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

Refer to NMFS No: WCR- 2018-9304

June 11, 2018

Nancy A. Haley
California North Branch Office
U.S. Army Corps of Engineers
1325 J Street
Sacramento, California 95814-2922

Re: Endangered Species Act Section 7(a)(2) Biological Opinion, Magnuson-Stevens Fishery Conservation and Management Act Essential Fish Habitat Response, and Fish and Wildlife Coordination Act Recommendations for the Horseshoe Bend Levee Improvement Project (SPK-2016-00287)

Dear Ms. Haley:

Thank you for your letter received on March 28, 2018, requesting initiation of formal consultation with NOAA's National Marine Fisheries Service (NMFS) pursuant to section 7 of the Endangered Species Act of 1973 (16 U.S.C. 1531 et seq.) for the Horseshoe Bend Levee Improvement Project in Piper Slough near Bethel Island, California.

We also received your request for consultation pursuant to the essential fish habitat (EFH) provisions in section 305 (b) of the Magnuson-Stevens Fishery Conservation and Management Act [16 U.S.C. 1855(b)] for this action. NMFS' review concludes that the project will adversely affect the EFH of Pacific Coast Salmon in the action area.

Based on the best available scientific and commercial information, the biological opinion concludes that the Horseshoe Bend Levee Improvement Project is not likely to jeopardize the continued existence of the Federally listed threatened Central Valley (CV) spring-run Chinook salmon evolutionarily significant unit (ESU) *(Oncorhynchus tshawytscha),* threatened California Central Valley (CCV) steelhead distinct population segment (DPS) (*O. mykiss),* endangered Sacramento River winter-run Chinook salmon ESU (*O. tshawytscha*), or the threatened southern DPS (sDPS) of North American green sturgeon *(Acipenser medirostris)*, and is not likely to destroy or adversely modify their designated critical habitats. For the above species, NMFS has included an incidental take statement with reasonable and prudent measures and 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 the proposed action will modify a stream or other body of water, NMFS also provides recommendations and comments for the purpose of conserving fish and wildlife resources under the Fish and Wildlife Coordination Act [16 U.S.C. 662(a)].

Please contact Tancy Moore in NMFS' West Coast Region, California Central Valley Office 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,

for Maria Rea

Barry A. Thom
Regional Administrator

Enclosure

Cc: To the File: 151422-WCR2017-SA00395

Ms. Chandra Brown (Chandra.L.Browne@usace.army.mil), Project Manager, Regulatory Division, U.S. Army Corps of Engineers, Sacramento District, 1325 J Street, Sacramento, California 95814

Ms. Dayna Winchell (dwinchell@huntenv.com), Senior Scientist, Hunting Environmental, 3606 Cambridge Road, Cameron Park, California 95682

Ms. Regina Espinoza, Bethel Island Municipal Improvement District, Post Office Box 244, Bethel Island, California 94511-0244

Mr. Jeff Butzlaff, Bethel Island Municipal Improvement District, Post Office Box 244, Bethel Island, California 94511-0244

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

Horseshoe Bend Levee Improvement Project

NMFS Consultation Number: PCTS No: WCR-2018-9304/ARN: 151422-WCR2017-SA00395

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?
CV spring-run Chinook salmon ESU (*Oncorhynchus tshawytscha*)	Threatened	Yes	No	No	
California Central Valley steelhead DPS (*O. mykiss*)	Threatened	Yes	No	Yes	No
Southern DPS of North American green sturgeon (*Acipenser medirostris*)	Threatened	Yes	No	Yes	No
Sacramento River winter-run Chinook salmon ESU (*O. tshawytscha*)	Endangered	Yes	No	No	

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

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

Issued By: Maria Rea

for Barry A. Thom
Regional Administrator

Date: June 11, 2018

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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 this 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.

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

1.2 Consultation History

On August 11, 2017, NMFS received a request via mail for informal consultation from the United States Army Corps of Engineers (USACE) for project effects to Sacramento River winter-run Chinook salmon, Central Valley (CV) spring-run Chinook salmon, California Central Valley (CCV) steelhead, and the southern DPS of the North American green sturgeon and the critical habitat for these species.

On February 1, 2018, NMFS responded to this request with a letter of insufficiency requesting more information about the project and stating NMFS does not concur with the determination that the project is not likely to adversely affect the above species and their critical habitat.

On February 14, 2018 NMFS attended a site visit with representatives from the Department of Water Resources, California Department of Fish and Game and the consultant for the Bethel Island Municipal Improvement District.

