



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

Refer to NMFS ECO #: WCR-2022-02946

December 05, 2022

Marshall K. Harper
Chief, Environmental Resources Branch
Planning Division
1325 J Street
Sacramento, California 95814

Re: Endangered Species Act Section 7(a)(2) Biological Opinion for the Sacramento River Bank Protection Project Benthic Sampling Program Reinitiation.

Dear Mr. Harper:

Thank you for your request on October 12, 2022, 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 monitoring associated with the Sacramento River Bank Protection Project Post-Authorization Change Report Program. The Program was previously analyzed in a Framework Programmatic Biological Opinion (WCRO-2019-01893). This consultation was conducted in accordance with the 2019 revised regulations that implement section 7 of the ESA (50 CFR Part 402, as amended; 84 Fed. Reg. 44976, 45016 (August 27, 2019)).

The enclosed biological opinion, based on the best available scientific and commercial information, concludes that the proposed monitoring is not likely to jeopardize the continued existence of the federally listed endangered Sacramento River winter-run Chinook salmon (*Oncorhynchus tshawytscha*) evolutionarily significant unit (ESU), the threatened Central Valley spring-run Chinook salmon ESU (*O. tshawytscha*), the threatened southern distinct population segment (DPS) of the North American green sturgeon (*Acipenser medirostris*), and the threatened California Central Valley steelhead DPS (*O. mykiss*).

Please contact Ally Bosworth in the NMFS West Coast Region's California Central Valley Office at (916)-358-0117 or via email at Allison.Bosworth@noaa.gov if you have any questions concerning this consultation, or if you require additional information.



Sincerely,

A. Catharine Marcinkevage

Cathy Marcinkevage
Assistant Regional Administrator
California Central Valley Office

Enclosure

cc: ARN 151422-WCR2017-SA00268
Miranda Douth, USACE Environmental Manager, miranda.s.douth@usace.army.mil
Ashley Lopez, USACE Environmental Manager, ashley.k.lopez@usace.army.mil



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

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

Sacramento River Bank Protection Project Benthic Sampling Program

NMFS Consultation ECO Number: WCR-2022-00148

Action Agency: U.S. Army Corps of Engineers

Affected Species and NMFS' Determinations:

ESA-Listed Species	Status	Is Action Likely to Adversely Affect Species?	Is Action Likely to Jeopardize the Species?	Is Action Likely to Adversely Affect Critical Habitat?	Is Action Likely to Destroy or Adversely Modify Critical Habitat?
Sacramento River winter-run Chinook salmon ESU (<i>Oncorhynchus tshawytscha</i>)	Endangered	Yes	No	No	No
Central Valley spring-run Chinook salmon ESU (<i>O. tshawytscha</i>)	Threatened	Yes	No	No	No
California Central Valley steelhead Distinct Population Segment (DPS) (<i>O. mykiss</i>)	Threatened	Yes	No	No	No
Southern DPS North American green sturgeon (<i>A. medirostris</i>)	Threatened	Yes	No	No	No

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

Issued By: *A. Catharine Marcinkevage*
 Cathy Marcinkevage
 Assistant Regional Administrator, California Central Valley Office

Date: December 5, 2022



TABLE OF CONTENTS

1. Introduction..... 1
1.1. Background..... 1
1.2. Consultation History..... 1
1.3. Proposed Federal Action 2

2. Endangered Species Act: Biological Opinion And Incidental Take Statement 3
2.1. Analytical Approach..... 3
2.2. Rangewide Status of the Species and Critical Habitat 5
 2.2.1. Recovery Plans11
 2.2.2. Global Climate Change11
2.3. Action Area 12
2.4. Environmental Baseline..... 12
2.5. Effects of the Action..... 13
2.6. Cumulative Effects 14
2.7. Integration and Synthesis 14
 2.7.1. Summary Status of the Species, Environmental Baseline, and Cumulative
 Effects15
2.8. Conclusion..... 17
2.9. Incidental Take Statement 17
 2.9.1. Amount or Extent of Take.....17
 2.9.2. Effect of the Take18
 2.9.3. Reasonable and Prudent Measures18
 2.9.4. Terms and Conditions.....18
2.10. Conservation Recommendations 19
2.11. Reinitiation of Consultation 19

3. Data Quality Act Documentation and Pre-Dissemination Review..... 20
3.1. Utility..... 20
3.2. Integrity 20
3.3. Objectivity 20

4. References 21

TABLE OF TABLES

Table 1. Description of species, current Endangered Species Act (ESA) listing classifications, and summary of species status.	5
Table 2. Description of critical habitat, listing, and status summary.	8
Table 3. Approximate Location of SRBPP PACR Benthic Sampling, by River Mile.	12

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 U.S.C. 1531 *et seq.*), as amended, and implementing regulations at 50 CFR part 402.

