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

APR 04 2017

Refer to NMFS No: WCR-2017-6665

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 for the Sacramento River Bank Protection Project at River Mile 71.3

Dear Ms. Kirchner:

Thank you for your letter received January 12, 2017 requesting initiation of consultation with NOAA's National Marine Fisheries Service (NMFS) pursuant to section 7 of the Endangered Species Act of 1973 (ESA) (16 U.S.C. 1531 et seq.) for the Sacramento River Bank Protection Project (SRBPP) on the Sacramento River at river mile (RM) 71.3.

This biological opinion (BO) is based on the final Environmental Assessment/Initial Study for Levee Repair at 25 Erosion Sites and Supplemental Information and Analysis for SRBPP, RM 71.3, received by NMFS on January 12, 2016. Based on the best available scientific and commercial information, the BO concludes that the project is not likely to jeopardize the continued existence of the Federally listed threatened CV spring-run Chinook salmon ESU, (*Oncorhynchus tshawytscha*), the endangered Sacramento River winter-run Chinook salmon ESU (*O. tshawytscha*), the threatened CCV steelhead DPS (*O. mykiss*) or the Southern DPS of the North American green sturgeon (*Acipencer medirostris*) and is not likely to destroy or adversely modify their designated critical habitats. NMFS has included an incidental take statement with reasonable and prudent measures and non-discretionary terms and conditions that are necessary and appropriate to avoid, minimize, or monitor incidental take of listed species associated with the project. Because NMFS continues to be concerned about potential impacts of bank stabilization projects on green sturgeon, NMFS has also included conservation recommendations that the USACE should consider that will help address the impacts of future projects completed under the SRBPP programmatic.

This letter also transmits NMFS's review of potential effects of the Proposed Action on essential fish habitat (EFH) for Pacific Coast Salmon, designated under the Magnuson-Stevens Fishery Conservation and Management Act (MSA). This review was pursuant to section 305(b) of the MSA, implementing regulations at 50 CFR 600.920, and agency guidance for use of the ESA consultation process to complete EFH consultation. The document concludes that the project will adversely affect the EFH of Pacific Coast Salmon in the Action Area.

Please contact Tancy Moore in NMFS' WCR CCVAO at (916) 930-3605 or via email at Tancy.Moore@noaa.gov if you have any questions concerning this section 7 consultation, or if you require additional information.

Sincerely,

Maria Rea

for Barry A. Thom
Regional Administrator

Enclosure

Cc: California Central Valley Office
Division Chron File: ARN 151422-WCR2017-SA00318

Mr. Michael Fong, Environmental Planning Section, U.S. Army Corps of Engineers, Sacramento District, 1325 J Street, Sacramento, California 95814

Ms. Patty Goodman, Environmental Planning Section, U.S. Army Corps of Engineers, Sacramento District, 1325 J Street, Sacramento, California 95814

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Endangered Species Act (ESA) Section 7(a)(2) Biological Opinion Reinitiation

Sacramento River Bank Protection Project River Mile 71.3
NMFS Consultation Number: WCR-2017-6665

Action Agency: U.S. Army Corps of Engineers

Affected Species and NMFS' Determinations:

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

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

Issued By: Maria Rea
for Barry A. Thom
Regional Administrator

Date: APR 04 2017

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1. INTRODUCTION

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

1.1 Background

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

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

We completed pre-dissemination review of this document using standards for utility, integrity, and objectivity in compliance with applicable guidelines issued under the Data Quality Act (DQA) (section 515 of the Treasury and General Government Appropriations Act for Fiscal Year 2001, Public Law 106-554). The document will be available through NMFS' Public Consultation Tracking System https://pcts.nmfs.noaa.gov/pcts-web/homepage.pcts. A complete record of this consultation is on file at the NMFS California Central Valley Area Office.

1.2 Consultation History

On November 2, 2007, NMFS received a formal consultation request from the U.S. Army Corps of Engineers (USACE) for Phase II of the Sacramento River Bank Protection Project (SRBPP). In response, NMFS issued a programmatic BO for this project on July 02, 2008. The programmatic BO requires subsequent formal consultations for site specific projects developed under the Phase II authority for SRBPP.

On August 18, September 14, and October 20, 2016, NMFS and the USACE held preconsultation technical meetings regarding work to be completed as part of the above programmatic consultation at river mile (RM) 71.3 on the Sacramento River.

On January 12 2017, the USACE sent a letter requesting initiation of formal consultation for this work at RM 71.3, hereafter referred to as SRBPP RM 71.3. This letter was accompanied by a Draft Environmental Assessment/Initial Study for Levee Repair of 25 Erosion Sites, a Final Environmental Assessment/Initial Study for Levee Repair of 25 Erosion Sites, and a Supplemental Information and Analysis for the SRBPP.

NMFS requested more information about the project on January 18, 2017 and February 10, 2017. NMFS received this information and initiated consultation on February 17, 2017. A complete administrative record is on file at the NMFS Central Valley Area Office in Sacramento, California.

1.3 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 402.02). USACE and the Central Valley Flood Protection Board (CVFPB) propose to implement bank protection measures on the Sacramento River at river mile (RM) 71.3, located near the Sacramento International Airport in Yolo County, California.

The levee erosion at site RM 71.3 is likely due to high-velocity flood flows, boat wake wave impacts, and erodible levee materials. Figures 1 and 2 below shows a cross section of the repair, which will be 515 feet long. The upper bench (at A – B on Figure 1), will have a rock slope of 2.5H:1V (horizontal to vertical ratio), and the lower bench (at B – C on Figure 1) will have a slope of 10H:1V. The upper and lower bench will be covered in a total of 33,837 ft^2 of soil-filled quarry stone, with a 0.5 foot of soil cover on top to support riparian plantings. A mix of trees, willows, and native understory/grasses will be planted on both the upper and lower slope of the riparian bench. The species to be planted and the specific zones they will be planted in is described in Figure 2 and Table 2. A beaver barrier fence (at C on Figure 1) will be installed immediately below the riparian plantings in order to protect them from beaver predation. The riverside edge of the bench will be set at the summer mean water surface elevation (SMWSE). Just below the lower bench, a rock toe will be installed with a 2:1 slope using 13,684 ft^2 of quarry stone (at C – D on Figure 1), which will remain bare. Table 1 describes the repair site characteristics.

Table 1. Repair Site Characteristics

Repair Site Characteristics	**Value**
Length of Repair Site (feet)	515
Site Area (acres)	4.48
Quarry stone volume (cubic yards)	7,934
Soil-filled quarry stone volume (cubic yards)	4,700
Soil cover volume (cubic yards)	727
Final bank slope outside of planted bench area (H:V)	2.5:1
Final slope within riparian bench (H:V)	10:1
Instream Woody Material to be removed (linear feet along bank)	123
Instream Woody Material to be anchored at MSWL (linear feet)	257.5

The USACE plans to mitigate for project impacts to salmon and steelhead by purchasing credits from an approved mitigation bank at a 1:1 ratio. Specifically, a total of 0.60 acres (26,079 ft^2) of credits will be purchased, which represents the maximum negative weighted response index value (WRI) estimated by the standard assessment methodology (SAM) analysis. This analysis is described below in the *Analytical Approach* and *Effects of the Action* sections.

No trees will be removed for the proposed project. Although a total of 123 linear feet of instream woody material (IWM) will need to be removed to facilitate the repair of the bank, 257.5 linear feet of IWM will be installed as mitigation. The IWM will be installed at SMWSE in grouping spaced 20-25 feet apart with one end buried in the quarry stone to anchor it. In-water construction will be limited to between July 1 and November 30. A complete description of avoidance and mitigation measures for the proposed project can be found in the Sacramento River Bank Protection Project Phase II programmatic BO, issued on July 02, 2008.

In an effort to improve the evaluation of impacts to green sturgeon from bank protection actions, USACE will conduct pre and post construction monitoring to monitor changes to benthic form and function. The goals of the monitoring will be to establish an understanding of existing benthic form and communities within the project reach, explore and develop monitoring techniques, and provide information for future monitoring. Monitoring will be conducted upstream, downstream, and at RM 71.3. Pre and post construction monitoring will occur at a minimum once quarterly, but may be conducted as often as once per month if relevant to achieving the goals stated above. Post-construction monitoring would continue for at least 5 years, but may be continued up to 10 years. USACE anticipates that long term monitoring conducted in conjunction with construction of the bank protection action at RM 71.3 will be superseded by more comprehensive monitoring efforts. Monitoring results will be reported to NMFS at a minimum once per year, or as appropriate. In addition, USACE will coordinate regularly with NMFS through the Interagency Working Group to ensure that monitoring continues to meet the stated goals above.

1.3.1 Interrelated and Interdependent Actions

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

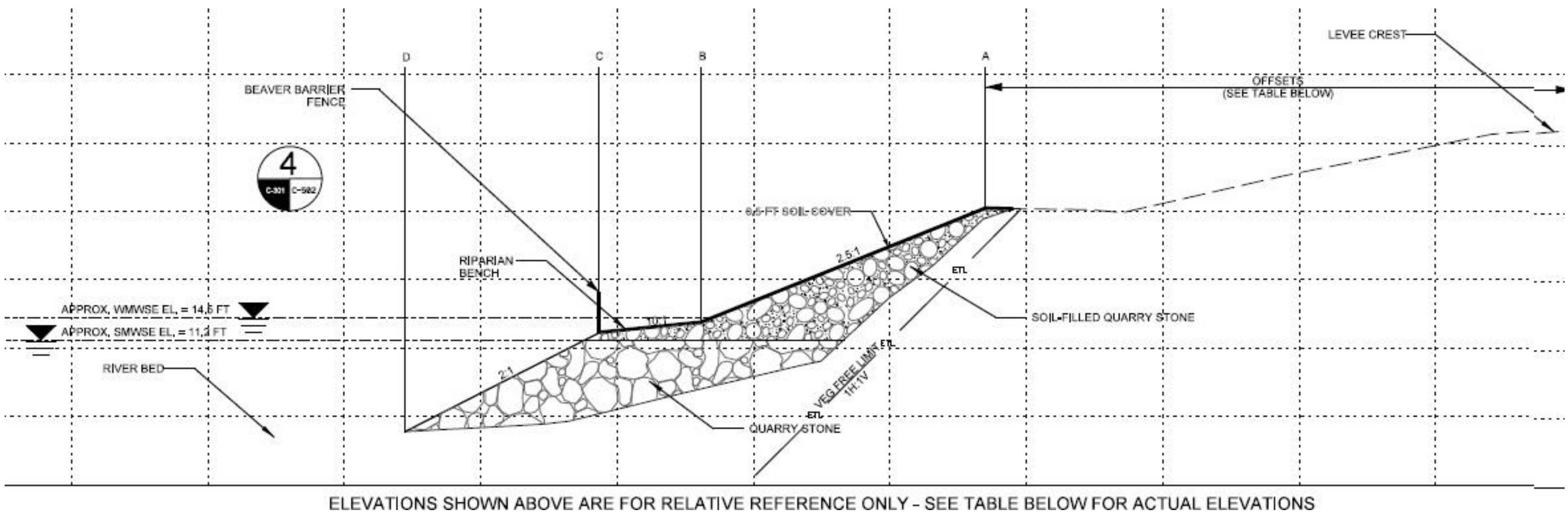

Figure 1. Cross section of the bank repair for the Sacramento River Bank Protection Project work to be completed at river mile 71.3 of the Sacramento River

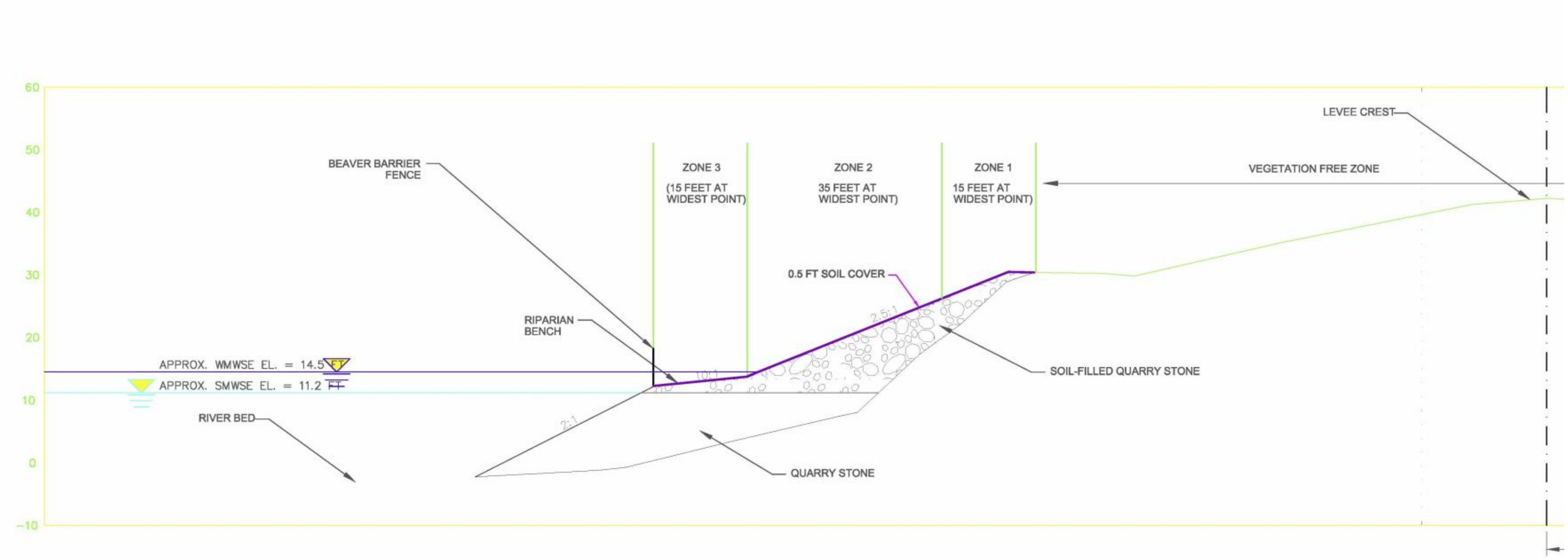

Figure 2. Cross section of the bank repair for the Sacramento River Bank Protection Project work to be completed at river mile 71.3 of the Sacramento River

Table 2. Riparian planting palette

Planting Zone	Area of Planting Zone (sq. ft)	Area of Planting Zone (ac)	Notes	Species Name	Common Name
Zone 1	20,977	0.48	Zone 1A Overstory	*Quercus lobata*	Valley oak
				Quercus wislizeni	Interior live oak
				Artemisia douglasiana	California mugwort
				Baccharis salicifolia	mule fat
			Zone 1A- Understory Hydroseed Mix	*Achillea millefolium*	yarrow
				Elymus glaucus	blue wildrye
				Hordeum brachyantherum ssp. californicum	California barley
				Leymus triticoides	creeping wild rye
				Leymus triticoides	creeping wild rye
				Lotus purshianus var. purshianus	Spanish clover
				Lupinus bicolor	miniature lupine
				Nasella pulchra	purple needle grass
				Trifolium wildenovii	tomcat clover
				Vulpia microstachys	small fescue

Planting Zone	Area of Planting Zone (sq. ft)	Area of Planting Zone (ac)	Notes	Species Name	Common Name
Zone 2	20,263	0.47	**Zone 2 Over & Middle Story**	*Acer negundo*	Box elder
				Alnus rhombifolia	White Alder
				Cephalanthus occidentalis	Buttonbush
				Fraxinus latifolia	Oregon ash
				Populus fremonitii ssp. Fremonitii	Fremont cottonwood
				Quercus lobata	Valley oak
			Zone 2 Understory grasses	*Agrostis exarta*	spike bentgrass
				Ambrosia psilostachya	western ragweed
				Artemisia douglasiana	California mugwort
				Carex barbarae	Santa Barbara carex
				Deschampsia elongata	slender hairgrass
				Elymus trachycaulus	slender wheatgrass
				Hordeum brachyantherum ssp. californicum	California barley
				Juncus Balticus	Baltic rush
				Juncus Effusus	Common rush
				Leymus triticoides	creeping wild rye

Planting Zone	Area of Planting Zone (sq. ft)	Area of Planting Zone (ac)	Notes	Species Name	Common Name
Zone 3	20,263	0.47	**Zone 3 Over & Middle Story**	*Acer negundo*	Box elder
				Alnus rhombifolia	White Alder
				Cephalanthus occidentalis	Buttonbush
				Fraxinus latifolia	Oregon ash
				Populus fremonitii ssp. Fremonitii	Fremont cottonwood
				Salix exigua	Sandbar willow
				Salix lasiolepii	Arroyo willow
			Zone 3 Understory grasses	*Agrostis exarta*	spike bentgrass
				Ambrosia psilostachya	western ragweed
				Artemisia douglasiana	California mugwort
				Carex barbarae	Santa Barbara carex
				Deschampsia elongata	slender hairgrass
				Elymus trachycaulus	slender wheatgrass
				Hordeum brachyantherum ssp. californicum	California barley
				Juncus Balticus	Baltic rush
				Juncus Effusus	Common rush
				Leymus triticoides	creeping wild rye
Fascine Bundles				*Salix exigua*	Sandbar willow

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 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:

1. Identify the rangewide status of the species and critical habitat expected to be adversely affected by the Proposed Action.
2. Describe the environmental baseline in the Action Area.
3. Analyze the effects of the Proposed Action on both species and their habitat using an "exposure-response-risk" approach.
4. Describe any cumulative effects in the Action Area.