NMFS received the requested information on March 7, 2018 and answers to additional questions on March 14, 2018.

On March 28, 2018, the USACE officially requested formal consultation for the Horseshoe Bend Levee Improvement Project. On this date, NMFS initiated consultation.

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 proposed to authorize the Bethel Island Municipal Improvement District (BIMID) to repair a damaged levee on Piper Slough in Contra Costa County, California. The purpose of the project is to repair a portion of the levee that has known deficiencies including steep waterside slopes, active scour, seepage through the levee, and potentially liquefiable material within the levee and foundation. This repair, which will be 5,000 feet in length, is located at approximately the intersection of Taylor Road and Canal Road on Bethel Island in an area known as Horseshoe Bend.

The following changes will be made to the levee to improve levee stability and facilitate flood fighting:

- Widening the levee crest to a minimum of 22 feet in order to better facilitate flood fighting and placing class 2 aggregate base rock on the levee crest to provide an all-weather levee maintenance road.
- Installing up to 5,000 feet of riprap on the north side of Bethel Island to minimize scour. A total of 0.3 acres of riprap will be installed. Within the 5,000 feet, there will be a 2,000-linear-foot stretch, where the levee will be set back 15 feet from its current position, creating a waterside bench.
- Constructing a l,000-foot landside stability berm for additional levee stability. The landside berm will be planted with riparian forest and scrub shrub. A 1,000-foot seepage blanket will also be installed on the landside of the levee.

Although the project will remove 1.7 acres of scrub shrub and 1.5 acres of riparian forest, all the vegetation to be removed is located on the landside of the levee. At the levee repair location, there is currently only degraded riprap, weeds, and ruderal grasses. No vegetation is proposed for removal below the ordinary high water mark (OHWM). The levee repair design consists of a riprap toe at the waterline. Just above the riprap toe but still below the OHWM, all riprap placed will be mixed with a 70:30 ratio of riprap to soil, with a 1-foot layer of soil on top to facilitate the planting of landside vegetation, which will be a variety of native trees, shrubs, and herbaceous plants. The project will also incorporate a 2,000-linear-foot vegetated waterside bench, which will provide shading to aquatic habitat.

To compensate for impacts to salmonids resulting from the proposed repair, off-site mitigation credits for salmon and steelhead will be purchased from a NMFS-approved conservation bank at a 3:1 ratio for all riprap placed. Since 0.3 acres of new riprap will be placed, a total of 0.9 acres of credit will be purchased. NMFS-approved mitigation banks with service areas that include the proposed action area include the Cosumnes Floodplain Mitigation Bank, Liberty Island Conservation Bank, and the Fremont Landing Conservation Bank. The proposed action area is also located within the Bullock Bend Mitigation Bank service area, however, there are no credits currently available at this site.

1.3.1 Avoidance and Minimization Measures

- The repair will be completed between July 1 and October 31 to minimize impacts to ESA-listed fish species.
- Before any activities begin on the project, a NMFS-approved biologist will conduct a Worker Environmental Awareness Program (WEAP) for all construction personnel. At a minimum, the training will include a description of all special-status species that have the potential to occur within the action area, their habitat requirements, the specific measures that are being implemented to conserve the species for the current project, and the boundaries within which the project may be accomplished.
- A spill prevention plan will be prepared, describing measures to minimize the risk of fluids or other materials used during construction (e.g. oil, transmission/hydraulic fluid) from entering the channel or contaminating adjacent riparian areas. In addition to a spill prevention plan, a cleanup protocol will be developed before construction begins and will be implemented in case of a spill.
- The project will not stockpile any materials on the levee site.
- A stormwater pollution prevention plan (SWPPP) will be created and implemented to ensure the proper installation and maintenance of sediment control measures. Implementation of the SWPPP will be phased for the suitable timing for dry-weather protective measures and rainy season protective measures.
- All refueling, maintenance, and staging of equipment and vehicles will occur at least 60 feet from riparian habitat or water bodies and not in a location where a spill would drain directly toward aquatic habitat. Refueling of construction equipment and vehicles will occur only within designated areas where possible spills would be readily contained.
- The number of access routes, size of staging areas, and total area of the activity will be limited to the minimum necessary to achieve the project goal.

1.3.2 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 project.

