposed program to ensure their effectiveness.
2. Measures shall be taken to minimize the impacts of bank protection by implementing integrated on-site and off-site conservation measures that provide beneficial growth and survival conditions for juvenile salmonids, and the sDPS of North American green sturgeon. Measures shall be taken to maintain, monitor, and adaptively manage all conservation measures throughout the life of the proposed program to ensure their effectiveness.
3. Measures shall be taken to ensure that contractors, construction workers, and all other parties involved with this program implement the program as proposed in the biological assessment and this BO.
4. Measures shall be taken to ensure that USACE levee vegetation management policies that influence SRBPP PACR repair design are based on best available science and consider the potential benefits of levee vegetation to levee integrity, public safety, and ESA-listed fish species.
5. Measures shall be taken to minimize the amount and duration of placement of rock revetment below the OHW of the Sacramento River.
6. Measures shall be taken to ensure that future flood risk reduction projects that result from this program minimize, to the maximum extent practicable, any adverse effects on federally listed salmon, steelhead and green sturgeon that are subject to this consultation.
7. Measures shall be taken to ensure that riparian habitat within the study area is preserved and protected to the maximum extent feasible for protection of fish habitat features that are the subject of this BO.

3.4 Statutory Response Requirement

As required by section 305(b)(4)(B) of the MSA, USACE 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 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 Part 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

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

4. FISH AND WILDLIFE COORDINATION ACT

The purpose of the FWCA is to ensure that wildlife conservation receives equal consideration, and is coordinated with other aspects of water resources development (16 USC 661). The FWCA establishes a consultation requirement for Federal agencies that undertake any action to modify any stream or other body of water for any purpose, including navigation and drainage (16 USC 662(a)), regarding the impacts of their actions on fish and wildlife, and measures to mitigate those impacts. Consistent with this consultation requirement, NMFS provides recommendations and comments to Federal action agencies for the purpose of conserving fish and wildlife resources, and providing equal consideration for these resources. NMFS' recommendations are provided to conserve wildlife resources by preventing loss of and damage to such resources. The FWCA allows the opportunity to provide recommendations for the conservation of all species and habitats within NMFS' authority, not just those currently managed under the ESA and MSA.

The following recommendations apply to the proposed action:

(1) USACE should recommend that contractors use biodegradable lubricants and hydraulic fluid in construction machinery. The use of petroleum alternatives can greatly reduce the risk of contaminants such as polycyclic aromatic hydrocarbons (PAHs) or heavy metals directly or indirectly entering the aquatic ecosystem.

The action agency must give these recommendations equal consideration with the other aspects of the proposed action so as to meet the purpose of the FWCA.

This concludes the FWCA portion of this consultation.

5. 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.

5.1 Utility

Utility principally refers to ensuring that the information contained in this consultation is helpful, serviceable, and beneficial to the intended users. The intended users of this opinion are USACE. Individual copies of this opinion were provided to USACE. The format and naming adheres to conventional standards for style.

5.2 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.

5.3 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 Part 402.01 et seq., and the MSA implementing regulations regarding EFH, 50 CFR Part 600.

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

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

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

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