5. 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.
6. Reach a conclusion about whether species are jeopardized or critical habitat is adversely modified.
7. If necessary, suggest a RPA to the Proposed Action.

2.1.1 Use of Analytical Surrogates

Analytical Surrogates for Salmonids

The effects of the SRBPP RM 71.3 levee repair on salmonids are primarily analyzed using Standard Assessment Methodology (SAM). The USACE provided the background data, assumptions, analyses, and assessment of habitat compensation requirements for the Federally protected fish species relevant to this consultation.

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

It is a computational modeling and tracking tool that evaluates bank protection alternatives by taking into account several key factors affecting threatened and endangered fish species. By identifying and then quantifying the response of focal species to changing habitat conditions over time, project managers, biologists and design engineers can make changes to project design to avoid, minimize, or 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. The model is used to assess species responses as a result of changes to habitat conditions, either by direct quantification of bank stabilization design parameters (*e.g.,* bank slope, substrate). The preferred hierarchy of mitigation in all cases is avoid, minimize, compensate onsite and compensate off-site. 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 to species and habitat, temporal delays in habitat function of onsite compensatory mitigation, and limitations associated with being able to provide full compensation at project sites, which warrants the need for some form of off-site compensation.

In 2003, the USACE established a program to carry out "a process to review, improve, and validate analytical tools and models for USACE Civil Works business programs". Reviews are conducted to ensure that planning models used by the USACE are technically and theoretically sound, computationally accurate, and in compliance with the USACE planning policy. As such, all existing and new planning models developed by the USACE are required to be certified through the appropriate Planning Center of Expertise and Headquarters in accordance with USACE rules and procedures. The assumptions, model variables, and modeling approaches used in the SAM have been developed to be adapted and validated through knowledge gained from monitoring and experimentation within the SRBPP while retaining the original overall assessment method and framework.

In late 2010, the certification process for the SAM was initiated by the USACE, Sacramento District in coordination with the Ecosystem Planning Center of Expertise. The process entailed charging a panel of six experts to review the SAM, along with the SAM (version 3.0). The Review Panel was composed of a plan formulation expert, fisheries biologist, aquatic ecologist, geomorphologist/geologist, population biologist/modeling expert, and software programmer.
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. The SAM systematically evaluates the response of each life stage to habitat features affected by bank protection projects.

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

The WRI represent an index of a species growth and survival based on a 30-day exposure to post project conditions over the life of the project. As such, negative SAM values can be used as a surrogate to quantify harm to a target fish species by life stage and season. Also, although SAM values represent an index of harm to a species, since the values are expressed as “weighted bankline feet” or “weighted area”, these values can be used to help quantify compensatory conservation actions such as habitat restoration, and are used for that purpose in this BO.
The *Effects of the Action* section of this BO analyzes the effects of the SRBPP RM 71.3 levee repair project.

Analytical Surrogates for Green Sturgeon

Impacts to the Southern DPS of the North American green sturgeon are also estimated using an analytical surrogate. Although the SAM model does have a green sturgeon component, NMFS has determined that the model may not have the precision to accurately index green sturgeon responses to changes in modeled habitat attributes and that a more rigorous modeling approach needs development. Critical habitat for green sturgeon in the action is designated in the Sacramento River below ordinary high water (OHW). For this BO, NMFS has determined the amount of critical habitat covered by rock revetment would serve as the best analytical surrogate for impacts to all life stages of green sturgeon. However, the OHW mark could not be collected at the time of this consultation due to the unusually high flows that occurred during the winter of 2017. Therefore, the amount of bare rock revetment will serve as the analytical surrogate for project effects.

2.2 Rangewide Status of the Species and Critical Habitat

This BO examines the status of each species that would be adversely affected by the Proposed Action. The status is determined by the level of extinction risk that the listed species face, based on parameters considered in documents such as recovery plans, status reviews, and listing decisions. This informs the description of the species' likelihood of both survival and recovery. The species status section also helps to inform the description of the species' current "reproduction, numbers, or distribution" as described in 50 CFR 402.02. The BO also examines the condition of critical habitat throughout the designated area, evaluates the 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.

2.2.1 California Central Valley Spring-run Chinook salmon

- Listed as threatened (September 16, 1999, 64 FR 50394), reaffirmed (June 28, 2005, 70 FR 37160).
- Designated critical habitat (September 2, 2005, 70 FR 52488)

The Federally listed ESU of Central Valley (CCV) spring-run Chinook salmon and designated critical habitat for this ESU occurs in the Action Area and may be affected by the Proposed Action. Detailed information regarding ESU listing and critical habitat designation history, designated critical habitat, ESU life history, and VSP (viable salmonid population) parameters can be found in NMFS 2014 Recovery Plan for the Evolutionarily Significant Units of Sacramento River Winter-Run Chinook salmon, Central Valley Spring-Run Chinook salmon, and the Distinct Population Segment of California Central Valley steelhead.

Historically, spring-run Chinook salmon were the second most abundant salmon run in the Central Valley and one of the largest on the west coast (CDFG 1990). These fish occupied the upper and middle elevation reaches (1,000 to 6,000 feet) of the San Joaquin, American, Yuba, Feather, Sacramento, McCloud and Pit rivers, with smaller populations in most tributaries with sufficient habitat for over-summering adults (Stone 1872, Rutter 1904, Clark 1929). The Central Valley drainage as a whole is estimated to have supported spring-run Chinook salmon runs as large as 600,000 fish between the late 1880s and 1940s (CDFG 1998). The San Joaquin River historically supported a large run of spring-run Chinook salmon, suggested to be one of the largest runs of any Chinook salmon on the West Coast with estimates averaging 200,000-500,000 adults returning annually (CDFG 1990).

Monitoring of the Sacramento River mainstem during spring-run Chinook salmon spawning timing indicates some spawning occurs in the river (CDFW, unpublished data, 2014). Genetic introgression has likely occurred here due to lack of physical separation between spring-run and fall-run Chinook salmon populations (CDFG 1998). Sacramento River tributary populations in Mill, Deer, and Butte creeks are likely the best trend indicators for the CV spring-run Chinook salmon ESU. Generally, these streams have shown a positive escapement trend since 1991, displaying broad fluctuations in adult abundance (CDFW 2016). The Feather River Fish Hatchery (FRFH) spring-run Chinook salmon population represents an evolutionary legacy of populations that once spawned above Oroville Dam. The FRFH population is included in the ESU based on its genetic linkage to the natural spawning population, and the potential for development of a conservation strategy (June 28, 2005, 70 FR 37160).

The Central Valley Technical Review Team (TRT) estimated that historically there were 18 or 19 independent populations of CV spring-run Chinook salmon, along with a number of dependent populations, all within four distinct geographic regions, or diversity groups (Lindley *et al.* 2004). Of these populations, only three independent populations currently exist (Mill, Deer, and Butte creeks tributary to the upper Sacramento River) and they represent only the northern Sierra Nevada diversity group. Additionally, smaller populations are currently persisting in Antelope and Big Chico creeks, and the Feather and Yuba rivers in the northern Sierra Nevada diversity group (CDFG 1998). In the San Joaquin River basin, observations in the last decade suggest that spring-running populations may currently occur in the Stanislaus and Tuolumne rivers (Franks 2015).

The CV spring-run Chinook salmon ESU is comprised of two known genetic complexes. Analysis of natural and hatchery spring-run Chinook salmon stocks in the Central Valley indicates that the northern Sierra Nevada diversity group spring-run Chinook salmon populations in Mill, Deer, and Butte creeks retain genetic integrity as opposed to the genetic integrity of the Feather River population, which has been somewhat compromised by introgression with the fall-run ESU (Good *et al.* 2005a, Garza *et al.* 2007, Cavallo *et al.* 2011).

Because the populations in Butte, Deer and Mill creeks are the best trend indicators for ESU viability, we can evaluate risk of extinction based VSP in these watersheds. Over the long term, these three remaining populations are considered to be vulnerable to anthropomorphic and naturally occurring catastrophic events. The viability assessment of CV spring-run Chinook salmon conducted during NMFS' 2010 status review (NMFS 2011a), found that the biological status of the ESU had worsened since the last status review (2005) and recommended that the species status be reassessed in two to three years as opposed to waiting another five years, if the decreasing trend continued. In 2012 and 2013, most tributary populations increased in returning adults, averaging over 13,000. However, 2014 returns were lower again, just over 5,000 fish, indicating the ESU remains highly fluctuating. The most recent status review was conducted in 2015 (NMFS 2016b), which looked at promising increasing populations in 2012-2014; however, the 2015 returning fish were extremely low (1,488), with additional pre-spawn mortality reaching record lows. Since the effects of the 2012-2015 drought have not been fully realized, we anticipate at least several more years of very low returns, which may result in severe rates of decline (NMFS 2016b).

Spring-run Chinook salmon adults are vulnerable to climate change because they over-summer in freshwater streams before spawning in autumn (Thompson *et al*. 2011). CV spring-run Chinook salmon spawn primarily in the tributaries to the Sacramento River, and those tributaries without cold water refugia (usually input from springs) will be more susceptible to impacts of climate change. Even in tributaries with cool water springs, in years of extended drought and warming water temperatures, unsuitable conditions may occur. Additionally, juveniles often rear in the natal stream for one to two summers prior to emigrating, and would be susceptible to warming water temperatures. In Butte Creek, fish are limited to low elevation habitat that is currently thermally marginal, as demonstrated by high summer mortality of adults in 2002 and 2003, and will become intolerable within decades if the climate warms as expected. Ceasing water diversion for power production from the summer holding reach in Butte Creek resulted in cooler water temperatures, more adults surviving to spawn, and extended population survival time (Mosser *et al*. 2013).

Summary of the Central Valley spring-run Chinook salmon ESU viability

In summary, the extinction risk for the CV spring-run Chinook salmon ESU remains at moderate risk of extinction (NMFS 2016b). Based on the severity of the drought and the low escapements as well as increased pre-spawn mortality in Butte, Mill, and Deer creeks in 2015, there is concern that these CV spring-run Chinook salmon strongholds will deteriorate into high extinction risk in the coming years based on the population size or rate of decline criteria (NMFS 2016b).

Critical Habitat and Physical or Biological Features for Central Valley Spring-run Chinook salmon

The critical habitat designation for CV spring-run Chinook salmon lists the PBFs (June 28, 2005, 70 FR 37160), which are described in NMFS 2014 Recovery Plan for the Evolutionarily Significant Units of Sacramento River Winter-Run Chinook salmon, Central Valley Spring-Run Chinook salmon, and the Distinct Population Segment of California Central Valley steelhead. In summary, the PBFs include freshwater spawning sites, freshwater rearing sites, freshwater migration corridors, and estuarine habitat. The geographical range of designated critical habitat includes stream reaches of the Feather, Yuba, and American rivers, Big Chico, Butte, Deer, Mill, Battle, Antelope, and Clear creeks, and the Sacramento River, as well as portions of the northern Delta (June 28, 2005, 70 FR 37160).

Summary of the Value of CV spring-run Chinook salmon Critical Habitat for the Conservation of the Species

Currently, many of the PBFs of CV spring-run Chinook salmon critical habitat are degraded, and provide limited high quality habitat. Features that lessen the quality of migratory corridors for juveniles include unscreened or inadequately screened diversions, altered flows in the Delta, scarcity of complex in-river cover, and the lack of floodplain habitat. Although the current conditions of CV spring-run Chinook salmon critical habitat are significantly degraded, the spawning habitat, migratory corridors, and rearing habitat that remain are considered to have high intrinsic value for the conservation of the species.

2.2.2 California Central Valley Steelhead

- Originally listed as threatened (March 19, 1998, 63 FR 13347); reaffirmed as threatened (January 5, 2006, 71 FR 834).
- Designated critical habitat (September 2, 2005, 70 FR 52488).

The Federally listed distinct population segment (DPS) of California Central Valley (CCV) steelhead and designated critical habitat for this DPS occurs in the Action Area and may be affected by the Proposed Action. Detailed information regarding DPS listing and critical habitat designation history, designated critical habitat, DPS life history, and VSP parameters can be found in the NMFS 2014 Recovery Plan for the Evolutionarily Significant Units of Sacramento River Winter-Run Chinook salmon, Central Valley Spring-Run Chinook salmon, and the Distinct Population Segment of California Central Valley steelhead.

Historic CCV steelhead run sizes are difficult to estimate given the paucity of data, but may have approached one to two million adults annually (McEwan 2001). By the early 1960s the CCV steelhead run size had declined to about 40,000 adults (McEwan 2001). Current abundance data for CCV steelhead is limited to returns to hatcheries and redd surveys conducted on a few rivers. The hatchery data is the most reliable because redd surveys for steelhead are often made difficult by high flows and turbid water usually present during the winter-spring spawning period. CCV steelhead returns to Coleman National Fish Hatchery (NFH) have increased over the last four years, 2011 to 2014. After hitting a low of only 790 fish in 2010, the last two years, 2013 and 2014, have averaged 2,895 fish. Wild adults counted at the hatchery each year represent a small fraction of overall returns, but their numbers have remained relatively steady, typically 200–300 fish each year. Numbers of wild adults returning each year have ranged from 252 to 610 from 2010 to 2014.

Redd counts are conducted in the American River and in Clear Creek (Shasta County). An average of 143 redds have been counted on the American River from 2002–2015 [data from Hannon *et al.* (2003), Hannon and Deason (2008), Chase (2010)]. An average of 178 redds have been counted in Clear Creek from 2001 to 2015 following the removal of Saeltzer Dam, which allowed steelhead access to additional spawning habitat. The Clear Creek redd count data ranges from 100-1023 and indicates an upward trend in abundance since 2006 (USFWS 2015).

The returns of CCV steelhead to the Feather River Hatchery experienced a sharp decrease from 2003 to 2010, with only 679, 312, and 86 fish returning in 2008, 2009 and 2010, respectively. In recent years, however, returns have experienced an increase with 830, 1797, and 1505 fish returning in 2012, 2013 and 2014 respectively. Overall, steelhead returns to hatcheries have fluctuated so much from 2001 to 2015 that no clear trend is present.