2. ENDANGERED SPECIES ACT: ANALYSIS OF EFFECTS 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

It is impossible to 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 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 take for this project is an ecological surrogate of habitat disturbance. Descriptions of the habitat disturbance anticipated during the rehabilitation of the levee repair site, including any potential loss of aquatic and riparian habitat and the placement of rock revetment, were provided in the biological assessment.

2.1.2 Mitigation Banks and the Environmental Baseline

Conservation banks present a unique factual situation, and this warrants a particular approach to how they are addressed. Specifically, when NMFS is consulting on a proposed action that includes conservation bank credit purchases, it is likely that physical restoration work at the bank site has already occurred and/or that a section 7 consultation occurred at the time of bank establishment. A traditional reading of "environmental baseline," might suggest that the overall ecological benefits of the conservation bank actions therefore belong in the environmental baseline. However, under this reading, all proposed actions, whether or not they included proposed credit purchases, would benefit from the environmental 'lift' of the entire conservation bank because it would be factored into the environmental baseline. In addition, where proposed actions did include credit purchases, it would not be possible to attribute their benefits to the proposed action, without double-counting. These consequences undermine the purposes of conservation banks and also do not reflect their unique circumstances. Specifically, conservation banks are established based on the expectation of future credit purchases. In addition, credit purchases as part of a proposed action will also be the subject of a future section 7 consultation.

It is therefore appropriate to treat the beneficial effects of the bank as accruing incrementally at the time of specific credit purchases, not at the time of bank establishment or at the time of bank restoration work. Thus, for all projects within the service area of a conservation bank, only the benefits attributable to credits sold are relevant to the environmental baseline. Where a proposed action includes credit purchases, the benefits attributable *to those credit purchases* are considered effects of the action. That approach is taken in this BO.

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, including the various watersheds and coastal and marine environments that make up the designated area, and discusses the current function of the essential physical and biological features.

The designations of critical habitat for some species use the term "primary constituent elements" (PCEs) or "essential features." The recently revised critical habitat regulations (81 FR 7414; February 11, 2016) replace this term with 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.

2.2.1 Sacramento River Winter-run Chinook Salmon

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

The federally listed evolutionary significant unit (ESU) of Sacramento River winter-run Chinook salmon and designated critical habitat for this ESU occur 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 viable salmonid population (VSP) parameters can be found in Appendix B: Rangewide Status of the Species and Critical Habitat.

Historically, Sacramento River winter-run Chinook salmon population estimates were as high as 120,000 fish in the 1960s, but declined to less than 200 fish by the 1990s (NMFS 2011a). 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 to 2009, and low in-river survival rates (NMFS 2011b). In 2014 and 2015, the population was approximately 3,000 adults, slightly above the 2007 to 2012 average, but below the high (17,296) for the last 10 years (CDFW 2016a).

The year 2014 was the third year of a drought that increased water temperatures in the upper Sacramento River, and egg-to-fry survival to the Red Bluff Diversion Dam (RBDD) was approximately 5 percent (NMFS 2016a). Due to the anticipated lower than average survival in 2014, hatchery production from Livingston Stone National Fish Hatchery (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 (approximately 4 percent) due to the inability to release cold water from Shasta Dam in the fourth year of a drought. As expected, winter-run Chinook salmon returns in 2016 were a low, as they show the impact of 1,546 (CDFW 2017), due to drought impacts on juveniles from brood year 2013 (NMFS 2016a).

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 Chinook salmon conservation program at 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 to 2010 average) compared to the estimated natural production that passes RBDD, which is 4.7 million per year based on the 2002 to 2010 average (Poytress and Carrillo 2011). Therefore, hatchery production typically represents approximately 3 to 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 percent, with the most recent generation at 20 percent 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 National Fish Hatchery (CNFH) weir). The Battle Creek Salmon and Steelhead Restoration Project (BCSSRP) is currently removing these impediments, restoring spawning and rearing habitat suitable for winter-run Chinook salmon in Battle Creek, which will be reintroduced to establish an additional population. Approximately 299 miles of former tributary spawning habitat above Shasta Dam are inaccessible to winter-run Chinook salmon. 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 chinook salmon redds have occurred in the first 10 miles downstream of Keswick Dam. Most components of the winter-run Chinook salmon life history (e.g., spawning, incubation, freshwater rearing) have been compromised by the construction of Shasta Dam.

The greatest risk factor for winter-run Chinook salmon lies within its spatial structure (NMFS 2011a). The winter-run Chinook salmon 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 upper Sacramento River by spawning gravel augmentation, hatchery supplementation, and regulation of the finite cold water pool behind Shasta Dam to reduce water temperatures.