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

1.2. Consultation History

- **30 August 2019** – NMFS issued the Sacramento River Bank Protection Project Post-Authorization Change Report (SRBPP PACR) Program BO (NMFS 2019). U.S. Army Corps of Engineers (USACE) proposed the development of a Green Sturgeon Habitat Mitigation and Monitoring Plan (HMMP) in multiple bank repair projects in the Central Valley, including the SRBPP PACR Program. As described in the SRBPP PACR Program BO, in-river monitoring will be implemented pre-construction to reflect any changes to species using the bank repair areas. Monitoring is also to occur during construction, and will continue post-construction.
- **14 January 2022** – NMFS received the request for ESA section 7 consultation for SRBPP Benthic Sampling Program associated with the Green Sturgeon HMMP.
- **28 January 2022** – NMFS determined there was insufficient information and requested more information regarding the frequency of sampling and clarifying sampling protocol from USACE.
- **31 January 2022** – USACE provided additional information. NMFS requested additional clarification.
- **2 February 2022** – NMFS received clarification, consultation was initiated. Although the USACE determined the proposed action was not likely to adversely affect (NLAA) Sacramento River winter-run Chinook salmon evolutionarily significant unit (ESU), Central Valley spring-run Chinook salmon ESU, and California Central Valley steelhead distinct population segment (DPS), NMFS disagreed with the NLAA determinations for those species, but had enough information to proceed with the formal consultation.

- **12 October 2022** – NMFS received a request to amend the proposed action to address an error regarding the proposed sampling frequency, which needed to be increased. The Corps also proposed a change to include a second size of ponar sampler (nine-inch by nine-inch) to compare effectiveness of different sized samples in detecting benthic organisms, which has been incorporated into this biological opinion.

On July 5, 2022, the U.S. District Court for the Northern District of California issued an order vacating the 2019 regulations that were revised or added to 50 FR part 402 in 2019 (“2019 Regulations,” see 84 FR 44976, August 27, 2019) without making a finding on the merits. On September 21, 2022, the U.S. Court of Appeals for the Ninth Circuit granted a temporary stay of the district court’s July 5 order. As a result, the 2019 regulations are once again in effect, and we are applying the 2019 regulations here. For purposes of this consultation, we considered whether the substantive analysis and conclusions articulated in the biological opinion and incidental take statement would be any different under the pre-2019 regulations. We have determined that our analysis and conclusions would not be any different.

1.3. Proposed Federal Action

Under the ESA, “action” means all activities or programs of any kind authorized, funded, or carried out, in whole or in part, by Federal agencies (see 50 CFR 402.02). We considered whether or not the proposed action would cause any other activities that would have consequences and determined that it would not. A consequence is caused by the proposed action if it would not occur but for the proposed action and it is reasonably certain to occur.

Future actions associated with the SRBPP PACR Program include bank repair projects that would occur within the SRBPP PACR Program area, which encompasses the levees and weirs of various basins within the Sacramento River Flood Control Project (SRFCP). This consultation is intended to cover benthic sampling in the Sacramento River mainstem below County Route 9 bridge in Corning (RM 218), as well as tributaries and bypasses within the SRBPP PACR program area. The SRBPP PACR Program encompasses over 1,000 miles of levees and weirs. This area extends north to south along the Sacramento River, upstream from Chico at RM 184 to the Town of Collinsville at river mile (RM) zero. The SRBPP PACR Program also includes Cache Creek, the lower reaches of Elder and Deer Creeks, the lower reaches of the American River (RM 0–23), Feather River (RM 0–61), Yuba River (RM 0–11), and Bear River (RM 0–17), portions of Three Mile, Steamboat, Sutter, Miner, Georgiana, and Cache Sloughs, as well as a number of flood bypasses and distributaries. Additional details of the SRBPP PACR Program BO are incorporated here by reference (NMFS 2019).

The U.S. Army Corps of Engineers (USACE) proposes the implementation of the previously developed benthic sampling program in support of the SRBPP and Green Sturgeon HMMP. The purpose of the benthic sampling program is to identify potential food sources for green sturgeon in the lower Sacramento River and to conduct site-specific monitoring to determine the localized effects of levee repair on the benthic community. The HMMP includes specific elements focused on filling important data gaps on green sturgeon life history and both the micro and macro habitat ecology. The benthic sampling program is an integral component of the HMMP. The USACE proposes up to 25 total sites for sampling events. The timing for sampling will be once

each in the spring, summer, and fall, typically in March, June, and November for a total of 3 separate sampling events at each site annually for ten (10) years.

Historical sampling locations include the Sacramento River mainstem at RMs 15, 16.8, 25, 26, 35, 45, 55, 65, 71.3, 75, and 85. Benthic sampling would generally be in the same area of the Sacramento River as well as upstream and downstream of historical sampling locations, where green sturgeon “hotspots” have been identified by California Department of Fish and Wildlife (CDFW), and along the lower American River from RM 0 to RM 5. Future modifications to the benthic sampling program may be made and would be annotated in future reports. In addition, further development of the green sturgeon HMMP could impact future implementation of the benthic sampling program. If changes are made to the program, including sampling frequency or expansion of sampling locations, USACE will coordinate with NMFS to determine if consultation would need to be reinitiated.