An estimated 100,000 to 300,000 naturally produced juvenile steelhead are estimated to leave the Central Valley annually, based on rough calculations from sporadic catches in trawl gear (Good *et al.* 2005). Nobriga and Cadrett (2001) used the ratio of adipose fin-clipped (hatchery) to unclipped (wild) steelhead smolt catch ratios in the USFWS Chipps Island trawl from 1998 through 2000 to estimate that about 400,000 to 700,000 steelhead smolts are produced naturally each year in the Central Valley. Trawl data indicate that the level of natural production of steelhead has remained very low since the 2011 status review, suggesting a decline in natural production based on consistent hatchery releases. Catches of steelhead at the fish collection facilities in the southern Delta are another source of information on the production of wild steelhead relative to hatchery steelhead (CDFW data: ftp.delta.dfg.ca.gov/salvage). The overall catch of steelhead has declined dramatically since the early 2000s, with an overall average of 2,705 in the last 10 years. The percentage of wild (unclipped) fish in salvage has fluctuated, but has leveled off to an average of 36 percent since a high of 93 percent in 1999.

About 80 percent of the historical spawning and rearing habitat once used by anadromous *O. mykiss* in the Central Valley is now upstream of impassible dams (Lindley *et al.* 2006). Many historical populations of CCV steelhead are entirely above impassable barriers and may persist as resident or adfluvial rainbow trout, although they are presently not considered part of the DPS. Steelhead are well-distributed throughout the Central Valley below the major rim dams (Good *et al.* 2005, NMFS 2016a). Most of the steelhead populations in the Central Valley have a high hatchery component, including Battle Creek (adults intercepted at the Coleman NFH weir), the American River, Feather River, and Mokelumne River.

California Central Valley steelhead abundance and growth rates continue to decline, largely the result of a significant reduction in the amount and diversity of habitats available to these populations (Lindley *et al.* 2006). Recent reductions in population size are supported by genetic analysis (Nielsen *et al.* 2003). Garza and Pearse (2008) analyzed the genetic relationships among Central Valley steelhead populations and found that unlike the situation in coastal California watersheds, fish below barriers in the Central Valley were often more closely related to below barrier fish from other watersheds than to *O. mykiss* above barriers in the same watershed. This pattern suggests the ancestral genetic structure is still relatively intact above barriers, but may have been altered below barriers by stock transfers. The genetic diversity of CCV steelhead is also compromised by hatchery origin fish, placing the natural population at a high risk of extinction (Lindley *et al.* 2007). Steelhead in the Central Valley historically consisted of both summer-run and winter-run migratory forms. Only winter-run (ocean maturing) steelhead currently are found in California Central Valley rivers and streams as summer-run have been extirpated (McEwan and Jackson 1996, Moyle 2002).

Although CCV steelhead will experience similar effects of climate change to Chinook salmon in the Central Valley, as they are also blocked from the vast majority of their historic spawning and rearing habitat, the effects may be even greater in some cases, as juvenile steelhead need to rear in the stream for one to two summers prior to emigrating as smolts. In the Central Valley, summer and fall temperatures below the dams in many streams already exceed the recommended temperatures for optimal growth of juvenile steelhead, which range from 14°C to 19°C (57°F to 66°F). Several studies have found that steelhead require colder water temperatures for spawning and embryo incubation than salmon (McCullough *et al.* 2001a). In fact, McCullough *et al.* (2001) recommended an optimal incubation temperature at or below 11°C to 13°C (52°F to 55°F). Successful smoltification in steelhead may be impaired by temperatures above 12°C (54°F), as reported in Richter and Kolmes (2005). As stream temperatures warm due to climate change, the growth rates of juvenile steelhead could increase in some systems that are currently relatively cold, but potentially at the expense of decreased survival due to higher metabolic demands and greater presence and activity of predators. Stream temperatures that are currently marginal for spawning and rearing may become too warm to support wild steelhead populations.

Summary of California Central Valley Steelhead DPS viability

All indications are that natural CCV steelhead have continued to decrease in abundance and in the proportion of natural fish over the past 25 years (Good *et al.* 2005, NMFS 2016a); the long-term trend remains negative. Hatchery production and returns are dominant. Most wild CCV populations are very small 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.

In summary, the status of the CCV steelhead DPS appears to have remained unchanged since the 2011 status review, and the DPS is likely to become endangered within the foreseeable future throughout all or a significant portion of its range (NMFS 2016a).

Critical Habitat and Physical or Biological Features for California Central Valley Steelhead

The critical habitat designation for CV spring-run steelhead lists the PBFs (June 28, 2005, 70 FR 37160), which are described in NMFS 2014 Recovery Plan for the Evolutionarily Significant Units of Sacramento River Winter-Run Chinook salmon, Central Valley Spring-Run Chinook salmon, and the Distinct Population Segment of California Central Valley steelhead. In summary, the PBFs include freshwater spawning sites; freshwater rearing sites; freshwater migration corridors; and estuarine areas.. The geographical extent of designated critical habitat includes: the Sacramento, Feather, and Yuba rivers, and Deer, Mill, Battle and Antelope creeks in the Sacramento River basin; the San Joaquin River, including its tributaries but excluding the mainstem San Joaquin River above the Merced River confluence; and the waterways of the Delta.

Summary of the Value of California Central Valley Steelhead Critical Habitat for the Conservation of the species

Many of the PBFs of CCV steelhead critical habitat are currently degraded and provide limited high quality habitat. Passage to historical spawning and juvenile rearing habitat has been largely reduced due to construction of dams throughout the Central Valley. Levee construction has also degraded the value for the conservation of the species of freshwater rearing and migration habitat and estuarine areas as riparian vegetation has been removed, reducing habitat complexity, food resources, and resulting in many other ecological effects. Contaminant loading and poor water quality in Central California waterways poses threats to lotic fish, their habitat and food resources. Additionally, due to reduced access to historical habitats, genetic introgression is occurring because naturally-produced fish are interacting with hatchery-produced fish which has the potential to reduce the long-term fitness and survival of this species.

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

2.2.3 Sacramento River Winter-run Chinook Salmon

- First listed as threatened (August 4, 1989, 54 FR 32085).
- Reclassified as endangered (January 4, 1994, 59 FR 440), reaffirmed as endangered (June 28, 2005, 70 FR 37160).
- Designated critical habitat (June 16, 1993, 58 FR 33212).

The Federally listed evolutionary significant unit (ESU) of Sacramento River winter-run Chinook salmon and designated critical habitat for this ESU occurs in the action area and may be affected by the proposed action. Detailed information regarding ESU listing and critical designation habitat history, designated critical habitat, ESU life history, and viable salmonid population (VSP) parameters can be found in NMFS 2014 Recovery Plan for the Evolutionarily Significant Units of Sacramento River Winter-Run Chinook salmon, Central Valley Spring-Run Chinook salmon, and the Distinct Population Segment of California Central Valley steelhead.

Historically, Sacramento River winter-run Chinook salmon (winter-run) population estimates were as high as 120,000 fish in the 1960s, but declined to less than 200 fish by the 1990s (NMFS 2011b) . In recent years, since carcass surveys began in 2001, the highest adult escapement occurred in 2005 and 2006 with 15,839 and 17,296, respectively (CDFG 2012). However, from 2007 to 2013, the population has shown a precipitous decline, averaging 2,486 during this period, with a low of 827 adults in 2011(CDFG 2012). This recent declining trend is likely due to a combination of factors such as poor ocean productivity (Lindley *et al.* 2009), drought conditions from 2007-2009, and low in-river survival rates (NMFS 2011b). In 2014 and 2015, the population was approximately 3,000 adults, slightly above the 2007–2012 average, but below the high (17,296) for the last 10 years (CDFW 2016).

2014 was the third year of a drought that increased water temperatures in the upper Sacramento River, and egg-to-fry survival to the RBDD was approximately 5 percent (NMFS 2016c). Due to the anticipated lower than average survival in 2014, hatchery production from LSNFH was tripled (*i.e*., 612,056 released) to offset the impact of the drought (CVP and SWP Drought Contingency Plan 2014). In 2014, hatchery production represented 83 percent of the total in-river juvenile production. In 2015, egg-to-fry survival was the lowest on record (~4 percent) due to the inability to release cold water from Shasta Dam in the fourth year of a drought. Winter-run returns in 2016 are expected to be low as they show the impact of drought on juveniles from brood year 2013 (NMFS 2016c).

Although impacts from hatchery fish (*i.e*., reduced fitness, weaker genetics, smaller size, less ability to avoid predators) are often cited as having deleterious impacts on natural in-river populations (Matala *et al.* 2012), the winter-run conservation program at Livingston Stone National Fish Hatchery (LSNFH) is strictly controlled by the USFWS to reduce such impacts. The average annual hatchery production at LSNFH is approximately 176,348 per year (2001-2010 average) compared to the estimated natural production that passes RBDD, which is 4.7 million per year based on the 2002-2010 average (Poytress and Carrillo 2011). Therefore, hatchery production typically represents approximately 3-4 percent of the total in-river juvenile winter-run production in any given year. However, the average over the last 12 years (about four generations) is 13% with the most recent generation at 20% hatchery influence, making the population at a moderate risk of extinction.

The distribution of winter-run spawning and initial rearing historically was limited to the upper Sacramento River (upstream of Shasta Dam), McCloud River, Pitt River, and Battle Creek, where springs provided cold water throughout the summer, allowing for spawning, egg incubation, and rearing during the mid-summer period (Yoshiyama *et al.* 1998). The construction of Shasta Dam in 1943 blocked access to all of these waters except Battle Creek, which currently has its own impediments to upstream migration (*i.e.*, a number of small hydroelectric dams situated upstream of the Coleman Fish Hatchery weir). The Battle Creek Salmon and Steelhead Restoration Project (BCSSRP) is currently removing these impediments, which should restore spawning and rearing habitat for winter-run Chinook salmon in Battle Creek and possibly establish an additional population in the future. Approximately 299 miles of former tributary spawning habitat above Shasta Dam is inaccessible to winter-run. Yoshiyama *et al.* (2001) estimated that in 1938, the upper Sacramento River had a "potential spawning capacity" of approximately 14,000 redds equal to 28,000 spawners. Since 2001, the majority of winter-run redds have occurred in the first 10 miles downstream of Keswick Dam. Most components of the winter-run life history (*e.g.*, spawning, incubation, freshwater rearing) have been compromised by the construction of Shasta Dam.

The greatest risk factor for winter-run lies within its spatial structure (NMFS 2011b) . The winter-run ESU is comprised of only one population that spawns below Keswick Dam. The remnant and remaining population cannot access 95 percent of their historical spawning habitat and must therefore be artificially maintained in the Sacramento River by: (1) spawning gravel augmentation, (2) hatchery supplementation, and (3) regulation of the finite cold-water pool behind Shasta Dam to reduce water temperatures.

Winter-run require cold water temperatures in the summer that simulate their upper basin habitat, and they are more likely to be exposed to the impacts of drought in a lower basin environment. Battle Creek is currently the most feasible opportunity for the ESU to expand its spatial structure but restoration is not scheduled to be completed until 2020. The Central Valley Salmon and Steelhead Recovery Plan includes criteria for recovering the winter-run Chinook salmon ESU, including re-establishing a population into historical habitats upstream of Shasta Dam (NMFS 2014).

Winter-run Chinook salmon embryonic and larval life stages that are most vulnerable to warmer water temperatures occur during the summer, so this run is particularly at risk from climate warming. The only remaining population of winter-run Chinook salmon relies on the cold water pool in Shasta Reservoir, which buffers the effects of warm temperatures in most years. The exception occurs during drought years, which are predicted to occur more often with climate change (Yates *et al.* 2008). The shifts in air temperature and precipitation that are anticipated to occur with climate change will likely compromise the quantity and/or quality of winter-run Chinook salmon habitat available downstream of Keswick Dam. It is imperative for additional populations of winter-run Chinook salmon to be re-established into historical habitat in Battle Creek and above Shasta Dam for long-term viability of the ESU (NMFS 2014).

Summary of the Sacramento River winter-run Chinook salmon ESU viability

In summary, the extinction risk for the winter-run ESU has increased from moderate risk to high risk of extinction since 2005, and several listing factors have contributed to the recent decline, including drought, poor ocean conditions and hatchery. Large-scale fish passage and habitat restoration actions are necessary for improving the winter-run ESU viability (NMFS 2016c).

Critical Habitat and Physical or Biological Features for Sacramento River Winter-run Chinook salmon

The critical habitat designation for Sacramento River winter-run Chinook salmon lists the PBFs (June 16, 1993, 58 FR 33212, 33216-33217), which are described in NMFS 2014 Recovery Plan for the Evolutionarily Significant Units of Sacramento River Winter-Run Chinook salmon, Central Valley Spring-Run Chinook salmon, and the Distinct Population Segment of California Central Valley steelhead. This designation includes the following waterways, bottom and water of the waterways and adjacent riparian zones: 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 (June 16, 1993, 58 FR 33212). NMFS clarified that "adjacent riparian zones" are limited to only those areas above a stream bank that provide cover and shade to the near shore aquatic areas (June 16, 1993, 58 FR 33212, 33214). Although the bypasses (*e.g.*, Yolo, Sutter, and Colusa) are not currently designated critical habitat for winter-run, NMFS recognizes that they may be utilized when inundated with Sacramento River flood flows and are important rearing habitats for juvenile winter-run. Also, juvenile winter-run may use tributaries of the Sacramento River for non-natal rearing.

Summary of the Value of Sacramento River Winter-run Chinook Salmon Critical Habitat for the Conservation of the Species

Currently, many of the PBFs of winter-run critical habitat are degraded, and provide limited high quality habitat. Features that lessen the quality of migratory corridors for juveniles include unscreened diversions, altered flows in the Delta, and the lack of floodplain habitat. In addition, water operations that limit the extent of cold water below Shasta Dam have reduced the available spawning habitat (based on water temperature). Although the current conditions of winter-run critical habitat are significantly degraded, the spawning habitat, migratory corridors, and rearing habitat that remain are considered to have high intrinsic value for the conservation of the species. Also, juvenile winter-run may use tributaries of the Sacramento River for non-natal rearing (Maslin *et al.* 1997, Pacific States Marine Fisheries Commission 2014).

<u>2.2.4 Southern Distinct Population Segment (sDPS) of North American Green Sturgeon</u>

- Listed as threatened (April 7, 2006, 71 FR 17757).
- Critical habitat designated (October 9, 2009, 74 FR 52300).

The Federally listed southern distinct population segment (sDPS) of North American green sturgeon and designated critical habitat for this DPS occurs in the Action Area and may be affected by the Proposed Action. Detailed information regarding DPS listing and critical habitat designation history, designated critical habitat, and DPS life history can be found on the green sturgeon page of NMFS's website at http://www.westcoast.fisheries.noaa.gov/protected_species/green_sturgeon/green_sturgeon_pg.html.

Green sturgeon are known to range from Baja California to the Bering Sea along the North American continental shelf. During late summer and early fall, subadults and non-spawning adult green sturgeon can frequently be found aggregating in estuaries along the Pacific coast (Emmett *et al.* 1991, Moser and Lindley 2006). Using polyploid microsatellite data, Israel *et al.* (2009) found that green sturgeon within the Central Valley of California belong to the sDPS. Additionally, acoustic tagging studies have found that green sturgeon found spawning within the Sacramento River are exclusively sDPS green sturgeon (Lindley *et al.* 2011). In waters inland from the Golden Gate Bridge in California, sDPS green sturgeon are known to range through the estuary and the Delta and up the Sacramento, Feather, and Yuba rivers (Israel *et al*. 2009, Bergman *et al.* 2011, Seesholtz *et al.* 2014). It is unlikely that green sturgeon utilize areas of the San Joaquin River upriver of the Delta with regularity, and spawning events are thought to be limited to the upper Sacramento River and its tributaries. There is no known modern usage of the upper San Joaquin River by green sturgeon, and adult spawning has not been documented there (Jackson and Van Eenennaam 2013).