Winter-run Chinook salmon 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 (Recovery Plan) includes criteria for recovering the winter-run Chinook salmon ESU, including re-establishing a population into historical habitats in Battle Creek as well as 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, which makes the species 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 how the CVP and SWP will operate incorporates the effects of climate change in three possible forms: less total precipitation; a shift to more precipitation in the form of rain rather than snow; or, earlier spring snow melt (Reclamation 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 2014a).

2.2.1.1 Summary of the Sacramento River Winter-run Chinook Salmon Evolutionarily Significant Unit Viability

There are several criteria that would qualify the winter-run Chinook salmon population at moderate risk of extinction (continued low abundance, a negative growth rate over two complete generations, significant rate of decline since 2006, increased hatchery influence on the population, and increased risk of catastrophe), and because there is still only one population that spawns below Keswick Dam, the Sacramento River winter-run Chinook salmon ESU is at a high risk of extinction in the long term. The extinction risk for the winter-run Chinook salmon 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 influence (NMFS 2016a). Thus, large-scale fish passage and habitat restoration actions are necessary for improving the winter-run Chinook salmon ESU viability (NMFS 2016a).

2.2.1.2 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 (58 FR 33212, 33216-33217; June 16, 1993), which are described in Appendix B. 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 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 (58 FR 33212; June 16, 1993). NMFS clarified that “adjacent riparian zones” are limited to only those areas above a stream bank that provide cover and shade to the nearshore aquatic areas (58 FR 33212, 33214; June 16, 1993). Although the bypasses (e.g., Yolo, Sutter, and Colusa) are not currently designated critical habitat for winter-run Chinook salmon, 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 Chinook salmon may use tributaries of the Sacramento River for non-natal rearing (Maslin et al. 1997, Pacific States Marine Fisheries Commission 2014).

2.2.1.3 Summary of Sacramento River Winter-run Chinook Salmon Critical Habitat

Currently, many of the PBFs of winter-run Chinook salmon critical habitat are degraded and provide limited high quality habitat. Factors 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 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 Central Valley Spring-run Chinook Salmon

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

The federally listed ESU of CV spring-run Chinook salmon and designated critical habitat for this ESU occur in the action area and may be affected by the PA. Detailed information regarding ESU listing and critical habitat designation history, designated critical habitat, ESU life history, and VSP parameters can be found in Appendix B.

Historically, CV 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 CV 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 CV 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 to 500,000 adults returning annually (CDFG 1990).

Monitoring of the Sacramento River mainstem during CV spring-run Chinook salmon spawning timing indicates some spawning occurs in the river (CDFW 2014). Genetic introgression has likely occurred here due to lack of physical separation between spring-run and fall-run Chinook salmon populations (CDFG 1998). Battle Creek and the upper Sacramento River represent persisting populations of CV spring-run Chinook salmon in the basalt and porous lava diversity group, though numbers remain low. Other 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 showed a positive escapement trend between 1991 and 2006, displaying broad fluctuations in adult abundance (Table A-3 in Appendix B). The Feather River Fish Hatchery (FRFH) CV 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 (70 FR 37160; June 28, 2005).

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 (i.e., 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). The northwestern California diversity group has two low abundance persisting populations of spring-run in Clear and Beegum creeks. In the San Joaquin River basin, the southern Sierra Nevada diversity group, 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. 2008; Cavallo et al. 2011).

Because the populations in Butte, Deer and Mill creeks are the best trend indicators for ESU viability, NMFS can evaluate risk of extinction based on 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 the status review recommends that the species status be reassessed in 2 to 3 years as opposed to waiting another 5 years if the decreasing trend continued. In 2012 and 2013, most tributary populations increased in returning adults, averaging more than 13,000. However, 2014 returns were lower again—approximately 5,000 fish—indicating the ESU remains highly fluctuating. The most recent status review was conducted in 2015 (NMFS 2016b), and it looked at promising increasing populations in 2012 to 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 to 2015 drought have not been fully realized, NMFS anticipates 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 they 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, 2003, and 2015, 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).

2.2.2.1 Summary of the Central Valley Spring-run Chinook Salmon Evolutionarily Significant Unit Viability

In summary, the extinction risk for the CV spring-run Chinook salmon ESU was evaluated for years 2012 – 2014, which remained at moderate risk of extinction (Williams et al. 2016). However, 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).

2.2.2.2 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 (70 FR 52488; September 2, 2005), which are described in Appendix B. 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 Sacramento, 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 (70 FR 52488; September 2, 2005).