Each location will use a ponar bottom sampling device at five (5) points along a transect that bisects the river perpendicular to its direction of flow. At each of the five points, four successful petite ponar drops will be conducted, two samples with two different sizes of ponar (one being six-inch by six-inch, the other being nine-inch by nine-inch), for a maximum of 20 successful samples at each site. A failed deployment of the ponar (*e.g.*, ponar fails to close upon hitting the river bottom, or debris keeps the ponar from closing completely) will result in redeployment. The ponar samples a section of the river bottom and has a closed volume of 2.4 liters (six-inch by six-inch) or 8.2 liters (nine-inch by nine-inch). The maximum volume sampled at each transect will be 24 liters. At each sampling location latitude and longitude coordinates will be recorded. Contents retrieved by ponar will be emptied onto screen classifiers to sift through any collected substrate and remove any invertebrates or detritus that may house invertebrates. The substrate will then be recorded. Any collected organisms or detritus will be placed in labelled sample jars and filled with 90 percent ethanol for preservation.

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

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

2.1. Analytical Approach

This BO includes both a jeopardy analysis and an adverse modification analysis. The jeopardy analysis relies upon the regulatory definition of “jeopardize the continued existence of” a listed species, which is “to engage in an action that reasonably would be expected, directly or

indirectly, to reduce appreciably the likelihood of both the survival and recovery of a listed species in the wild by reducing the reproduction, numbers, or distribution of that species” (50 CFR 402.02). Therefore, the jeopardy analysis considers both survival and recovery of the species.

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

The designations of critical habitat for Central Valley (CV) spring run Chinook salmon ESU, California Central Valley (CCV) steelhead DPS, and Southern DPS (sDPS) North American green sturgeon use the term primary constituent element (PCE) or essential features. The 2016 final rule (81 FR 7414; February 11, 2016) that revised the critical habitat regulations (50 CFR 424.12) replaced this term with physical or biological features (PBFs). The shift in terminology does not change the approach used in conducting a “destruction or adverse modification” analysis, which is the same regardless of whether the original designation identified PCEs, PBFs, or essential features. In this BO, we use the term PBF to mean PCE or essential feature, as appropriate for the specific critical habitat.

The ESA Section 7 implementing regulations define effects of the action using the term “consequences” (50 CFR 402.02). As explained in the preamble to the final rule revising the definition and adding this term (84 FR 44976, 44977; August 27, 2019), that revision does not change the scope of our analysis, and in this opinion we use the terms “effects” and “consequences” interchangeably.

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

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

2.2. Rangewide Status of the Species and Critical Habitat

This opinion examines the status of each species that is likely to be adversely affected by the proposed action. The status is determined by the level of extinction risk that the listed species face, based on parameters considered in documents, such as recovery plans, status reviews, and listing decisions. This informs the description of the species’ likelihood of both survival and recovery. The species status section also helps to inform the description of the species’ “reproduction, numbers, or distribution” for the jeopardy analysis. The opinion also examines the condition of critical habitat throughout the designated area, evaluates the value of the various watersheds and coastal and marine environments that make up the designated area, and discusses the function of the PBFs that are essential for the conservation of the species.

Table 1. Description of species, current Endangered Species Act (ESA) listing classifications, and summary of species status.

Species and Recovery Plans	Listing Classification and Federal Register Notice	Status Summary
<p>Sacramento River winter-run Chinook salmon evolutionarily significant unit (ESU) Final Recovery Plan for the Evolutionarily Significant Units of Sacramento River Winter-run Chinook Salmon and Central Valley Spring-run Chinook Salmon and the Distinct Population Segment of California Central Valley Steelhead (CV salmonid recovery plan) (NMFS 2014)</p>	<p>Endangered, 70 FR 37160; June 28, 2005</p>	<p>According to the NMFS 5-year species status review (NMFS 2016c), the status of the winter-run Chinook salmon ESU, the extinction risk has increased from moderate risk to high risk of extinction since the 2007 and 2010 assessments. Based on the Lindley <i>et al.</i> (2007) criteria, the population is at high extinction risk in 2019. High extinction risk for the population was triggered by the hatchery influence criterion, with a mean of 66 percent hatchery origin spawners from 2016 through 2018. Several listing factors have contributed to the recent decline, including drought, poor ocean conditions, and hatchery influence. Thus, large-scale fish passage and habitat restoration actions are necessary for improving the winter-run Chinook salmon ESU viability. The overall status of the winter-run Chinook salmon ESU likely has declined since the 2015 viability assessment (Williams <i>et al.</i> 2016) due to the recent increase in hatchery influence. Viability information since the 2015 viability assessment has been incorporated into the analysis of this consultation and will be reflected in an updated 5-year status review in 2022.</p>