Recent research indicates that the sDPS is composed of a single, independent population, which principally spawns in the mainstem Sacramento River and also breeds opportunistically in the Feather River and possibly even the Yuba River (Bergman *et al.* 2011, Seesholtz *et al.* 2014). Concentration of adults into a very few select spawning locations makes the species highly vulnerable to poaching and catastrophic events. The apparent, but unconfirmed, extirpation of spawning populations from the San Joaquin River narrows the available habitat within their range, offering fewer habitat alternatives. Whether sDPS green sturgeon display diverse phenotypic traits such as ocean behavior, age at maturity, and fecundity, or if there is sufficient diversity to buffer against long-term extinction risk is not well understood. It is likely that the diversity of sDPS green sturgeon is low, given recent abundance estimates (NMFS 2015).

Trends in abundance of sDPS green sturgeon have been estimated from two long-term data sources: (1) salvage numbers at the State and Federal pumping facilities (see below), and (2) by incidental catch of green sturgeon by the California Department of Fish and Wildlife's (CDFW) white sturgeon sampling/tagging program. Historical estimates from these sources are likely unreliable because the sDPS was likely not taken into account in incidental catch data, and salvage does not capture range-wide abundance in all water year types. A decrease in sDPS green sturgeon abundance has been inferred from the amount of take observed at the south Delta pumping facilities, the Skinner Delta Fish Protection Facility, and the Tracy Fish Collection Facility. This data should be interpreted with some caution. Operations and practices at the facilities have changed over the decades, which may affect salvage data. These data likely indicate a high production year vs. a low production year qualitatively, but cannot be used to rigorously quantify abundance.

Since 2010, more robust estimates of sDPS green sturgeon have been generated. As part of a doctoral thesis at UC Davis, Ethan Mora has been using acoustic telemetry to locate green sturgeon in the Sacramento River, and to derive an adult spawner abundance estimate (Mora *et al.* 2015). Preliminary results of these surveys estimate an average annual spawning run of 223 (DIDSON) and 236 (telemetry) fish. This estimate does not include the number of spawning adults in the lower Feather or Yuba Rivers, where green sturgeon spawning was recently confirmed (Seesholtz *et al.* 2014).

The parameters of green sturgeon population growth rate and carrying capacity in the Sacramento Basin are poorly understood. Larval count data shows enormous variance among sampling years. In general, sDPS green sturgeon year class strength appears to be highly variable with overall abundance dependent upon a few successful spawning (NFMS 2010b). Other indicators of productivity such as data for cohort replacement ratios and spawner abundance trends are not currently available for sDPS green sturgeon.

Southern DPS green sturgeon spawn primarily in the Sacramento River in the spring and summer. Anderson-Cottonwood Irrigation District Diversion Dam (ACID) is considered the upriver extent of green sturgeon passage in the Sacramento River) (71 FR 17757, April 7, 2006). The upriver extent of green sturgeon spawning, however, is approximately 30 kilometers downriver of ACID where water temperature is higher than ACID during late spring and summer (NMFS 2017) . Thus, if water temperatures increase with climate change, temperatures adjacent to ACID may remain within tolerable levels for the embryonic and larval life stages of green sturgeon, but temperatures at spawning locations lower in the river may be more affected. It is uncertain, however, if green sturgeon spawning habitat exists closer to ACID, which could allow spawning to shift upstream in response to climate change effects. Successful spawning of green sturgeon in other accessible habitats in the Central Valley (*i.e.*, the Feather River) is limited, in part, by late spring and summer water temperatures (NMFS 2015). Similar to salmonids in the Central Valley, green sturgeon spawning in tributaries to the Sacramento River is likely to be further limited if water temperatures increase and higher elevation habitats remain inaccessible.

Summary of Green Sturgeon sDPS viability

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 (NFMS 2010a). 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 2010a). Lindley *et al.* (2008), in discussing winter-run Chinook salmon, states that an ESU (or DPS) represented by a single population at moderate risk of extinction is at high risk of extinction over a large timescale; this would apply to the sDPS for green sturgeon. The most recent 5-year status review for sDPS green sturgeon found that some threats to the species have recently been eliminated, such as take from commercial fisheries and removal of some passage barrier (NMFS 2015). Since many of the threats cited in the original listing still exist, the threatened status of the DPS is still applicable (NMFS 2015).

Critical Habitat and Physical or Biological Features for sDPS Green Sturgeon

The critical habitat designation for sDPS green sturgeon lists the PBFs (October 9, 2009, 74 FR 52300), which are described on the green sturgeon page of NMFS's website at http://www.westcoast.fisheries.noaa.gov/protected_species/green_sturgeon/green_sturgeon_pg.html. In summary, the PBFs include the following for both freshwater riverine systems and estuarine habitats: food resources, water flow, water quality, migratory corridor, depth, and sediment quality. Additionally, for riverine systems, the designation includes substrate type or size. Substrate type or size is also a PBF for freshwater riverine systems. In addition, the PBFs include migratory corridor, water quality, and food resources in nearshore coastal marine areas. The geographical range of designated critical habitat includes the following.
In freshwater, the geographical range includes:

- the Sacramento River from the Sacramento I-Street bridge to Keswick Dam, including the Sutter and Yolo bypasses and the lower American River from the confluence with the mainstem Sacramento River upstream to the highway 160 bridge,
- the Feather River from its confluence with the Sacramento River upstream to Fish Barrier Dam,
- the Yuba River from its confluence with the Feather River upstream to Daguerre Point Dam, and
- the Sacramento-San Joaquin Delta (as defined by California Water Code section 12220, except for listed excluded areas).

In coastal bays and estuaries, the geographical range includes:

- San Francisco, San Pablo, Suisun, and Humboldt bays in California,
- Coos, Winchester, Yaquina, and Nehalem bays in Oregon,
- Willapa Bay and Grays Harbor in Washington, and
- the lower Columbia River estuary from the mouth to river kilometer 74.

In coastal marine waters, the geographical range includes all U.S. coastal marine waters out to the 60-fathom depth bathymetry line from Monterey Bay north and east to include waters in the Strait of Juan de Fuca, Washington.

Summary of the Value of sDPS Green Sturgeon Critical Habitat for the Conservation of the Species

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

2.2.5 Global Climate Change

One major factor affecting the rangewide status of the threatened and endangered anadromous fish in the Central Valley and aquatic habitat at large is climate change.

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

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

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

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

Spring-run Chinook salmon adults are vulnerable to climate change because they over-summer in freshwater streams before spawning in autumn (Thompson *et al.* 2011). Spring-run Chinook salmon spawn primarily in the tributaries to the Sacramento River, and those tributaries without cold water refugia (usually input from springs) will be more susceptible to impacts of climate change. Even in tributaries with cool water springs, in years of extended drought and warming water temperatures, unsuitable conditions may occur. Additionally, juveniles often rear in the natal stream for one to two summers prior to emigrating, and would be susceptible to warming water temperatures. In Butte Creek, fish are limited to low elevation habitat that is currently thermally marginal, as demonstrated by high summer mortality of adults in 2002 and 2003, and will become intolerable within decades if the climate warms as expected. Ceasing water diversion for power production from the summer holding reach in Butte Creek resulted in cooler water temperatures, more adults surviving to spawn, and extended population survival time (Mosser *et al.* 2013).

Although steelhead will experience similar effects of climate change to Chinook salmon, as they are also blocked from the vast majority of their historic spawning and rearing habitat, the effects may be even greater in some cases, as juvenile steelhead need to rear in the stream for one to two summers prior to emigrating as smolts. In the Central Valley, summer and fall temperatures below the dams in many streams already exceed the recommended temperatures for optimal growth of juvenile steelhead, which range from 14°C to 19°C (57°F to 66°F). Several studies have found that steelhead require colder water temperatures for spawning and embryo incubation than salmon (McCullough *et al.* 2001b). In fact, McCullough *et al.* (2001b) recommended an optimal incubation temperature at or below 11°C to 13°C (52°F to 55°F). Successful smoltification in steelhead may be impaired by temperatures above 12°C (54°F), as reported in Richter and Kolmes (2005). As stream temperatures warm due to climate change, the growth rates of juvenile steelhead could increase in some systems that are currently relatively cold, but potentially at the expense of decreased survival due to higher metabolic demands and greater presence and activity of predators. Stream temperatures that are currently marginal for spawning and rearing may become too warm to support wild steelhead populations.

Southern DPS green sturgeon spawn primarily in the Sacramento River in the spring and summer. ACID is considered the upriver extent of green sturgeon passage in the Sacramento River. The upriver extent of green sturgeon spawning, however, is approximately 30 kilometers downriver of ACID where water temperature is higher than ACID during late spring and summer. Thus, if water temperatures increase with climate change, temperatures adjacent to ACID may remain within tolerable levels for the embryonic and larval life stages of green sturgeon, but temperatures at spawning locations lower in the river may be more affected. It is uncertain, however, if green sturgeon spawning habitat exists closer to ACID, which could allow spawning to shift upstream in response to climate change effects. Successful spawning of green sturgeon in other accessible habitats in the Central Valley (*i.e.*, the Feather River) is limited, in part, by late spring and summer water temperatures. Similar to salmonids in the Central Valley, green sturgeon spawning in the major lower river tributaries to the Sacramento River are likely to be further limited if water temperatures increase and suitable spawning habitat remains inaccessible.

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

2.3 Action Area

"Action area" means all areas to be affected directly or indirectly by the Federal action and not merely the immediate area involved in the action (50 CFR 402.02). The action area is not the same as the project 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 for the proposed action analyzed in amended programmatic BO for Phase II of the SRBPP extends from south-to-north along the Sacramento River from the town of Collinsville, at river mile (RM) 0 upstream to Chico at RM 194, and includes reaches of lower Elder and Deer creeks. The SRBPP also includes Cache Creek, 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), as well as portions of Threemile, Steamboat, Sutter, Miner, Georgiana, and Cache sloughs. This represents the full geographic extent of the 24,000 linear feet of bank protection described in the amended programmatic BO for Phase II of the SRBPP and the effects that are associated with these projects. The action area for this repair at RM 71.3 is within this broader action area.

The proposed action is located on the Sacramento River at river mile 71.3, near the Sacramento International Airport in Yolo County, California. For projects with in-water construction activities, such as installation of riprap, the downstream extent of the action area is defined by the distance of potential turbidity and sediment deposition. For the proposed repair, turbidity impacts are expected to occur up to 100 feet from the shoreline and up to 400 feet downstream of any in-water construction activities. This estimation is based on previous turbidity monitoring efforts at other SRBPP project sites, which found that the level of turbidity 300 feet downstream from construction resembled baseline conditions. The levee repair itself will be approximately 515 feet in length. The action area also encompasses the associated floodplains and riparian areas at and adjacent to the project site.

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 402.02).

The environmental baseline describes the status of listed species and critical habitat in the action area, to which we add the effects of the proposed erosion repair, to consider the effects of the proposed Federal actions within the context of other factors that impact the listed species. The effects of the proposed Federal action are evaluated in the context of the aggregate effects of all factors that have contributed to the status of listed species and, for non-Federal activities in the action area, those actions that are likely to affect listed species in the future, to determine if implementation of the proposed erosion repair is likely to cause an appreciable reduction in the likelihood of both survival and recovery or result in destruction or adverse modification of critical habitat.

The action area, which encompasses the Sacramento River and associated floodplains and riparian areas at and adjacent to river mile 71.3 of the Sacramento River, functions primarily as a rearing and migratory habitat for Sacramento River winter-run Chinook salmon, CV spring-run Chinook salmon, and CCV steelhead. The Southern DPS of North American green sturgeon uses the area as a migration corridor for juveniles and adults. Holding post-spawn adults and rearing juveniles may utilize the area on their way to the estuary. Due to the life history timing of winter- and spring-run Chinook salmon, steelhead and North American green sturgeon, it is possible for one or more of the following life stages to be present within the action area throughout the year: adult migrants, spawners, rearing juveniles, or emigrating juveniles.

The action area is within designated critical habitat for Sacramento River winter-run Chinook salmon, CV spring-run Chinook salmon, and CCV steelhead. Habitat requirements for these species are similar. The PBFs of salmonid habitat within the action area include: freshwater rearing habitat and freshwater migration corridors. The essential features of these PBFs include adequate substrate, water quality, water quantity, water temperature, water velocity, shelter, food, riparian vegetation, space, and safe passage conditions. The intended conservation roles of habitat in the action area is to provide appropriate freshwater rearing and migration conditions for juveniles and unimpeded freshwater migration conditions for adults. However, the conservation condition and function of this habitat has been severely impaired through several factors, discussed in more detail in the *Status of the Species and Critical Habitat* section of the SRBPP Phase II programmatic BO. The result has been the reduction in quantity and quality of several essential features of migration and rearing habitat required by juveniles to grow and survive. In spite of the degraded condition of this habitat, the intrinsic conservation value of the action area is high as it is used by all Federally listed salmonids in the Central Valley.

The action area is also within designated critical habitat for Southern DPS of the North American green sturgeon. PBFs for sDPS green sturgeon within freshwater riverine systems include food resources, substrate type/size, flow, water quality, migration corridor free of passage impediments, depth (holding pools), and sediment quality. As is the case with salmonids, PBFs in the area been severely impaired through several factors (discussed in more detail in the *Status of the Species and Critical Habitat* section of the SRBPP Phase II programmatic BO). However, utilization of the area by several green sturgeon life stages means the habitat is still of high conservation value.

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 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 RM 71.3 levee repair, NMFS examined the potential proposed actions in the designated action areas. We analyzed construction-related impacts and the expected short- and long-term fish response to habitat modifications using the SAM. We also reviewed and considered the USACE's proposed conservation measures. This assessment relied heavily on the information from the USACE's SAM analysis in the Supplemental Information and Analysis for the SRBPP – Sacramento River Mile 71.3.

2.5.1 Construction Impact Analysis for Salmonids and Green Sturgeon

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. Only those fish that are holding adjacent to or migrating past the construction site will be directly exposed or affected by construction. Those fish that are exposed to the effects of construction activities will encounter short-term (*i.e.*, minutes to hours) construction-related noise, physical disturbance, and water quality changes that may cause injury or harm by increasing the susceptibility of some individuals to predation by temporarily disrupting normal behaviors, and affecting sheltering abilities.

NMFS expects that adult and juvenile CCV steelhead, juvenile winter-run Chinook salmon, juvenile spring-run Chinook salmon, and adult and juvenile green sturgeon may be present in the action area, and therefore exposed to the effects of construction activities. Adult salmonids and adult green sturgeon will likely respond to construction activities by quickly swimming away from the construction sites, and will escape injury. Furthermore, adult fish are not expected to sustain any physical damage due to construction because 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. Juveniles salmonids and green sturgeon may be exposed construction activities, but NMFS expects relatively few juvenile fish are expected to be injured or killed by in-river construction activities as construction will be suspended under high flow conditions, when the largest numbers of fish are migrating; most fish are expected to avoid construction activities due to their predominately crepuscular migration behaviors; and most of those that are exposed to construction are expected to detect project-related disturbance and noise and avoid being injured or killed. A complete description of construction related impacts can be found programmatic BO for Phase II of the SRBPP, issued July 2, 2008.

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 DO levels available to aquatic organisms. NMFS expects that adherence to best management practices (BMPs) that dictate the use, containment, and cleanup of contaminants will minimize the risk of introducing such products to the waterway. A complete description of the avoidance and minimization measures regarding exposure to toxic substances can be found in the programmatic BO.