2.2.2.3 Summary of Central Valley Spring-run Chinook Salmon Critical Habitat

Currently, many of the PBFs of CV spring-run Chinook salmon critical habitat are degraded and provide limited high quality habitat. Factors that lessen the quality of migratory corridors for juveniles include unscreened or inadequately screened diversions, altered flows in the Delta, 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.

2.2.3 California Central Valley Steelhead

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

The federally listed DPS of California Central Valley (CCV) steelhead and designated critical habitat for this DPS occur in the action area and may be affected by the PA. Detailed information regarding DPS listing and critical habitat designation history, designated critical habitat, DPS life history, and VSP parameters can be found in Appendix B.

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 are limited to returns to hatcheries and redd surveys conducted on a few rivers. The hatchery data are 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 CNFH increased from 2011 to 2014 (see Appendix B for further information). After hitting a low of only 790 fish in 2010, 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 to 300 fish each year. Numbers of wild adults returning each year ranged from 252 to 610 from 2010 to 2014, respectively.

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 to 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 to 1,023 and indicates an upward trend in abundance since 2006 (USFWS 2015).

The returns of CCV steelhead to the FRFH 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, 1,797, and 1,505 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 2017). 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 CCV steelhead 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 2016c). Most of the steelhead populations in the Central Valley have a high hatchery component, including Battle Creek (adults intercepted at the CNFH weir), the American River, Feather River, and Mokelumne River.

The CCV 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 CCV 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 Chinook salmon 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 57 degrees Fahrenheit (°F) to 66°F (14 degrees Celsius (°C) to 19°C). Several studies have found that steelhead require colder water temperatures for spawning and embryo incubation than salmon (McCullough et al. 2001). In fact, McCullough et al. (2001) recommended an optimal incubation temperature at or below 52°F to 55°F (11°C to 13°C). Successful smoltification in steelhead may be impaired by temperatures above 54°F (12°C), 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.

2.2.3.1 Summary of California Central Valley Steelhead Distinct Population Segment 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 2016c); 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 near future throughout all or a significant portion of its range (NMFS 2016c).

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

The critical habitat designation for CCV steelhead lists the PBFs (70 FR 52488; September 2, 2005), which are described in Appendix B. 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 following: the Sacramento, Feather, and Yuba rivers and the 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.

2.2.3.3 Summary of California Central Valley Steelhead Critical Habitat

Many of the PBFs of CCV steelhead critical habitat are 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 freshwater rearing and migration habitat and estuarine areas as riparian vegetation has been removed, reducing habitat complexity and food resources and resulting in many other ecological effects. Contaminant loading and poor water quality in central California waterways pose 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 efforts.

2.2.4 Southern Distinct Population Segment of North American Green Sturgeon

- Listed as threatened (71 FR 17757; April 7, 2006)
- Designated critical habitat (74 FR 52300; October 9, 2009)

The federally listed sDPS of North American green sturgeon and designated critical habitat for this DPS occur in the action area and may be affected by the PA. Detailed information regarding DPS listing and critical habitat designation history, designated critical habitat, DPS life history, and VSP parameters can be found in Appendix B.

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, Cramer Fish Sciences 2011, Seeholtz 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 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 the Yuba River (Cramer Fish Sciences 2011, Seeholtz 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 (CDFW 2017), and (2) by incidental catch of green sturgeon by the CDFW's white sturgeon sampling/tagging program (Dubois and Harris 2015, 2016). 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 rangewide 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 (SDFPF), and the Tracy Fish Collection Facility (TFCF). This data should be interpreted with some caution. Operations and practices at the facilities have changed over the project lifetime, which may affect salvage data.

These data likely indicate a high production year versus 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 the University of California at Davis (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 (using dual-frequency identification sonar (DIDSON) and 236 (using 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 events (NMFS 2010). Other indicators of productivity such as data for cohort replacement ratios and spawner abundance trends are not currently available for sDPS green sturgeon.

The sDPS green sturgeon spawn primarily in the Sacramento River in the spring and summer. The 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 (Heublein et al. in review). 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.

2.2.4.1 Summary of Green Sturgeon Southern Distinct Population Segment 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 (NMFS 2010). 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 2010). 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 barriers (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).