Species and Recovery Plans	Listing Classification and Federal Register Notice	Status Summary
<p>Central Valley spring-run Chinook salmon ESU CV salmonid recovery plan (NMFS 2014)</p>	<p>Threatened, 70 FR 37160; June 28, 2005</p>	<p>According to the NMFS 5-year species status review (NMFS 2016b), the status of the CV spring-run Chinook salmon ESU, until 2015, had improved since the 2010, 5-year species status review. The improved status is due to extensive restoration, and increases in spatial structure with historically extirpated populations (Battle and Clear Creeks) trending in the positive direction. Recent declines of many of the dependent populations, high pre-spawn and egg mortality during the 2012 to 2016 drought, and uncertain juvenile survival during the drought are likely increasing the ESU's extinction risk. Monitoring data showed sharp declines in adult returns from 2014 through 2018 (CDFW 2018). Viability information since the 2015 viability assessment has been incorporated into the analysis of this consultation and will be reflected in an updated 5-year status review in 2022.</p>
<p>California Central Valley steelhead distinct population segment (DPS) CV salmonid recovery plan (NMFS 2014)</p>	<p>Threatened, 71 FR 834; January 5, 2006</p>	<p>According to the NMFS 5-year species status review (NMFS 2016a), the status of CCV steelhead appears to have remained unchanged since the 2011 status review that concluded that the DPS was in danger of extinction. Most natural-origin CCV populations are very small, are not monitored, and may lack the resiliency to persist for protracted periods if subjected to additional stressors, particularly widespread stressors such as climate change. The genetic diversity of CCV steelhead has likely been impacted by low population sizes and high numbers of hatchery fish relative to natural-origin fish. The life-history diversity of the DPS is mostly unknown, as very few studies have been published on traits such as age structure, size at age, or growth rates in CCV steelhead. While updated data on steelhead in the American River is mostly based on hatchery returns, natural spawning populations within the Sacramento tributaries have fluctuated, but showed a steady decline in the past 10 years (Scriven <i>et al.</i> 2018). Viability information since the 2015 viability assessment has been incorporated into the analysis of this consultation and will be reflected in an updated 5-year status review in 2022.</p>

Species and Recovery Plans	Listing Classification and Federal Register Notice	Status Summary
<p>Southern DPS of North American green sturgeon Recovery Plan for the Southern Distinct Population Segment of North American Green Sturgeon (<i>Acipenser medirostris</i>) (NMFS 2018)</p>	<p>Threatened, 71 FR 17757; April 7, 2006</p>	<p>According to the NMFS 5-year species status review (NMFS 2021) and the 2018 final recovery plan (NMFS 2018), some threats to the species have recently been eliminated, such as take from commercial fisheries and removal of some passage barriers. Also, several habitat restoration actions have occurred in the Sacramento River Basin, and spawning was documented on the Feather and Yuba Rivers. However, the species viability continues to face a moderate risk of extinction because many threats have not been addressed, and the only spawning location that is known to support the sDPS occurs in a single reach of the main stem Sacramento River. Current threats include poaching and habitat degradation. A recent method has been developed to estimate the annual spawning run and population size in the upper Sacramento River so species can be evaluated relative to recovery criteria (Mora <i>et al.</i> 2018). Although passage improvements have occurred at Fremont Weir and spawning events have been documented in the Feather and Yuba rivers, no changes to the species status or threats are evident since the last review (NMFS 2021).</p>

Table 2. Description of critical habitat, listing, and status summary.

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

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

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

The following list contains continued limiting factors in common to all of the above species:

- Dams block access to historical spawning and summer holding areas along with altering river flow regimes and temperatures (up to 90 percent for winter-run and spring-run Chinook salmon).
- Water management/Diversions/Barriers
- Loss of floodplain rearing habitat (levees/bank protection)
- Urbanization and rural development
- Logging
- Grazing
- Agriculture

- Mining – historic hydraulic mining from the California Gold Rush era
- Estuarine modified and degraded, thus reducing developmental opportunities for juvenile salmon
- Predation
- Dredging and sediment disposal
- Contaminants
- Altering prey base for fish (especially for sDPS green sturgeon)
- Fisheries
- Hatcheries
- ‘Natural’ factors (e.g. ocean conditions)
- Climate change exacerbating flow and water temperature related impacts (see below for more detail)

2.2.1. Recovery Plans

In July 2014, NMFS released a final Recovery Plan for winter-run Chinook salmon, CV spring-run Chinook salmon, and CCV steelhead (NMFS 2014). The Recovery Plan outlines actions to restore habitat and access, and improve water quality and quantity conditions in the Sacramento River to promote the recovery of listed salmonids. Key recovery actions in the Recovery Plan include conducting landscape-scale restoration throughout the Delta, incorporating ecosystem restoration into Central Valley flood control plans that includes breaching and setting back levees, and restoring flows throughout the Sacramento and San Joaquin River basins and the Delta. NMFS released a final Recovery Plan for the sDPS green sturgeon (NMFS 2018), which focuses on fish screening and passage projects, floodplain and river restoration, and riparian habitat protection in the Sacramento River Basin, the Delta, San Francisco Estuary, and nearshore coastal marine environment as strategies for recovery.