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 project. Increases in turbidity can disrupt feeding and migratory behavior activities of salmonids, but NMFS anticipates the BMPs described in the programmatic BO will greatly minimize the risk of injury or death caused by increases in turbidity.

2.5.2 Project Effects on Salmonids, Estimated Using Standard Assessment Methodology as an Analytical Surrogate

2.5.2.1 Methodology for the SAM analysis

The SRBPP RM 71.3 impacts on salmonids were analyzed using SAM. The USACE provided the background data, assumptions, analyses, and assessment of habitat compensation requirements for the Federally protected fish species relevant to this consultation.

The SAM allows agencies to quantitatively assess the potential effects of bank protection and stream restoration projects to ensure that these activities do not jeopardize Chinook salmon and steelhead or destroy or adversely modify their critical habitat. 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 employs six habitat variables to characterize near-shore and floodplain habitats of listed fish species:

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 of the bank (i.e., D50) along each average seasonal water surface elevation;
4. **Instream structure** — percent of shoreline coverage of instream woody material 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 an MS Access database to track species responses to project 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 LWD 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-project or without-project), 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, compare project designs to existing conditions, and evaluate the effectiveness of onsite and off-site habitat compensation actions.

Following the procedures outlined in the SAM Users 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-project 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 ECT was used to calculate a time series of the relative response indices for each pre-project and with-project 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-project responses are assessed as a net benefit for the focus fish species (i.e., the bank repair action produced superior conditions than pre-project conditions). Negative differences indicate the bank repair actions produced inferior conditions when compared with pre-project conditions; they generally require additional habitat compensation.

This SAM analysis was conducted with the goal of evaluating the response of focus anadromous fish species to the project design updates described above. The pre-project and with-project conditions for this analysis are based on the SAM analysis of 25 sites included in the 2009 EA/IS of 25 erosion repair sites. Some pre-project and with-project conditions were modified to be consistent with current application of the SAM model and to reflect the updates to site design. The current application of the SAM has been simplified by assuming two key water surface elevations for habitat analysis: summer/fall and winter/spring. For the purpose of this analysis, pre-project and with-project values from the existing 25 sites SAM analysis were simplified by adopting fall values for summer/fall MWSE and winter values for winter/spring MWSE.

The SAM evaluates the response of focus fish species and their critical life-stages to bank protection measures over a 50 year period of analysis. Results are output as either bankline or wetted area Weighted Response Indices (WRI). The maximum negative WRI for a juvenile life stage are identified and used as a proxy for offsetting project effects. Although the SAM results are presented as bankline weighted and wetted area weighted WRIs, this analysis will focus on wetted area WRIs because they provide a more relevant representation of project effects than bankline WRIs. Wetted-area weighted results incorporate consideration of loss of wetted area due to construction of project features. The SAM incorporates the value of onsite mitigative features; therefore, the maximum negative WRI should be interpreted as the remaining potential effect that must be mitigated through additional onsite or offsite features, or through the purchase of offsite 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 year (water year) and season of installed bank protection features, including rock placement, soil and instream woody material installation, and vegetation plantings, were considered in this analysis for the with-project conditions. The pre-project and with-project conditions at RM 71.3 used in the SAM analyses are presented in Tables 4 and 5 of the SRBPP 71.3 SAM Analysis. Descriptions of the habitat variables used in the analysis are discussed below.

1. Shoreline length

Shoreline length is used as a quantitative attribute by which the qualitative attributes of a site are weighted to achieve a relative response factor. Shoreline lengths at a bank protection site are defined as the total length of continuous shoreline corresponding to each average seasonal flow (USACE 2012). Shoreline lengths were determined by assessing water surface elevations modeled across the breadth of the action area. Pre-project and with-project modeled water surface elevations were used to estimate seasonal shoreline lengths.

2. Wetted areas

Wetted area is used as a quantitative attribute by which the qualitative attributes of a site are weighted to achieve a relative response factor. Wetted areas at average flow conditions are defined as the wetted channel area of each site (the area between seasonal MWSE and centerline of the river). River centerline was determined through satellite imagery analysis. Seasonal MWSEs were determined by referencing digital elevation models created for each site.

3. Bank slope

In the SAM, bank slope serves as an indicator of the availability of shallow-water habitat and is obtained from point estimates of bank slope (horizontal change to vertical change, dH:dV) along each seasonal shoreline (i.e., the line where the water surface intersects the bank on average fall, winter, spring, and summer) (USACE 2012). Bank slope for pre-project conditions were derived from the 2009 SAM analysis. The existing bank slope values were originally estimated from onsite survey data or by using GIS software with the topography at each site to determine a bank slope extending from each seasonal shoreline to a depth of approximately 3 ft. With-project bank slopes were estimated by referencing designs.

4. Floodplain inundation ratio

In the SAM, floodplain habitat availability is considered important for juvenile life stages and is defined by areas that are flooded by the 2-year flood event (Q2), and measured by calculating a Floodplain Inundation Ratio (USACE 2012). This ratio is calculated by dividing the wetted channel and inundated floodplain areas during the 2-year flood event (AQ2) by the wetted channel area (AQavg) during average winter and spring flows. For this analysis, pre-project and with-project values for floodplain inundation ration were derived from the 2009 SAM analysis. The amount of available floodplain habitat is consequently proportional to the ratio's positive deviation from unity (i.e., values greater than 1). In the absence of a levee setback actions, the amount of available floodplain areas and channel cross sections would not be greatly altered during bank protection activities and thus have minimal impact in a SAM analysis.

5. Bank Substrate Size

Bank substrate size is directly affected by bank revetment and is considered an important determinant of predation risk and growth for nearly all life stages of the focus fish species (USACE 2012). Therefore, the relevant life stages are positively affected by smaller sizes of bank substrate and negatively affected by larger sizes of bank substrate. For this assessment, bank substrate size represents the median particle size (D50 in inches) within the submerged portion of the bank immediately below (0–3 feet) the seasonal MWSE. The pre-project bank substrate size used in this SAM analysis is consistent with the 2009 SAM value of 0.25 inches for all seasons. Determination of with-project bank substrate size was made by updating values based on changes in design.

6. Instream Structure

Instream structure is defined as instream woody material (IWM, excluding live bank vegetation) that is partially or fully submerged during average seasonal flows (USACE 2012). IWM is included in nearly all bank protection designs because it provides hiding and resting cover for focus fish and their predators, in addition to affecting invertebrate food production. Within the SAM (USACE 2012), bankline cover of IWM along the shorelines is assumed to be proportional to habitat quality for most life stages of the focus fish species. Pre-project and with-project IWM values were determined using site visit estimates along with vegetation planning designs developed by USACE.

7. Aquatic Vegetation

Aquatic vegetation is defined as aquatic or inundated bank vegetation that is partially or fully submerged during average seasonal flows (USACE 2012). Floating, submerged, and emergent aquatic vegetation serve as hiding cover, and as an invertebrate food production base for both focus fish and their predators. Habitat quality is therefore considered to benefit proportionally with the relative amount of aquatic vegetation along a shoreline. Determination of the cover from aquatic vegetation under with-project conditions was determined by updating values based on changes in design. Aquatic vegetation is not typically planted at the summer/fall MWSE. Installation of fascine bundles is expected to provide some value to both aquatic vegetation and shade habitat components; however, the successful establishment of fascine bundles at erosion repair sites has varied greatly and cannot be relied upon to contribute to habitat benefits. Aquatic vegetation at winter/spring MWSE is expected to follow a typical growth model, originally developed by Stillwater Sciences in the 25 sites EA SAM analysis (USACE 2009) and augmented for this SAM analysis based on the planting plan cover objectives. Specifically, the objective when designing planting plans for all vegetative cover is 80%; therefore, the expectation of maximum cover for all seasons was modified from 100% to 80%.

8. Shade

Shade is represented by overhead canopy cover and is measured by estimating the percent of shoreline in which riparian vegetation extends over the water during average seasonal flows. Overhanging shade is considered to benefit habitat quality by providing hiding cover and food availability for the focus fish species. Values for pre-project shade were derived from the 2009 SAM analysis. Determination of with-project shade cover was made by updating values based on changes in design (protecting all trees in place). Values for shade in winter and spring were modified by 25% and 75% of the existing values, respectively, to incorporate consideration of annual winter defoliation and spring leafing out.

2.5.2.2 Results of the SAM Analysis

USACE utilizes a reasonable worst-case scenario approach when evaluating the SAM results. This approach errs on the side of caution so that bank protection actions and onsite mitigation are more likely to meet or exceed modeled expectations, while limiting temporal and permanent effects. The SAM results presented below in Table 3 and Figures 3 through 8 are based on such a worst case scenario analysis. Table 3 shows negative WRI values, but there are several areas where the action will result in improved conditions. These are discussed below, and are summarized in the Supplemental Information and Analysis for the SRBPP – Sacramento River Mile 71.3, here after referred to as the SRBPP 71.3 SAM Analysis. In Table 3, year 0 refers to the year of construction.

The impacts will occur along approximately 515 feet of the right bank of the Sacramento River. For salmon and steelhead the main factor driving SAM deficits is the reduction in riparian habitat.

Certain life stages of salmonids have been omitted from the SAM analysis, as their responses to bank stabilization projects cannot be accurately modeled by SAM. These life stages include the following: adult migration for salmon and steelhead, outmigration of post spawning adult steelhead, and spawning and egg incubation for salmon and steelhead.

SAM modeled results for the adult migration life stages of salmon and steelhead were omitted since migrating adult salmonids are not expected to utilize the area near the shore where the project will occur or be influenced by the shoreline habitat features modeled by SAM, as they prefer deeper water. Furthermore, these fish are unlikely to be affected by the project because there will be no increase in predation and their upstream migration will not be impeded by any structural features. The site is only 515 feet in length and migrating adult salmonids are more likely to continue moving past the site if it does not provide habitat conditions that they prefer. Therefore, the project is not expected to impact the quality of the area as an adult migration corridor. The adult steelhead that are outmigrating as post spawning adults are not expected to be negatively impacted by the project for the same reasons.

The salmon and steelhead adult spawning and egg incubation life stages were not included in the SAM analysis as the impacts of bank modifications on these life stages has not been modeled for use in SAM analyses. Furthermore, these life stages do not occur in the RM 71.3 action area, and thus they are not expected to be impacted by the proposed project.

Summary of CV spring-run Chinook salmon, Sacramento River winter-run Chinook salmon, CCV steelhead and sDPS green sturgeon effects by water surface elevation:

At fall water surface elevations:

The reduction in riparian vegetation along 515 feet of the right bank of the Sacramento River leading to reduced growth and survival of fry and juvenile rearing CV spring-run Chinook salmon, winter-run Chinook salmon, and CCV steelhead is expected to last at least 50 years after any construction activities associated with the bank repair actions at RM 71.3. The amount and extent of this effect is quantified in Table 3. These adverse effects are greatest in Year 6 with a magnitude of -3,475 ft^2 WRI for all Chinook runs and -5,693 ft^2 for CCV steelhead, and continue for at least 50 years.

Reduced growth and survival of juvenile migrating (smolts) CV spring-run Chinook salmon, winter-run Chinook salmon, and CCV steelhead due to reductions in riparian along 515 feet of the right bank of the Sacramento River is expected for at least 50 years after any construction activities associated with the bank repair actions at RM 71.3. The amount and extent of this adverse effect is quantified in Table 3. These adverse effects are greatest in Year 7 following construction, with a magnitude of -23,456 ft^2 WRI for all Chinook runs and -26,097 ft^2 WRI for CCV steelhead, and continue for at least 50 years.

At winter water surface elevations:

Improved growth and survival of fry and juvenile rearing CV spring-run Chinook salmon, winter-run Chinook salmon, and CCV steelhead are expected after construction activities associated with the bank repair actions at RM 71.3 due to construction of a riparian bench and installation of IWM along 515 feet of the right bank of the Sacramento River. The amount and extent of this beneficial effect is quantified in Table 3. Beneficial effects are expected immediately following construction, and would increase to a magnitude of 10,795 ft^2 WRI for all Chinook runs, and 14,489 ft^2 WRI for CCV steelhead, by Year 50.

Reduced growth and survival of juvenile migrating (smolts) CV spring-run Chinook salmon, and winter-run Chinook salmon is expected for at least 5 years after any construction activities associated with the RM 71.3 repair due to reductions in riparian vegetation along 515 feet of the right bank of the Sacramento River. Reduced growth and survival of juvenile migrating (smolts) CCV steelhead is expected for at least 6 years after any construction activities due to reductions in riparian vegetation along 515 feet of the right bank of the Sacramento River. The amount and extent of this adverse effect is quantified in Table 3. These adverse effects are greatest in Year 1 following construction, with a magnitude of –5,043 ft^2 WRI for all Chinook runs and -4,371 ft^2 WRI for CCV steelhead. Beneficial effects are expected by Year 6 for all Chinook runs and Year 7 for CCV steelhead; by Year 50, beneficial effects would increase to a magnitude of 10,317 ft^2 WRI and 5,632 ft^2 for all Chinook runs and CCV steelhead respectively.

At spring water surface elevations:

Improved growth and survival of fry and juvenile rearing CV spring-run Chinook salmon, winter-run Chinook salmon, and CCV steelhead are expected after any construction activities associated with RM 71.3 repair due to construction of a riparian bench and installation of IWM along 515 feet of the right bank of the Sacramento River. The amount and extent of this beneficial effect is quantified in Table 3. Beneficial effects are expected immediately following construction, and would increase to a magnitude of 15,120 ft^2 WRI for all Chinook runs, and 18,705 ft^2 WRI for CCV steelhead, by Year 50.

Reduced growth and survival of juvenile migrating (smolts) CV spring-run Chinook salmon and winter-run Chinook salmon are expected for at least 3 years after any construction activities associated with the RM 71.3 repair due to reductions in riparian vegetation along 515 feet of the right bank of the Sacramento River. Reduced growth and survival of juvenile migrating (smolts) CCV steelhead is expected for at least 5 years after any construction activities associated with the RM 71.3 due to reductions in riparian vegetation along 515 feet of the right bank of the Sacramento River. These adverse effects are greatest in Year 1 following construction, with a magnitude of –3,598 ft^2 WRI for all Chinook runs and -4,732 ft^2 WRI for CCV steelhead. The amount and extent of these adverse effects is quantified in Table 3. For CCV steelhead, beneficial effects are expected by Year 6, and by Year 50 would increase to a magnitude of 6,046 ft^2 WRI. For Chinook runs, beneficial effects are expected by Year 4, and by Year 50 would increase to a magnitude of 11,177 ft^2 WRI.

At summer water surface elevations:

Reduced growth and survival of fry and juvenile rearing CV spring-run Chinook salmon, winter-run Chinook salmon, and CCV steelhead are expected to last at least 50 years after any construction activities associated with bank repair actions at RM 71.3 due to reductions in riparian vegetation along 515 feet of the right bank of the Sacramento River. The amount and extent of this effect is quantified in Table 3. These adverse effects are greatest in Year 1, with a magnitude of -3,744 ft^2 WRI for all Chinook runs, and -6,105 ft^2 for CCV steelhead, and are expected to last for at least 50 years.

Reduced growth and survival of juvenile migrating (smolts) CV spring-run Chinook salmon, is expected for at least 50 years after any construction activities associated with bank repair actions at RM 71.3 due to reductions in riparian vegetation along 515 feet of the right bank of the Sacramento River. The amount and extent of this adverse effect is quantified in Table 3. This adverse effect is greatest in Year 1 following construction, with a magnitude of -24,879 ft^2 WRI for CV spring-run Chinook salmon, and continue for at least 50 years.