2.2.4.2 Critical Habitat and Physical or Biological Features for Southern Distinct Population Segment Green Sturgeon

The critical habitat designation for sDPS green sturgeon lists the PBFs (74 FR 52300; October 9, 2009), which are described in Appendix B. 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, 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
    - The Delta (as defined by California Water Code section 12220, except for listed excluded areas)
- In coastal bays and estuaries, the geographical range includes:
    - San Francisco, San Pablo, Suisun, and Humboldt bays in California
    - Coos, Winchester, Yaquina, and Nehalem bays in Oregon
    - Willapa Bay and Grays Harbor in Washington
    - the lower Columbia River estuary from the mouth to river kilometer (RK) 74

In coastal marine waters, the geographical range includes all United States 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.

2.2.4.3 Summary of Southern Distinct Population Segment Green Sturgeon Critical Habitat

Currently, many of the PBFs of sDPS green sturgeon are degraded and provide limited high quality habitat. Factors that lessen the quality of migratory corridors for juveniles include unscreened or inadequately screened diversions, altered flows in the Delta, and presence of contaminants in sediment. Although the current conditions of 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 snowmelt (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.* 2001). 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.

The sDPS green sturgeon spawn primarily in the Sacramento River in the spring and summer. The 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 (Heublein *et al.* 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.

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 levee repair, which will be 5,000 feet in length, will occur on the banks of Piper Slough on the north side of Bethel Island, and is located at approximately at the intersection of Taylor Road and Canal Road in Contra Costa County, California. The action area consists of natural and non-natural vegetation communities. Natural communities include non-native annual grassland, willow scrub, seasonal wetlands, blackberry thicket, riparian forest fragment, and open water. Non-natural communities consist of pasture, man-made ditches and ponds, and haul roads.

For projects with in-river construction activities, such as installation of riprap, the downstream extent of the action area is defined by the distance of potential increased turbidity and sediment deposition. Based on turbidity measurements taken during construction for similar bank stabilization projects performed by the USACE, turbidity impacts for the proposed repair are expected to occur up to 100 feet from the shoreline and up to 400 feet downstream of any in-river construction activities. Therefore, the action area includes an approximate 5,400-foot stretch of Piper Slough.

Since the BIMID plans to purchase mitigation credits from a conservation bank, the action area also includes the areas affected by the mitigation banks that have service areas relevant to the project. These include the Fremont Landing Conservation Bank, which is a 100-acre floodplain site along the Sacramento River at the confluence of the Feather River (Sacramento River Mile 80); Cosumnes Floodplain Mitigation Bank, a 472 acre site at the confluence of the Cosumnes and Mokelumne Rivers; and Liberty Island Conservation Bank, a 186 acre site in the California Central Valley Delta.

2.4 Environmental Baseline

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

2.4.1 Water Development

The diversion and storage of natural flows by dams and diversion structures on Central Valley watersheds has depleted stream flows in the tributaries feeding the Delta and altered the natural cycles by which juvenile and adult salmonids and sDPS green sturgeon base their migrations. As much as 60 percent of the natural historical inflow to Central Valley watersheds and the Delta have been diverted for human uses. Depleted flows have contributed to higher temperatures, lower DO levels, and decreased recruitment of gravel and large woody debris (LWD, also referred to as instream woody material or IWM). More uniform flows year round have resulted in diminished natural channel formation, altered foodweb processes, and slower regeneration of riparian vegetation (Mount 1995).

2.4.2 Water Conveyance, Flood Control and Dredging

The development of the water conveyance system in the Delta has resulted in the construction of more than 1,100 miles of armored levees to increase channel flood capacity elevations and flow capacity of the channels (Mount 1995). Levee development in the Central Valley affects spawning habitat, freshwater rearing habitat, freshwater migration corridors, and freshwater riverine and estuarine habitat PBFs. The construction of levees disrupts the natural processes of the river, resulting in a multitude of habitat-related effects; including isolation of the watershed's natural floodplain behind the levee from the active river channel and its fluctuating hydrology.

Many of these levees use angular rock (riprap) to armor the bank from erosive forces. The effects of channelization, and riprapping, include the alteration of river hydraulics and cover along the bank as a result of changes in bank configuration and structural features. These changes affect the quantity and quality of nearshore habitat for juvenile salmonids (USFWS 2000). Simple slopes protected with rock revetment generally create nearshore hydraulic conditions characterized by greater depths and faster, more homogeneous water velocities than occur along natural banks. Higher water velocities typically inhibit deposition and retention of sediment and woody debris. These changes generally reduce the range of habitat conditions typically found along natural shorelines, especially by eliminating the shallow, slow-velocity river margins used by juvenile fish as refuge and escape from fast currents, deep water, and predators.