2.2.2. 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). 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).

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. 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. 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). The Anderson Cottonwood Irrigation Dam (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.

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 long term projections, 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).

For the Action Area, we adopt by reference here the entire section 2.3 of the SRBPP PACR Program BO (NMFS 2019). The area is also summarized below in Table 1.

Table 3. Approximate Location of SRBPP PACR Benthic Sampling, by River Mile.

Sacramento River	0-176
Feather River	0-12
American River	0-12

2.4. Environmental Baseline

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

For the Environmental Baseline, we adopt by reference here the entire section 2.4 of the NMFS 2019 SRBPP PACR BO (NMFS 2019).

There is an existing recreational fishery within the action area for other sport fish (non-ESA-listed) that share habitat where sampling will be occurring. The action area is frequented by boaters, recreational fishing, and other scientific collection methods. Any fish within the action area are likely to already encounter noise from boat traffic, and exposure to fishing gear on a regular basis.

2.5. Effects of the Action

Under the ESA, “effects of the action” are all consequences to listed species or critical habitat that are caused by the proposed action, including the consequences of other activities that are caused by the proposed action (see 50 CFR 402.02). A consequence is caused by the proposed action if it would not occur but for the proposed action and it is reasonably certain to occur. Effects of the action may occur later in time and may include consequences occurring outside the immediate area involved in the action (see 50 CFR 402.17). In our analysis, which describes the effects of the proposed action, we considered the factors set forth in 50 CFR 402.17(a) and (b).

Effects of Ponar Sampling on Fish

There is a small possibility that a fish could be struck by a falling or closing ponar. While fish are generally expected to move away from the immediate action area during a sampling event due to the presence of a motorboat, the splash caused by the ponar drop, and the fall of the ponar itself through the water column, all fish may not be able to respond quickly enough in all river conditions (high flows, deep sections of river, high turbidity). Due to the large number of samples and long running timeline of the benthic monitoring program being proposed, it is likely that a small number of fish may be injured or killed as a result of the proposed action. Adult salmonids tend to be in the mid-water column, and with their quicker response times, they are expected to be able to avoid the ponar easily, even in poor river conditions. Therefore, no adult salmonids are expected to be injured or killed due to benthic sampling activities. The benthic habits of adult sturgeon make them more likely to hold in place in response to stressors, and be at higher risk of injury or death from a collision with the falling ponar. A small number of adult sturgeon are expected to be injured or killed due to the implementation of the proposed action. Juvenile salmonids and sturgeon have overall poor swimming abilities, and generally move with the current. Larval and juvenile fish are the most susceptible to injury or entrainment by benthic sampling techniques (Wenger *et al.*, 2017). As the ponar is being dropped through many transects across the river, and during times when juveniles are present, it is anticipated that a small number of juvenile salmonids and sturgeon will be harassed, injured or killed during the proposed activities.

Effects of Ponar Sampling on Critical Habitat

The ponar will remove a small amount of sediment at each sampling location. At each transect, up to 106 liters of sediment will be removed. Any organisms within the sediment are kept for enumeration and ID. The number of benthic organisms removed represents a minute portion of the total benthic community in the river, and the removal of these organisms would not have a measurable impact on the species composition or abundance. Any hole or cavity created by the ponar would be small (2.4 liters or 8.2 liters per sample depending on which size ponar is used), and because the sampling location is in a larger river with flowing water, the cavity is expected

to quickly refill with sediment. The flow of any suspended sedimentation from the ponar collections would not be distinguishable from the natural sedimentation that occurs in flowing rivers and will not affect the listed species ability to forage or avoid predators. Most habitat effects noted from dredging activities (benthic sampling similar to ponar but on a larger scale), were related to increased suspended sediment and turbidity levels (Wenger *et al.*, 2017). The essential features to critical habitat are spawning habitat, freshwater rearing habitat, freshwater migration corridors, and estuarine areas. The sampling will be occurring outside of spawning and estuarine habitats, so no features of those are expected to be degraded. While very small disturbances will occur locally during sampling to freshwater rearing and migration corridor habitats, the effects are expected to be temporary and indistinguishable from surrounding habitats, and therefore negligible.