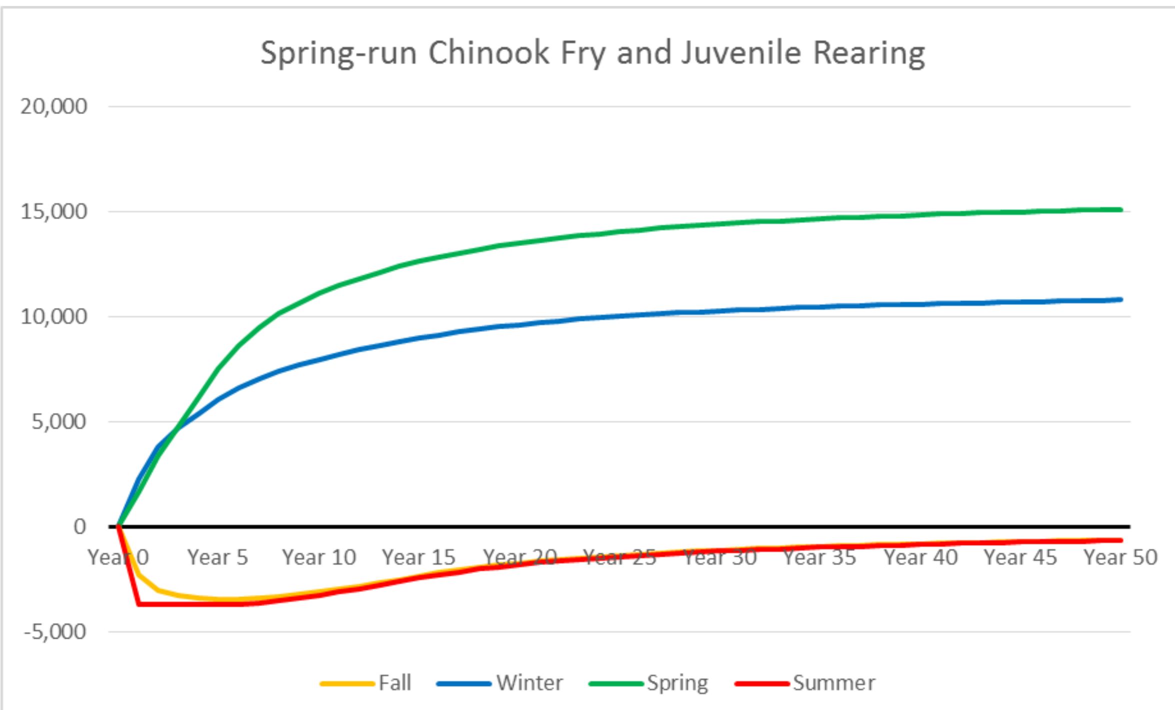

Figure 3. Wetted-area weighted response indices for spring-run Chinook salmon fry and juvenile rearing

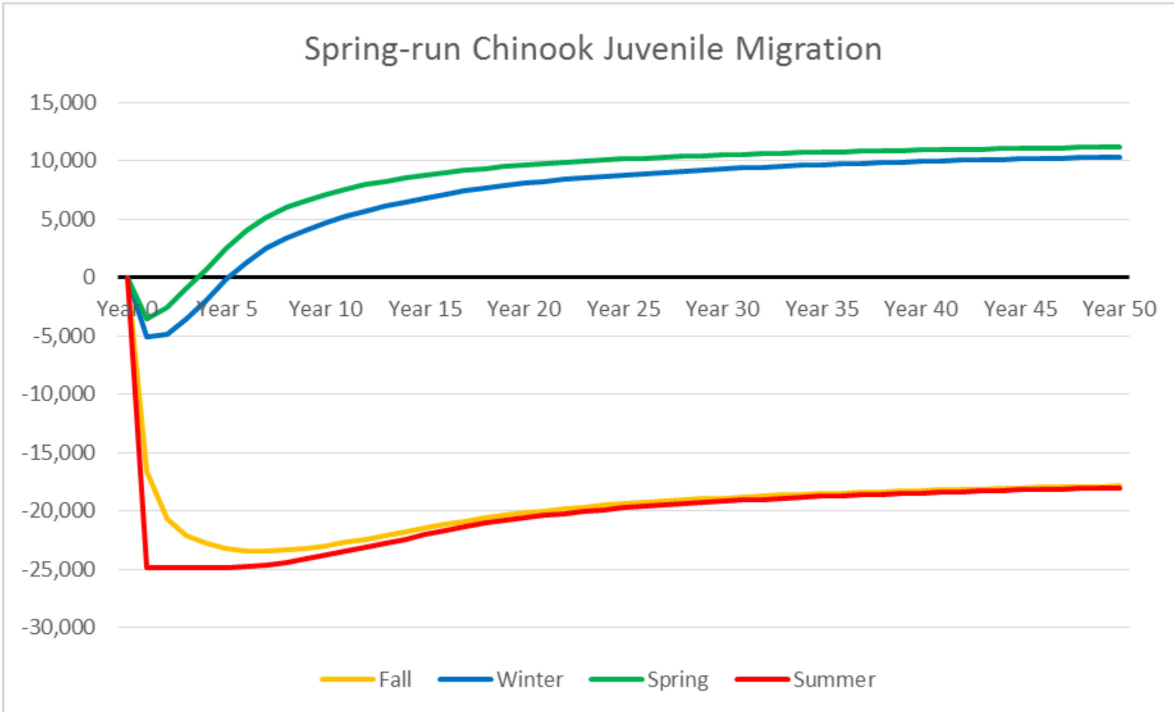

Figure 4. Wetted-area weighted response indices for spring-run Chinook salmon juvenile migration

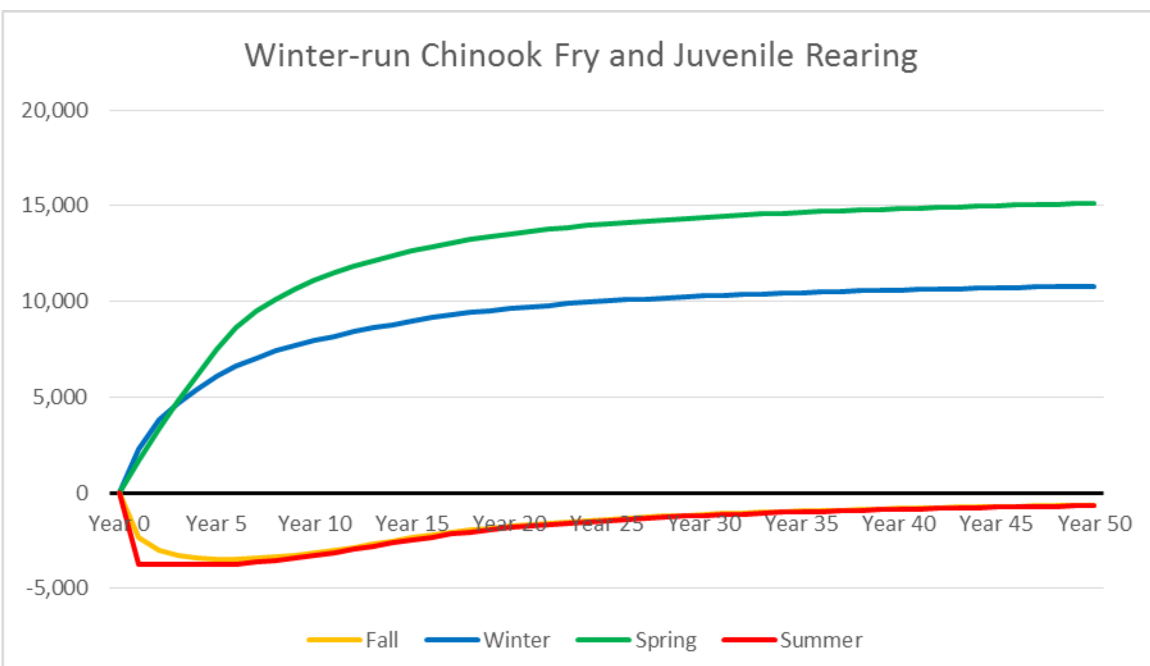

Figure 5. Wetted-area weighted response indices for winter-run Chinook salmon fry and juvenile rearing

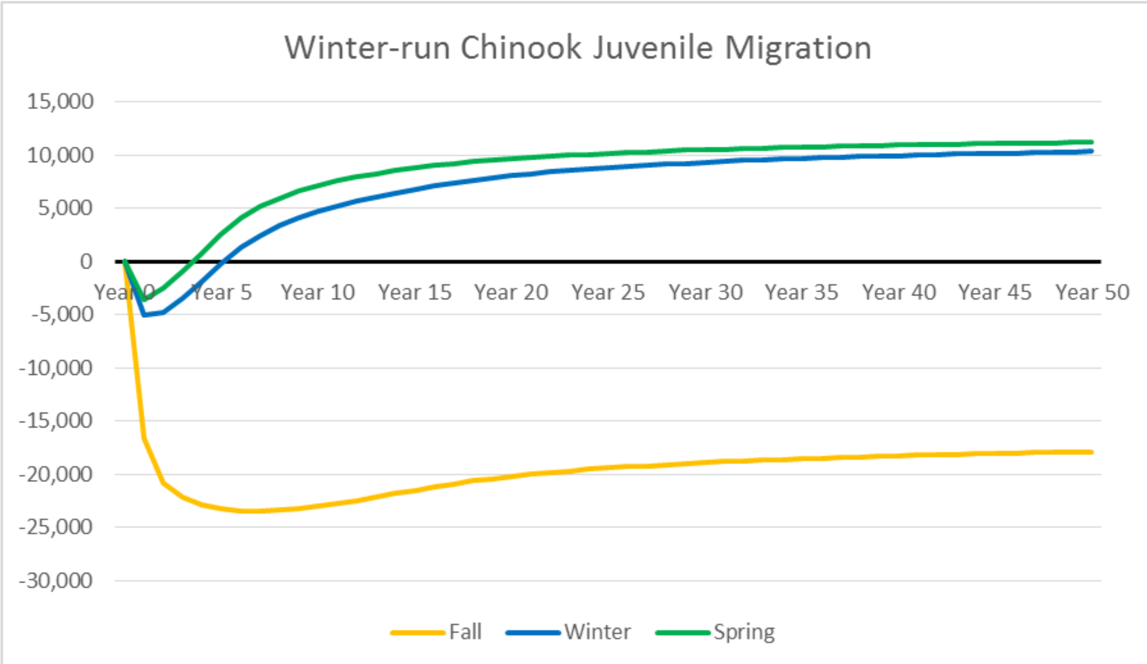

Figure 6. Wetted-area weighted response indices for winter-run Chinook salmon juvenile migration

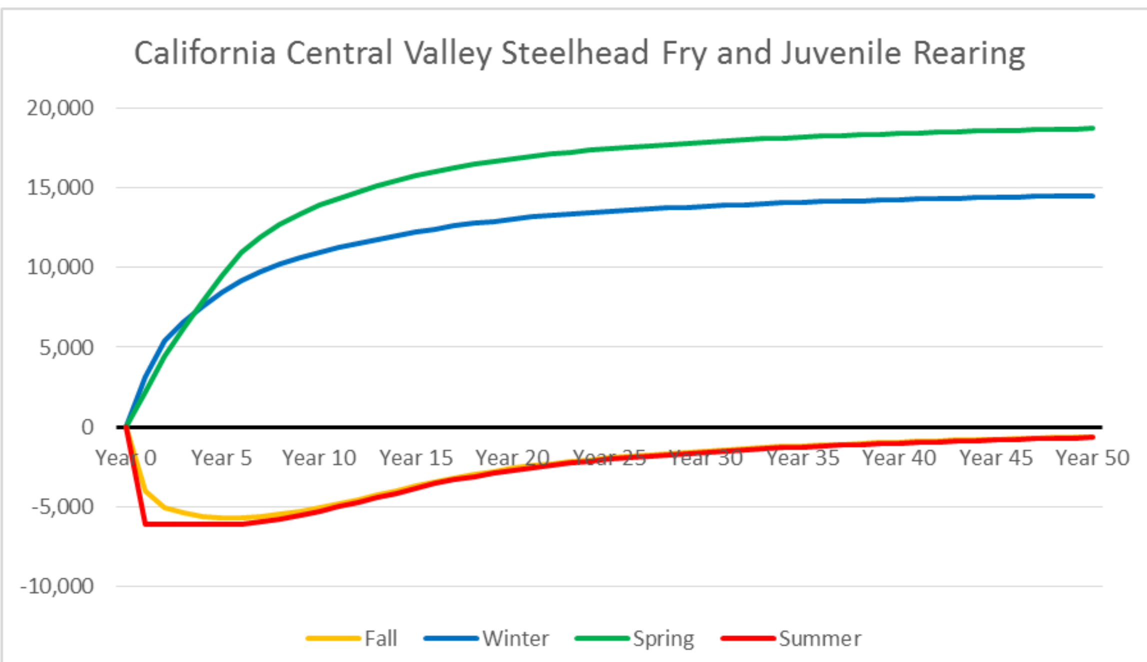

Figure 7. Wetted-area weighted response indices for steelhead fry and juvenile rearing

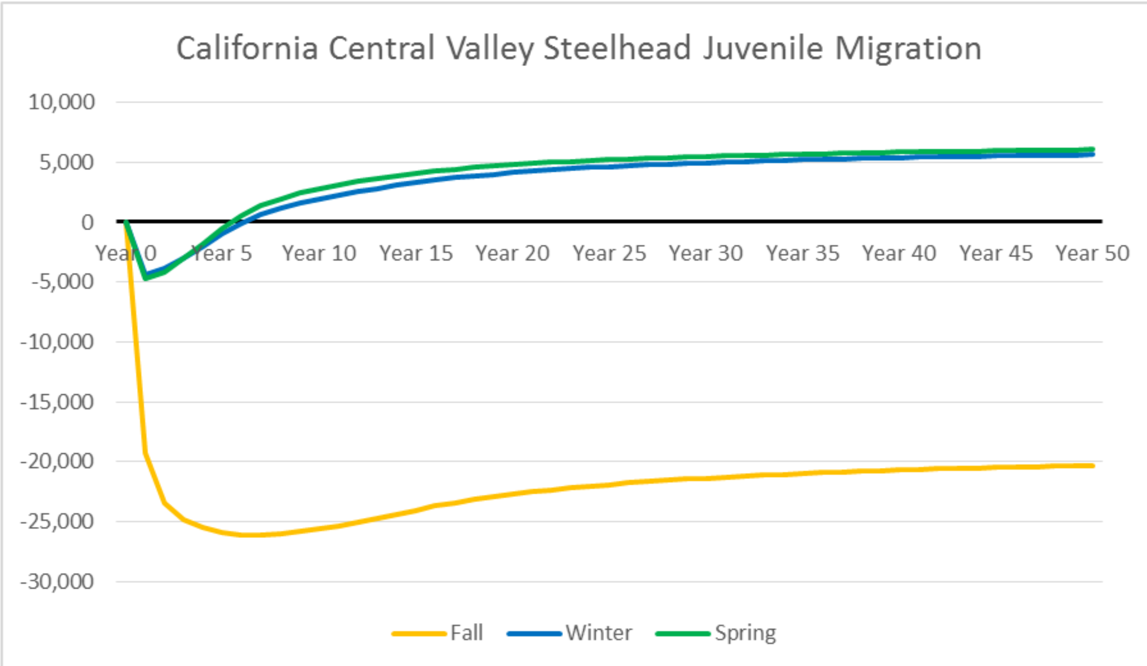

Figure 8. Wetted-area weighted response indices for steelhead juvenile migration

Table 2. Summary of SAM Results for the Proposed Levee Erosion Repair at RM 71.3

Season	Life Stage	Maximum Negative WRI[1] (ft^2)	Duration of Adverse Effect (Years after Construction)	Maximum Positive WRI[1] (ft^2)
Spring-run Chinook Salmon				
Fall	Fry and Juvenile Rearing	-3,475	50+	-
	Juvenile Migration	-23,456	50+	-
Winter	Fry and Juvenile Rearing	-	-	10,795
	Juvenile Migration	-5,043	5	10,317
Spring	Fry and Juvenile Rearing	-	-	15,120
	Juvenile Migration	-3,598	3	11,177
Summer	Fry and Juvenile Rearing	-3,744	50+	-
	Juvenile Migration	-24,879	50+	-
	Juvenile Migration[2]	-	-	-
Winter-run Chinook Salmon				
Fall	Fry and Juvenile Rearing	-3,475	50+	-
	Juvenile Migration	-23,456	50+	-
Winter	Fry and Juvenile Rearing	-	-	10,795
	Juvenile Migration	-5,043	5	10,317
Spring	Fry and Juvenile Rearing	-	-	15,120
	Juvenile Migration	-3,598	3	11,177
Summer	Fry and Juvenile Rearing	-3,744	50+	-
	Juvenile Migration[2]	-	-	-
Steelhead				
Fall	Fry and Juvenile Rearing	-5,693	50+	-
	Juvenile Migration	-26,097	50+	-
	Adult Residence	-23,618	50+	-
Winter	Fry and Juvenile Rearing	-	-	14,489
	Juvenile Migration	-4,371	6	5,632
	Adult Residence	-7,339	50+	-
Spring	Fry and Juvenile Rearing	-	-	18,705
	Juvenile Migration	-4,732	5	6,046
	Adult Residence	-10,037	50+	-
Summer	Fry and Juvenile Rearing	-6,105	50+	-
	Juvenile Migration[2]	-	-	-
	Adult Residence	-24,262	50+	-

[1]Results presented as wetted-area Weighted Response Indices (WRI)

2.5.3 Project Effects to sDPS Green Sturgeon, Estimated Using Habitat Loss as an Analytical Surrogates

The SAM is somewhat limited in its ability to predict a complete range of potential project impacts on all focus fish species and life stages, as it is focused primarily on changes to nearshore/bank habitat. The SAM does not adequately assess potential impacts to deeper benthic habitat where green sturgeon are more likely to be present. Although the SAM model does have a green sturgeon component, NMFS has determined that the model may not have the precision to accurately index green sturgeon responses to changes in modeled habitat attributes and that a more rigorous modeling approach needs development.