Little of the extensive tracts of wetland marshes that existed prior to 1850 along the valley's river systems and within the natural flood basins exist today. Most has been "reclaimed" for agricultural purposes, leaving only small remnant patches. Dredging of river channels to enhance inland maritime trade and to provide raw material for levee construction has also significantly and detrimentally altered the natural hydrology and function of the river systems in the Central Valley. This has led to declines in the natural meandering of river channels and the formation of pool and bar segments.

2.4.3 Water Quality

The water quality of the Delta has been negatively impacted over the last 150 years. Increased water temperatures, decreased DO levels, and increased turbidity and contaminant loads have degraded the quality of the aquatic habitat for the rearing and migration of salmonids and sDPS green sturgeon. In general, water degradation or contamination can lead to either acute toxicity, resulting in death when concentrations are sufficiently elevated, or more typically, when concentrations are lower, to chronic or sublethal effects that reduce the physical health of the organism, and lessens its survival over an extended period of time.

2.4.4 Hydrology in the Delta

Substantial changes have occurred in the hydrology of the Central Valley's watersheds over the past 150 years. Many of these changes are linked to the ongoing actions of the CVP and SWP in their pursuit of water storage and delivery of this water to their contractors.

Prior to the construction of the more than 600 dams in the mountains surrounding the Central Valley, parts of the valley floor hydrologically functioned as a series of natural reservoirs seasonally filling and draining every year with the cycles of rainfall and snowmelt in the surrounding watersheds. The magnitude of the seasonal flood pulses were reduced before entering the Delta, but the duration of the elevated flows into the Delta were prolonged for several months, thereby providing extended rearing opportunities for emigrating Chinook salmon, steelhead, and green sturgeon to grow larger and acquire additional nutritional energy stores before entering the main Delta and upper estuarine reaches. Furthermore, the construction of these dams has led to a lack of the variability in seasonal and inter-annual runoff, which has been substantially reduced with muted peak flows except in exceptional runoff years. Currently, average winter/spring flows are typically reduced compared to natural conditions, while summer/fall flows have been artificially increased by reservoir releases.

These changes in the hydrographs of the two main river systems in the Central Valley are also reflected in the inflow and outflow of water to the Delta. The operations of the dams and water transfer operations of the CVP and SWP have reduced the winter and spring flows into the Delta, while artificially maintaining elevated flows in the summer and late fall periods. The Delta has thus become a conveyance apparatus to move water from the Sacramento side of the Delta to the southwestern corner of the Delta where the CVP and SWP pumping facilities are located. Releases of water to the Delta during the normally low flow summer period have had several impacts on Delta ecology and hydrology. Since the projects started transferring water through the Delta, the normal variability in the hydrology of the Delta has diminished. Annual incursions of saline water into the Delta still occur each summer, but have been substantially muted compared to their historical levels by the release of summer water from the reservoirs (Herbold and Moyle 1989). The Delta has become a stable freshwater body, which is more suitable for introduced and invasive exotic freshwater species of fish, plants, and invertebrates than for the native organisms that evolved in a fluctuating and "unstable" Delta environment.

2.4.5 Status of ESA-listed species in the Action Area

The action area, which encompasses the banks of Piper Slough and associated floodplains and riparian areas at and adjacent to the levee repair, functions as a migratory corridor for Sacramento River winter-run Chinook salmon, CV spring-run Chinook salmon, CCV steelhead smolts, and green sturgeon. In addition, it also provides some use as holding and rearing habitat for each of these species. Juvenile salmonids may use the area for rearing for several months during the winter and spring. Green sturgeon use the area for rearing and migration year-round.

It is possible for adult Sacramento River winter-run, CV spring-run Chinook, CCV steelhead, and green sturgeon to pass through the action area on their way to their spawning grounds, but Piper Slough is not on the most direct path for upstream migration. Adult steelhead utilize the area as a migration corridor to and from spawning grounds. No spawning of salmonids or green sturgeon occurs within the action area, therefore no eggs or fry of these species is expected to occur in the action area.

2.4.5.1 Status of Sacramento River Winter-run in the Action Area

Adult winter-run typically migrate through the Delta between November and June with the peak occurring in March on their way to their spawning grounds. They travel to Sacramento River Basin tributaries as late as July (Lindley *et al.* 2004), and then hold in the upper tributaries. Spawning occurs from August through October, with a peak in September (Moyle 2002). During their upstream migration, winter-run adults have been known to stray into the San Joaquin River and around the Delta islands as they make their way through the maze of channels (CDFW 2016b).