Beneficial Effects

Obtaining additional information about sDPS green sturgeon is greatly needed, especially related to a robust abundance estimate, a greater understanding of their biology, and further information about their movements, distribution patterns, and micro- and macro-habitat ecology. In addition to other monitoring efforts and data collection currently occurring, the collection of habitat data from the benthic sampling will allow for a better understanding of what habitat currently is present for sDPS green sturgeon, and how those habitats are impacted by bank protection projects. The data to be collected will have a population wide benefit, and will be publicly available to biologists in the Central Valley.

2.6. Cumulative Effects

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

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

For the cumulative effects, we adopt by reference here the entire section 2.6 of the SRBPP PACR Program BO (NMFS 2019).

2.7. Integration and Synthesis

The Integration and Synthesis section is the final step in assessing the risk that the proposed action poses to species and critical habitat. In this section, we add the effects of the action (Section 2.5) to the environmental baseline (Section 2.4) and the cumulative effects (Section 2.6), taking into account the status of the species and critical habitat (Section 2.2), to formulate the agency’s biological opinion as to whether the proposed action is likely to: (1) reduce

appreciably the likelihood of both the survival and recovery of a listed species in the wild by reducing its numbers, reproduction, or distribution; or (2) appreciably diminish the value of designated or proposed critical habitat as a whole for the conservation of the species.

2.7.1. Summary Status of the Species, Environmental Baseline, and Cumulative Effects

Status of the Sacramento River Winter-Run Chinook salmon ESU

Best available information indicates that the Sacramento River winter-run Chinook salmon ESU remains at a high risk of extinction. The most recent 5-Year Status Review for winter-run Chinook salmon demonstrated that the ESU had further declined, and that continued loss of historical habitat and the degradation of remaining habitat continue to be major threats (NMFS 2016a). Based on the Lindley *et al.* (2007) criteria, the population remains at high extinction risk.

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 prior status review (2010/2011) While the extinction risk may have decreased during that time, fish returns have trended towards decline since then. CDFW has documented critically low returns for Butte, Deer, and Mill creeks which hold the only wild, independent populations of CV spring-run Chinook salmon (CDFW GrandTab). The effects of the December 2011 to March 2017 drought have resulted in severe rates of decline and a trend toward extirpation.

Status of the CCV Steelhead DPS

The 2016 status review (NMFS 2016c) concluded that overall, the status of CCV steelhead appears to have changed little since the 2011 status review and should remain as a threatened species. Although there is still a general lack of data on the status of wild populations, there 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. Despite some positive trends in salvage, all other concerns raised in the current status review remain.

Status of the Green Sturgeon southern DPS

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

Status of the Environmental Baseline and Cumulative Effects

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 the 2019 BO describe how contaminant discharges, aquaculture and hatcheries, increased urbanization, and increased installation of rock revetment affect the species in the action area. These actions typically result in habitat fragmentation, and conversion of complex nearshore aquatic habitat to simplified habitats that incrementally reduces the carrying capacity of the rearing and migratory corridors. The described effects of the overall levee program are not further exacerbated by the proposed monitoring actions. Similar future bank repair projects may be able to have the severity of these effects alleviated by the data and understanding that may come from the proposed monitoring.

2.7.2 Summary of effects to listed species

While we expect a small amount of injury or mortality associated with proposed monitoring activities, the low quantity of fish expected to be impacted will be a relatively small portion of the population overall. An effect of the proposed monitoring that cannot be quantified is the conservation benefit to the species resulting from the data and information to be collected. Collection of this data is necessary for understanding potential risks to SR winter-run Chinook salmon, CV spring-run Chinook salmon, CCV steelhead, sDPS green sturgeon resulting from levee repair, bank protection activities, the addition of riprap into a channel, and the permanent alteration of the substrate. All research findings will be used by NMFS, USACE, and potentially other state and federal agencies to benefit ESA-listed fish through improved conservation and management practices.

2.7.3 Risk to ESU/DPS

Overall, there would be a very small impact on the species' abundance, and no measurable effect on their spatial structure or diversity. The research findings of the proposed monitoring will be used by NMFS, USACE, and potentially other state and federal agencies to benefit ESA-listed fish through improved conservation and management practices, which will also rise to population level and ESU/DPS benefits as well.

Combining the minimal, adverse, and beneficial effects associated with the proposed action described above, the environmental baseline, cumulative effects, and status of the species, the

proposed project is not expected to reduce appreciably the likelihood of both the survival and recovery of the listed species in the wild by reducing their numbers, reproduction, or distribution, nor appreciably diminish the value of designated or proposed critical habitat as a whole for the conservation of the species.

2.8. Conclusion

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

2.9. Incidental Take Statement

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

2.9.1. Amount or Extent of Take

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

The most appropriate threshold for incidental take is an ecological surrogate of the quantity of samples taken per site, and annually, which will be tracked and reported. The samples are expected to result in injury or death from contact with the ponar sampler.