Critical habitat for green sturgeon in the action is designated in the Sacramento River below ordinary high water (OHW). For this BO, NMFS has determined the amount of critical habitat covered by rock revetment would serve as the best analytical surrogate for impacts to all life stages of green sturgeon. However, the OHW mark could not be collected at the time of this consultation due to the unusually high flows that occurred during the winter of 2017. Therefore, the amount of bare rock revetment will serve as the analytical surrogate for project effects. The amount of bare rock revetment (no vegetation) installed serves as the best analytical surrogate since it represents a direct quantification of the loss of soft benthic substrate where green sturgeon forage, described in greater detail below.

The proposed project will result in a loss of benthic substrate where adult green sturgeon forage for invertebrates to consume, as a total of 13,684 ft^2 will be permanently covered with bare rock revetment. Thus, adult green sturgeon utilizing the SRBPP RM 71.3 action area are expected to be adversely affected by the proposed project due to the reduction in food availability. Juvenile green sturgeon rearing and migrating in the SRBPP RM 71.3 action area are expected to be impacted by the permanent reduction in available habitat for the same reasons. However, the increase in IWM resulting from the project is expected benefit to juvenile green sturgeon by providing underwater structure.

The green sturgeon adult spawning and egg incubation life stages are not expected to be impacted by the proposed bank repair at RM 71.3, as there is no evidence to support the presence of spawning or egg incubation in the Sacramento River within the action area action area for SRBPP RM 71.3. Spawning and egg incubation are presumed to occur farther upstream. Thus, these life stages are not expected to be impacted by the proposed project.

2.5.4 Project Effects on Critical Habitat

Sacramento River winter-run Chinook salmon, CV spring-run Chinook salmon, and CCV steelhead Critical Habitat

The SAM model, which models fish response, serves as a good proxy for measuring impact to Sacramento River winter-run Chinook salmon, CV spring-run Chinook salmon, CCV steelhead, and because the model evaluates changes to important attributes of PBFs and essential features including overhanging shade, substrate size, instream woody material, bank slope, and instream aquatic vegetation. Therefore the SAM can serve to identify appropriate mitigation for short- and longer-term losses and modifications to PBFs of critical habitat. The changes to these features are recognized in Table 3 above.

SAM modeled impacts to PBFs for these species generally will last for 1 to at least 50 years and result from loss or modification of riparian vegetation. These losses and modifications affect juvenile rearing and migration PBFs by reducing in-stream cover, food production, and the quantity of sediment that allow for normal physiological and behavioral responses to the environment. However, with purchase of off-site mitigation, planting of riparian habitat onsite, and the implementation of conservation measures, impacts to PBFs will be adequately compensated. The purchase of credits at a mitigation bank would occur concurrently with implementation of the proposed action, which would ensure that no temporal loss to habitat is experienced. For these reasons we do not expect project impacts to the quality and availability of PBFs of critical habitat in this reach of the river to impact the current function of the action area or affect its ability to reestablish essential features that have been impacted by past and current actions. Therefore, we do not expect project-related impacts to reduce the conservation value of designated critical habitat of Sacramento River winter-run Chinook salmon, CV spring-run Chinook salmon, CCV steelhead.

Southern DPS of the North American Green Sturgeon Critical Habitat

The bank repair at RM 71.3 is expected to cause a reduction in critical habitat by permanently replacing up to 13,684 ft^2 of the natural river bed with bare rock revetment. The project is expected to adversely impact several of the essential features of critical habitat for sDPS green sturgeon. The PBF of food resources, which refers to the availability of prey items for juvenile, subadult, and adult life stages, is expected be adversely affected by the installation of 13,684 ft^2 bare rock revetment at the toe of the bank repair. The rock revetment will permanently cover 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 river bed will be permanently covered with large rocks and will no longer be available as foraging habitat.

SRBPP RM 71.3 is not expected to impact the PBFs of water flow or water quality, migration corridors (migratory pathways necessary for the safe and timely passage of all life stages), or depth (availability of deep pools for use as holding habitat).

2.6 Cumulative Effects

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

Some continuing non-Federal activities are reasonably certain to contribute to 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 Section 2.2.5.

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 results in dramatic reductions in natural population abundance which is mitigated for through the operation of hatcheries. Salmonid hatcheries can, however, have additional negative effects on ESA-listed salmonid populations. The high level of hatchery production in the 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 fish, predation of hatchery fish on wild fish, and increased fishing pressure on wild stocks as a result of hatchery production. Impacts of hatchery fish can occur in both freshwater and the marine ecosystems. Limited marine carrying capacity has implications for naturally produced fish experiencing competition with hatchery production. Increased salmonid abundance in the marine environment may also decrease growth and size at maturity, and reduce fecundity, egg size, age at maturity, and survival (Bigler *et al.* 1996). 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-suspension of 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 within the Sacramento River watershed. For example, most of the levees have roads on top of the levees which are either maintained by the county, reclamation district, owner, or by the state. Landowners may utilize 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 project.

2.7 Integration and Synthesis

The *Integration and Synthesis* section is the final step of NMFS' assessment of the risk posed to species and critical habitat as a result of the proposed action. In this section, NMFS performs two evaluations: whether, given the environmental baseline and status of the species and critical habitat, as well as future cumulative effects, it is reasonable to expect the proposed action is not likely to: (1) reduce the likelihood of both survival and recovery of the species in the wild; and (2) result in the destruction or adverse modification of designated critical habitat (as determined by whether the critical habitat will remain functional to serve the intended conservation role for the listed anadromous species or retain its current ability to establish those features and functions essential to the conservation of the species).

The *Analytical Approach* described the analyses and tools we have used to complete this analysis. This section is based on analyses provided in the *Status of the Species*, the *Environmental Baseline*, and the *Effects of the Action*.

In our *Status of the Species* section, NMFS summarized the current likelihood of extinction of each of the listed species. We described the factors that have led to the current listing of each species under the ESA across their ranges. These factors include past and present human activities and climatological trends and ocean conditions that have been identified as influential to the survival and recovery of the listed species. Beyond the continuation of the human activities affecting the species, we also expect that ocean condition cycles and climatic shifts will continue to have both positive and negative effects on the species' ability to survive and recover. The *Environmental Baseline* reviewed the status of the species and the factors that are affecting their survival and recovery in the action area. The *Effects of the Action* reviewed the exposure of the species and critical habitat to the proposed action and interrelated and interdependent actions, cumulative effects. NMFS then evaluated the likely responses of individuals, populations, and critical habitat. The *Integration and Synthesis* will consider all of these factors to determine the proposed action's influence on the likelihood of both the survival and recovery of the species, and on the conservation value of designated critical habitat.

The criteria recommended for low risk of extinction for Pacific salmonids are intended to represent a species and populations that are able to respond to environmental changes and withstand adverse environmental conditions. Thus, when our assessments indicate that a species or population has a moderate or high likelihood of extinction, we also understand that future adverse environmental changes could have significant consequences on the ability of the species to survive and recover. Also, it is important to note that an assessment of a species having a moderate or high likelihood of extinction does not mean that the species has little or no chance to survive and recover, but that the species faces moderate to high risks from various processes that can drive a species to extinction. With this understanding of both the current likelihood of extinction of the species and the potential future consequences for species survival and recovery, NMFS will analyze whether the effects of the proposed action are likely to in some way increase the extinction risk each of the species faces.

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

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

The basis of the “destruction or adverse modification” analysis is to evaluate whether the proposed action results in negative changes in the function and role of the critical habitat in the conservation of the species. As a result, NMFS bases the critical habitat analysis on the affected areas and functions of critical habitat essential to the conservation of the species, and not on how individuals of the species will respond to changes in habitat quantity and quality.

2.7.1 Status of the Sacramento River Winter-Run Chinook Salmon ESU

Lindley et al. (2007) determined that the winter-run population is at a moderate extinction risk according to population viability analysis, and at a low risk according to other criteria (i.e., population size, population decline, the risk of wide ranging catastrophe, hatchery influence). Data used in Lindley et al. (2007) did not include the significant decline in escapement numbers from 2007 to 2012. Lindley et al. (2007) also states that the winter-run ESU fails the “representation and redundancy rule” because it has only one population and that population spawns outside of the eco-region in which it evolved. An ESU represented by only one spawning population at moderate risk of extinction is at a high risk of extinction (Lindley et al. 2007). NMFS concludes that the winter-run ESU remains at a 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 has moved the Mill and Deer creek populations from the high extinction risk category, to moderate, and Butte Creek has remained in the low risk of extinction category. Additionally, the Battle Creek and Clear Creek populations have continued to show stable or increasing numbers the last five years, 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) has probably improved since the 2010/2011 status review and that the ESU’s extinction risk may have decreased, however the ESU is still facing significant extinction risk, and that risk is likely to increase over at least the next few years as the full effects of the recent drought are realized (NMFS 2016b).

2.7.3 Status of the CCV Steelhead DPS

The 2016 status review (NMFS 2016a) concluded that overall, the status of CCV steelhead appears to have changed little since the 2011 status review when the Technical Recovery Team concluded that the DPS was in danger of extinction. Further, 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 the last few 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 and dam removal 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 previous 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 (National Marine Fisheries Service 2010a).

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 *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 (National Marine Fisheries Service 2010a).

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

The action area is used by most diversity groups and populations of the salmon, steelhead and green sturgeon ESUs and DPSs that are the subject of this BO. 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 or future effects such as the discharge of point and non-point source chemical contaminant discharges, aquaculture and hatcheries and increased urbanization 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.

2.7.6 Summary of Project Effects on Sacramento River Winter-run Chinook salmon, CV spring-run Chinook salmon, CCV steelhead and sDPS Green Sturgeon Individuals

1. Construction and O&M-related Effects

During construction and O&M, some injury or death to individual fish could result from rock placement (crushing), or predation related to displacement of individuals away from the shoreline or at the margins or turbidity plumes. These construction type actions will occur during summer and early fall months, when the abundance of individual salmon and steelhead is low and should result in correspondingly low levels of injury or death.

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

For juvenile and outmigrating salmon and steelhead, the proposed action will result in some short term and long term adverse effects to individual salmon and steelhead that are exposed to the project features along the Sacramento River. These adverse effects are indexed by SAM model results and expressed as WRI deficits. The project results in long term WRI deficits for rearing and migrating juvenile salmon and steelhead at summer and fall water surface elevations, and do not recover over the 50 years modeled by the SAM analysis. In winter and spring, outmigrating salmon and steelhead will generally experience initial adverse effects in the years following the levee repair, but long term WRI values are positive. For juvenile and fry salmon and steelhead, both short term and long term WRI values in spring and winter are positive.

Migrating Chinook and steelhead residents (outmigrating post spawning adults) will likely not be impacted because adult salmonids are unlikely to use the nearshore habitat that will be affected by this project, as they prefer deeper water instead. Furthermore, the project is not anticipated to cause an increase in predation or install any structural features that might impede adult migration.

Although the project will result in a loss of benthic substrate where juvenile green sturgeon forage for food (13,684 ft^2), the project will result in an increase in IWM, which is expected benefit to juvenile green sturgeon by providing underwater structure. Similarly, adult green sturgeon will also be adversely affected by the loss of benthic habitat due to the reduction in food availability. However, the amount of benthic substrate lost is small compared to the amount of available habitat in the Sacramento River.

Because of the relatively small size of the project, the favorable response of many life stages to integrated conservation measures, the installation of riparian habitat onsite, and the USACE proposal to purchase compensatory mitigation credits, the action is not likely to appreciably reduce the survival or recovery of anadromous salmonids or green sturgeon.

2.7.7 Summary of Project 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 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, substrate type/size, flow, water quality, migration corridor free of passage impediments, depth (holding pools), and sediment quality.

Based on SAM modeled WRIs, we expect reductions in the value of PBFs for salmon and steelhead freshwater rearing, but these reductions are at fall and summer water surface elevations and not at water surface elevations when the habitat use is the highest and most significant. Green sturgeon PBFs of substrate type/size and food resources are expected to both be impacted by the proposed project, as project features will cover the soft benthic substrate where green sturgeon forage for food with riprap. As mitigation for these some of these impacts, the USACE plans to purchase credits from a NMFS-approved conservation bank at a 1:1 ratio equal to the largest WRI deficit for all life stages and seasons for salmonids (0.60 acres). Because of the relatively small size of the project, the favorable response of many life stages to integrated conservation measures, the installation of riparian habitat onsite, and the USACE proposal to purchase compensatory mitigation credits, the action is not likely to appreciably reduce the conservation value of designated critical habitat.

2.7.8 Summary

Although there are some short-term and SAM modeled WRI deficits, the effects of these deficits, when added to the environmental baseline and cumulative effects in the action area are small, and in some cases occur during seasons when fish abundance is low. To mitigate for some of the impacts of the RM 71.3 levee repair, the USACE plans install a riparian bench on the waterside levee slope and purchase mitigation credits off-site at a 1:1 ratio. The project is not expected to increase the extinction risk of the Sacramento River winter-run Chinook salmon, CV spring-run Chinook salmon, CCV steelhead or sDPS green sturgeon or reduce the conservation value of their 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' biological opinion that the Proposed Action is not likely to jeopardize the continued existence of CCV steelhead, Sacramento River Winter-run Chinook Salmon, CV spring-run Chinook salmon, or the sDPS of the North American green sturgeon or destroy or adversely modify designated critical habitat of these species.