Incidental take, in the form of harm resulting in injury or death are described as follows. Quantification of the number of fish exposed to sampling activities, and resulting injuries related to the ponar sampling, is not currently possible with available monitoring data, though numbers are anticipated to be low. Observations of individual fish within the river channel are not possible due to water clarity and depth. However, fish passing through or otherwise present in the Action Area during sampling activities would be exposed to the risks of injury or harm from the ponar sampler. Thus, the footprint of each sample size multiplied by the number of samples done annually defines the area in which projected annual incidental take will occur for this project. NMFS anticipates incidental take will be limited to the following:

1. Harm to rearing and migrating juveniles and small numbers of adult green sturgeon is expected within the sampling areas due to the ponar dropping on and/or entrainment of fish during sampling. Ponar sampling is expected to result in reduced fitness and survival for a small number of juvenile fish of each species in the action area each year. Harm to rearing juvenile SR winter-run, CV spring-run Chinook salmon, and CCV steelhead, and adult and juvenile green sturgeon from the sampling will be limited to a total number of annual sites times the quantity of 20 successful samples proposed at each location per sampling event.

Therefore, incidental take will be considered exceeded if sampling exceeds more than 20 successful samples in a single sampling event, or exceeds more than 60 samples at each site annually.

2.9.2. Effect of the Take

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

2.9.3. Reasonable and Prudent Measures

“Reasonable and prudent measures” are 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 monitor and reduce incidental take of listed fishes.

2.9.4. Terms and Conditions

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

1. The following terms and conditions implement reasonable and prudent measure 1:
 - a. In the event any unintentional entrainment of ESA-listed fish occurs, USACE shall immediately (within 24 hours) report to NMFS about the incident.
 - b. If any ESA-listed fish are killed during sampling, the incident shall be reported to NMFS immediately (within 24 hours) to determine if sampling changes are needed. Sampling shall not resume without written approval from NMFS.
 - c. USACE shall submit an annual report to NMFS of all sampling activities and any take that occurs as part of the project. This report shall be submitted no later than December 31 of each reporting cycle.
 - d. All reports for NMFS shall be sent (preferably by email) to:

Cathy Marcinkevage
Assistant Regional Administrator
California Central Valley Office
National Marine Fisheries Service
650 Capitol Mall, Suite 5-100
Sacramento California 95814
ccvo.consultationrequests@noaa.gov
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. USACE should carry and provide educational handouts on sturgeon to interested members of the public while performing proposed activities. Educational information should be targeted at reducing misidentification of sturgeon in the area to reduce the accidental take of sDPS green sturgeon in the white sturgeon recreation fishery.

2.11. Reinitiation of Consultation

This concludes formal consultation for the Sacramento River Bank Protection Project Benthic Sampling Program.

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

manner that causes an effect to the listed species or critical habitat that was not considered in the biological opinion or written concurrence; or (4) If a new species is listed or critical habitat designated that may be affected by the identified action.”

3. DATA QUALITY ACT DOCUMENTATION AND PRE-DISSEMINATION REVIEW

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

3.1. Utility

Utility principally refers to ensuring that the information contained in this consultation is helpful, serviceable, and beneficial to the intended users. The intended users of this opinion are the USACE. Individual copies of this opinion were provided to the USACE. The document will be available within 2 weeks at the NOAA Library Institutional Repository (<https://repository.library.noaa.gov/welcome>). The format and naming adhere to conventional standards for style.

3.2. 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.

3.3. Objectivity

Information Product Category: Natural Resource Plan

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

Best Available Information: This consultation and supporting documents use the best available information, as referenced in the References section. The analyses in this opinion 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 reviewed in accordance with West Coast Region ESA quality control and assurance processes.

4. REFERENCES

- California Department of Fish and Wildlife. 2018. GrandTab, unpublished data. CDFGs California Central Valley Chinook Population Database Report.
- Cohen, Stewart J., Kathleen A. Miller, Alan F. Hamlet, and Wendy Avis.. 2000. Climate change and resource management in the Columbia River basin. *Water International* 25(2): 253-272.
- Dettinger, M. D. and D. R. Cayan 1995. "Large-Scale Atmospheric Forcing of Recent Trends toward Early Snowmelt Runoff in California." *Journal of Climate* 8(3): 606-623.
- Lindley, S. T., R. S. Schick, E. Mora, P. B. Adams, J. J. Anderson, S. Greene, C. Hanson, B. P. May, D. McEwan, R. B. MacFarlane, C. Swanson, and J. G. Williams. 2007. Framework for Assessing Viability of Threatened and Endangered Chinook Salmon and Steelhead in the Sacramento-San Joaquin Basin. *San Francisco Estuary and Watershed Science* 5(1):26.
- McClure, M. 2011. Climate Change in Status Review Update for Pacific Salmon and Steelhead Listed under the ESA: Pacific Northwest., M. J. Ford, editor, NMFS-NWFCS-113, 281 p.
- McClure, M. M., M. Alexander, D. Borggaard, D. Boughton, L. Crozier, R. Griffis, J. C. Jorgensen, S. T. Lindley, J. Nye, M. J. Rowland, E. E. Seney, A. Snover, C. Toole, and V. A. N. H. K. 2013. Incorporating Climate Science in Applications of the U.S. Endangered Species Act for Aquatic Species. *Conservation Biology* 27(6):1222-1233.
- Mora, E.A., Battleson, R.D., Lindley, S.T., Thomas, M.J., Bellmer, R., Zarri, L.J. and Klimley, A.P., 2018. Estimating the annual spawning run size and population size of the southern distinct population segment of green sturgeon. *Transactions of the American Fisheries Society*, 147(1), pp.195-203.
- National Marine Fisheries Service (NMFS). 2014. Central Valley Recovery Plan for Winter-Run Chinook Salmon, Central Valley Spring-Run Chinook Salmon and California Central Valley Steelhead. West Coast Region, Sacramento, CA. 427 pp.
- National Marine Fisheries Service (NMFS). 2016a. California Central Valley Recovery Domain 5-year Status Review: Summary and Evaluation of Sacramento River Winter-run Chinook salmon Evolutionarily Significant Unit. U.S. Department of Commerce, NMFS West Coast Region, Sacramento, CA. 41 pages.
http://www.westcoast.fisheries.noaa.gov/publications/status_reviews/salmon_steelhead/2016/2016-12-12_5-year_review_report_sac_r_winter-run_chinook_final.pdf.
- National Marine Fisheries Service (NMFS). 2016b. Central Valley Recovery Domain 5-Year Status Review: Summary and Evaluation of Central Valley Spring-Run Chinook Salmon Evolutionarily Significant Unit. U.S. Department of Commerce, NMFS, West Coast Region, Sacramento, CA 41 pages.

http://www.westcoast.fisheries.noaa.gov/publications/status_reviews/salmon_steelhead/2016/2016_cv-spring-run-chinook.pdf

National Marine Fisheries Service (NMFS). 2016c. Central Valley Recovery Domain 5-Year Status Review: Summary and Evaluation of California Central Valley Steelhead Distinct Population Segment. U.S. Department of Commerce, NMFS, West Coast Region, Sacramento, CA 44 pages.
http://www.westcoast.fisheries.noaa.gov/publications/status_reviews/salmon_steelhead/2016/2016_cv-steelhead.pdf

National Marine Fisheries Service (NMFS). (2018). Recovery plan for the southern distinct population segment of North American green sturgeon (*Acipenser medirostris*). Sacramento, CA: National Marine Fisheries Service.

National Marine Fisheries Service. 2019. Biological opinion for Sacramento River Bank Protection Project Post Authorization Change Report. Prepared for U.S. Army Corps of Engineers, Sacramento District, Sacramento, CA. File No. WCRO-2019-01893. August 30, 2019.

Scriven, C., Sweeney, J., Sellheim, K. and Merz, J., 2018. Lower American River monitoring, 2018 steelhead (*Oncorhynchus mykiss*) spawning and stranding surveys. Central Valley Project, American River, California, Mid-Pacific Region. Cramer Fish Sciences, Sacramento, CA.

Thompson, L. C., M. I. Escobar, C. M. Mosser, D. R. Purkey, D. Yates, and P. B. Moyle. 2011. Water Management Adaptations to Prevent Loss of Spring-Run Chinook Salmon in California under Climate Change. *Journal of Water Resources Planning and Management* 138(5):465-478.

PFMC. 2014. Appendix A to the Pacific Coast Salmon Fishery Management Plan, as modified by Amendment 18. Identification and description of essential fish habitat, adverse impacts, and recommended conservation measures for salmon.

Wade, A. A., T. J. Beechie, E. Fleishman, N. J. Mantua, H. Wu, J. S. Kimball, D. M. Stoms, and J. A. Stanford. 2013. Steelhead Vulnerability to Climate Change in the Pacific Northwest. *Journal of Applied Ecology*: 50: 1093-1104..

Wenger, A.S., Harvey, E., Wilson, S., Rawson, C., Newman, S.J., Clarke, D., Saunders, B.J., Browne, N., Travers, M.J., Mcilwain, J.L. and Erftemeijer, P.L., 2017. A critical analysis of the direct effects of dredging on fish. *Fish and Fisheries*, 18(5): 967-985.

Williams, J. G. 2006. "Central Valley Salmon: A Perspective on Chinook and Steelhead in the Central Valley of California." *San Francisco Estuary and Watershed Science* 4(3): 1-398.

Williams, T. H., Brian C. Spence, David A. Boughton, Rachel C. Johnson, Lisa G. Crozier, Nathan J. Mantua, Michael R. O'Farrell, Steven T. Lindley. 2016). *Viability*

Assessment for Pacific Salmon and Steelhead listed under the Endangered Species Act:
Southwest. National Marine Fisheries Service: 1-53.