2.9 Incidental Take Statement

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

The measures described below are non-discretionary, and must be undertaken by the USACE so that they become binding conditions of any grant, contract or permit, as appropriate, for the exemption in section 7(o)(2) to apply. The USACE has a continuing duty to regulate the activity covered by this incidental take statement. If the USACE: (1) fails to assume and implement the terms and conditions, or (2) fails to require the permittee, contractor, or grantee to adhere to the terms and conditions of the incidental take statement through enforceable terms that are added to the permit, contract or grant document, the protective coverage of section 7(o)(2) may lapse. In order to monitor the impact of incidental take, the USACE must report the progress of the action and its impact on the species to NMFS as specified in the incidental take statement (50 CFR §402.14(i)(3)).

2.9.1 Amount or Extent of Take

NMFS anticipates incidental take of Sacramento River winter-run Chinook salmon, CV spring-run Chinook salmon, CCV steelhead, and the sDPS of North American green sturgeon in the action area through the implementation of the proposed action. NMFS cannot, using the best available information, quantify the anticipated incidental take of these species because of the variability and uncertainty associated with the population size of each species, annual variations in the timing of migration, and uncertainties regarding individual habitat use of the project area. However, it is possible to describe the general programmatic conditions and ecological surrogates using negative SAM WRI values. Accordingly, NMFS is quantifying take of Sacramento River winter-run Chinook salmon, CV spring-run Chinook salmon, CCV steelhead, and the sDPS of North American green sturgeon incidental to the action resulting from short-term construction impacts, as well as long-term impacts as indexed by the SAM model.

The amount and extent of take described below is in the form of harm due to habitat impacts that will reduce the growth and survival of individuals from predation, or by causing fish to relocate and rear in other locations and reduce the carrying capacity of the existing habitat. This SAM values represent the extent of habitat impacts that will harm fish. As described in the *Analytical Approach* and the *Effects of the Action* sections of this BO, the SAM values represent an index of fish response to habitat variables to which fish respond including bank slope, bank substrate size, instream structure, overhanging shade, aquatic vegetation and floodplain availability. Positive SAM values represent a positive growth and survival response and negative values index negative growth and survival. There is not a stronger ecological surrogate based on the information available. Due to a lack of site-specific fish data, the exact number of fish that will be affected is not known. The take related to project monitoring is not included below, because it was already described and exempted in the programmatic BO for Phase II of the SRBPP. The following level of incidental take from program activities is anticipated:

Incidental Take Associated with Construction:

1. Take of Sacramento River winter-run Chinook salmon, CV spring-run Chinook salmon, CCV steelhead, and sDPS of North American green sturgeon in the form of injury and death from predation caused by construction-related turbidity that extends up to 100 feet from the shoreline, and 400 feet downstream, along the project reach for levee construction activities.

2. Take of Sacramento River winter-run Chinook salmon, CV spring-run Chinook salmon, CCV steelhead, and the sDPS of North American green sturgeon, in the form of harm or injury of fish is expected from habitat-related disturbances from the placement of up to 13,684 ft^2 of quarry stone and 33,837 ft^2 of soil filled quarry stone. Take will be in the form of harm to the species through modification or degradation of the PBFs for rearing and migration that reduces the carrying capacity of habitat.

Incidental Take Associated with Operations and Maintenance

1. Take of Sacramento River winter-run Chinook salmon, CV spring-run Chinook salmon, CCV steelhead, and the sDPS of North American green sturgeon, in the form of harm from O&M actions is expected from habitat-related disturbances from the placement of up to 600 cubic yards of material per site under the programmatic BO for the extent of the project life (i.e., 50 years). Take will be in the form of harm to the species through modification or degradation of the PBFs for rearing and migration that reduces the carrying capacity of habitat.

Incidental Take Associated with Exposure to Project Facilities:

<u>Sacramento River Winter-run Chinook salmon, CV spring-run Chinook salmon, CCV steelhead</u>

***At fall water surface elevations*:**

1. Take in the form of harm to fry and juvenile rearing CV spring-run Chinook salmon, winter-run Chinook salmon and CCV steelhead for at least 50 years after project construction due to reductions in riparian habitat. The amount and extent of harm is quantified in Table 3 of this BO. Table 3 shows the amount and extent of harm is greatest in year 6 for each species at -3,475 ft^2 WRI, -3,475 ft^2 WRI, and -5,693 ft^2 WRI respectively, and continue for at least 50 years.

2. Take in the form of harm to juvenile migrating (smolts) CV spring-run Chinook salmon, winter-run Chinook salmon and CCV steelhead for at least 50 years after project construction due to reductions in riparian habitat. The amount and extent of harm is quantified in Table 3 of this BO. Table 3 shows the amount and extent of harm is greatest in year 7 for each species at -23,456 ft^2 WRI, -23,456 ft^2 ft^2 WRI, and -26,097 ft^2 WRI, respectively.

At winter water surface elevations:

1. Take in the form of harm to juvenile migrating (smolts) CV spring-run Chinook salmon, and winter-run Chinook salmon is expected for at least 5 years after construction and take of juvenile migrating (smolts) CCV steelhead is expected for at least 6 years after any construction due to reductions in riparian vegetation. The amount and extent of this adverse effect is quantified in Table 3. These adverse effects are greatest in Year 1 following construction, with a magnitude of –5,043 ft^2 WRI for all Chinook runs and -4,371 ft^2 WRI for CCV steelhead. Following Year 6 for all Chinook runs and Year 7 for CCV steelhead, the SAM modelled habitat conditions exceed baseline conditions and harm from habitat modification is not expected.

At spring water surface elevations:

1. Take in the form of harm to juvenile migrating (smolts) CV spring-run Chinook salmon, and winter-run Chinook salmon is expected for at least 3 years after construction and take of juvenile migrating (smolts) CCV steelhead is expected for at least 5 years after any construction due to reductions in riparian vegetation. The amount and extent of harm is quantified in Table 3 of this BO. These adverse effects are greatest in Year 1 following construction, with a magnitude of –3,598 ft^2 WRI for all Chinook runs and -4,732 ft^2 WRI for CCV steelhead. Following Year 4 for all Chinook runs and Year 6 for CCV steelhead, the SAM modelled habitat conditions exceed baseline conditions and harm from habitat modification is not expected.

***At summer water surface elevations*:**

1. Take in the form of harm to fry and juvenile rearing CV spring-run Chinook salmon, winter-run Chinook salmon and CCV steelhead for at least 50 years after project construction due to reductions in riparian habitat. The amount and extent of harm is quantified in Table 3 of this BO. These adverse effects are greatest in Year 1, with a magnitude of -3,744 ft^2 WRI for all Chinook runs, and -6,105 ft^2 for CCV steelhead, and are expected to last for at least 50 years.

2. Take in the form of harm to juvenile migrating (smolt) CV spring-run Chinook salmon, for at least 50 years after project construction due to reductions in riparian habitat. The amount and extent of harm is quantified in Table 3 of this BO. These adverse effects are greatest in Year 1 following construction, with a magnitude of -24,879 ft^2 WRI for CV spring-run Chinook salmon, and continue for at least 50 years.

Southern DPS of the North American Green Sturgeon

1. Take in the form of harm to juvenile rearing, juvenile migrating, and adult sDPS green sturgeon due to permanent replacement of 13,684 ft^2 of benthic habitat with bare quarry stone.

2.9.2 Effect of the Take

In the BO, NMFS determined that the amount or extent of anticipated take, coupled with other effects of the proposed action, is not likely to result in jeopardy to the Sacramento River winter-run Chinook salmon, CV spring-run Chinook salmon, CCV steelhead, and sDPS green sturgeon or destruction or adverse modification of their critical habitat.

2.9.3 Reasonable and Prudent Measures

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

1. Measures shall be taken to maintain, monitor, and adaptively manage all conservation measures throughout the life of the proposed project to ensure their effectiveness.
2. Measures shall be taken to minimize the impacts of bank protection by implementing integrated onsite and off-site conservation measures that provide beneficial growth and survival conditions for juvenile salmonids, and the sDPS of North American green sturgeon.
3. Measures shall be taken to ensure that contractors, construction workers, and all other parties involved with these projects implement the projects as proposed in the biological assessment and this BO.
4. Measures shall be taken to ensure that USACE levee vegetation management policies that influence SRBPP 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.

2.9.4 Terms and Conditions

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

1. Measures shall be taken to maintain, monitor, and adaptively manage all conservation measures throughout the life of the proposed project to ensure their effectiveness.

a. The USACE shall continue to coordinate with the IWG agencies and the Technical Team of the Interagency Collaborative Flood Management Program during the implementation and monitoring of this repair.
b. The USACE shall update their O&M Manual to ensure that the self-mitigating efforts and repair designs meet the expectation of the SAM values.
c. The USACE shall provide additional annual reports, as necessary, to describe the implementation of O&M actions, and summarize monitoring results.
d. The USACE shall increase the duration of project-specific monitoring from 5 to 10 years for all SAM-modeled measures. This requirement is based on the need to help validate that projects with SAM-modeled results are on a positive trajectory and successfully reaching or exceeding baseline values. Monitoring the effectiveness of the measures installed to meet SAM values may require scientific inquiry that extends beyond in-stream data collection. Tools such as computer modeling and hydraulic models as well as tagging studies should be used as necessary to assess the relative value of each element of the SAM model. In-stream studies must include sampling procedures to determine species composition and abundance together with physical observations and measurements at selected construction and control sites.
e. The USACE shall ensure that, for the life of the project, future maintenance actions ensure performance of the site to a level necessary to retain the SAM-modeled habitat values.
f. The USACE shall begin implementation of a Green Sturgeon Habitat Mitigation and Monitoring Program (HMMP). At a minimum, this shall include developing a work plan for implementation of the HMMP elements that have been described in the NMFS 2015 BOs for the West Sacramento and American River GRRs. This work plan should a plan for conducting pre- and post-project hydraulic monitoring of the action area, conducting benthic sampling in order to evaluate green sturgeon food availability, and developing a compensatory mitigation strategy for offsetting the spatial footprint of permanently lost benthic habitat that will occur as a result of project construction. The compensatory mitigation strategy shall account for temporal effects between project implementation and implementation of the mitigation measures. If the mitigation occurs offsite, the initial compensatory mitigation rate shall be at a 3:1 ratio to the project footprint. USACE shall send this work plan to NMFS within 60 days of receiving this BO. Benthic sampling and green sturgeon diet studies shall be conducted in collaboration with the Interagency Ecological Program (IEP).

2. Measures shall be taken to minimize the impacts of bank protection by implementing integrated onsite and off-site conservation measures that provide beneficial growth and survival conditions for juvenile salmonids, and the sDPS of North American green sturgeon.

   a. The USACE shall minimize the removal of existing riparian vegetation and IWM to the maximum extent practicable, and where appropriate, removed IWM will be anchored back into place. The trunks of trees left in place shall be protected from construction damage by wrapping them with coir fiber, jute fabric, 2X4s or other mechanisms that prevent trunk damage while minimizing the risk or levee scour.

b. The USACE shall purchase salmon and steelhead credits from a NMFS-approved conservation bank to compensate for the impacts to salmonids resulting from the project. Although the riparian plantings are expected to offset some of the impacts of vegetation removal at some water surface elevations, it will take time for the these plants to mature enough to fully replace the benefits lost by removal of riparian vegetation. The purchase of credits is necessary to adequately mitigate for this temporal loss of riparian habitat. Furthermore salmonid life stages present at summer and fall life stages experience a significant and permanent loss of habitat. The credit purchase shall be at a 1:1 ratio of the highest negative SAM value (0.60 acres, or 26,079 ft^2 of credits).

3. Measures shall be taken to ensure that contractors, construction workers, and all other parties involved with this project implement the project as proposed.

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

4. Measures shall be taken to ensure that USACE levee vegetation management policies that influence the SRBPP are based on best available science and consider the potential benefits of levee vegetation to levee integrity, public safety, and ESA-listed fish species.

   a. The USACE shall sponsor an independently facilitated workshop, inviting NMFS, USFWS, CDFW, DWR, local maintainers such as Sacramento Area Flood Control Agency, and the authors of the Synthesis of Levee Vegetation Research Results (2007-2014) to discuss the conclusions of this report and how local tree risk models that incorporate the best available science can be used in future risk assessments for levee repair programs.
   b. USACE tree risk assessments for SRBPP shall consider the 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.

    a. Construction involving the placement of rock revetment below the OHW will occur in accordance with BMPs and conservation measures described in the programmatic BO.
    b. Updates and reports required by these terms and conditions shall be submitted to:

       Maria Rea
       Central Valley Area Office
       National Marine Fisheries Service
       650 Capitol Mall, Suite 5-100
       Sacramento CA 95814
       FAX: (916) 930-3629
       Phone: (916) 930-3600

2.10 Conservation Recommendations

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

1. The 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 and salmonid habitat. The USACE should consider remediating one of these sites as mitigation for the next consultation to be completed under the SRBPP programmatic if there are impacts to green sturgeon habitat.

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 Sacramento River Bank Protection Program - 80,000 linear feet (SRBPP 80,000 lf) 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:

    g. Developing a prioritization framework for SRBPP 80,000 lf with a project design hierarchy the starts with set-back levees and landside levee repairs.
    h. Proactively seeking variance solutions ahead of consultation requests and/or project planning and implementation.

i. Proactively conducting real-estate investigations for landside work before consultation requests and/or project planning and implementation.
j. 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.
k. Proactively investigating and planning rock removal projects to mitigate future placement of revetment in critical habitat. For example, the USACE Chico Landing to Red Bluff project has legacy rock placement areas that are not serving any purpose toward protecting human safety and could be removed to facilitate riverine function such as side channel and floodplain inundation.

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

2.11 Reinitiation of Consultation

This concludes formal consultation for the Sacramento River Bank Protection Project (SRBPP) River Mile 71.3.

As 50 CFR 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 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 USACE and descriptions of EFH for Pacific coast salmon contained in the fishery management plans developed by the Pacific Fishery Management Council and approved by the Secretary of Commerce.

3.1 Essential Fish Habitat Affected by the Project

EFH designated under the Pacific Coast Salmon Fisheries Management Plan (FMP) may be affected by the Proposed Action. Additional 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.

3.2 Adverse Effects on Essential Fish Habitat

Construction activities would result in increased sedimentation, turbidity, and the potential for contaminants to enter the waterway. Installation of revetment would result in adverse effects to Pacific coast salmon EFH due to losses of riparian habitat and natural substrate. Effects to the HAPCs listed in Section 3.1 are discussed in context of effects to critical habitat PBFs as designated under the ESA in Section 2.5 and subsections. Effects to ESA-listed critical habitat and EFH HAPCs are appreciably similar, therefore no additional discussion is included. A list of temporary and permanent adverse effects to EFH HAPCs is included in this EFH consultation. Affected HAPCs are indicated by number, corresponding to the list in Section 3.1:

<u>Sedimentation and Turbidity</u>

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

<u>Contaminants and Pollution-related Effects</u>

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

<u>Installation of Revetment</u>

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

<u>Removal of Riparian Vegetation</u>

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

The terms and conditions and conservation recommendations in the preceding BO contain adequate measures to avoid, minimize, or otherwise offset the adverse effects to EFH. Therefore, NMFS has no additional EFH conservation recommendations to provide.

3.3 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 600.920(l)).

4. DATA QUALITY ACT DOCUMENTATION AND PRE-DISSEMINATION REVIEW

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

4.1 Utility

Utility principally refers to ensuring that the information contained in this consultation is helpful, serviceable, and beneficial to the intended users. The intended user of this BO is the Army Corps of Engineers. Other interested users could include the United States Fish and Wildlife Service and California Department of Fish and Wildlife. Individual copies of this BO were provided to USACE. This BO will be posted on the Public Consultation Tracking System website (https://pcts.nmfs.noaa.gov/pcts-web/homepage.pcts). The format and naming adheres to conventional standards for style.

4.2 Integrity

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

4.3 Objectivity

Information Product Category: Natural Resource Plan

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

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

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

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

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