Generally, juveniles migrate downstream in the winter and spring. Juvenile winter-run occur in the Delta primarily from November through early May, using length-at-date criteria from trawl and seine data in the Delta (USFWS 2016). Salvage data from the State and Federal pumping facilities shows presence of wild juvenile winter-run Chinook in the south Delta to be primarily in December to March (NMFS 2016d). Although winter-run are more likely to migrate through Sacramento River than to enter the south Delta, monitoring data shows they do have a presence throughout the Delta.

Since there is connectivity between the Sacramento River and south Delta, winter-run may be present in the action area from November to June for adults, and November to early May for juveniles. Since in-river work will not be occurring during these months, winter-run are not expected to be present during the proposed action (July 1 to October 31).

2.4.5.2 Status of CV Spring-run in the Action Area

Adult CV spring-run migrate through the Delta from January to June, primarily from February to April (CDFG 1998). Adult CCV steelhead migration typically begins in August and extends through the winter to as late as May. As with winter-run, adult CV spring-run may migrate through and rear within the action, but are not expected to be present in the action area during the proposed action.

From the tributaries, juveniles migrate downstream soon after emergence as young-of-the-year, or they remain in the creeks until the following fall, which appears to be more typical (Moyle *et al.* 1995). According to trawl and seine data in the Delta, juvenile CV spring-run may be present in the Delta during January to May (USFWS 2016).

Since there is connectivity between the Sacramento River and the action area, spring-run may be present from January to June for adults, and January to May for juveniles. Since in-river work will not be occurring during these months, spring-run are not expected to be present during the proposed action.

2.4.5.3 Status of CCV Steelhead in the Action Area

Adult steelhead enter freshwater in August (Moyle 2002) and peak migration of adults move upriver in late September (Hallock et al. 1957). Adult steelhead will hold until flows are high enough in the tributaries to migrate upstream where they will spawn from December to April (Hallock et al. 1961). Unlike salmon, not all steelhead die after spawning. A small percentage (typically females) migrate back downstream from the tributaries and reach the Sacramento River during March and April, and have a high presence in the Delta in May.

CCV steelhead juveniles (smolts) can start to appear in the action area as early as October, based on the data from the Chipps Island trawl (USFWS 2016) and CVP and SWP Fish Salvage Facilities (CDFW 2016b). In the Sacramento River, juvenile CCV steelhead generally migrate to the ocean in spring and early summer at 1 to 3 years of age and 100 to 250 mm FL, with peak migration through the Delta in March and April (Reynolds *et al.* 1993). CCV steelhead presence in CVP/SWP Fish Salvage Facilities increases from November through January (21.6 percent of average annual salvage) and peaks in February (37.0 percent) and March (31.1 percent) before rapidly declining in April (7.7 percent). By June, emigration essentially ends, with only a small number of fish being salvaged through the summer at the CVP and SWP Fish Salvage Facilities.

Since adult steelhead may be present in the Delta during their migration upstream (peaking in August/September) and downstream (peaking in May), they have a higher chance of being present during the proposed action than Chinook salmon. Though unlikely, juvenile steelhead may be present during the month of October, towards the end of the in-river construction period (July 1 to October 31).

2.4.5.4 Status of Southern DPS of North American Green Sturgeon in the Action Area

For green sturgeon, the action area functions as migratory, holding, and rearing habitat for adults, subadults, and juveniles, since their presence is considered year-round in the Delta. Both non-spawning adults and sub-adult green sturgeon use the Delta and estuary for foraging during the summer. The only known spawning areas for green sturgeon occur in the Sacramento River basin, therefore no eggs or larval green sturgeon are expected to occur in the action area.

Spawning in the San Joaquin River has not been recorded, although there appears to be at least some presence of adult fish in the river upstream of the Delta based on sturgeon report card data (CDFW 2014). Green sturgeon numbers are considerably lower than for other species of fish monitored at the facilities. Based on the salvage records from 1981–2015, green sturgeon may be present during any month of the year, but only a few juveniles have been observed since 2011 (CDFW 2016b).

In summary, adult and juvenile green sturgeon may be present during the proposed action since they occur in the Delta year-round, but due to their small population size, few are expected to be present during in-river work activities.

2.4.6 Status of Critical Habitat within the Action Area

The PBFs for Sacramento River winter-run, CV spring-run Chinook, and CCV steelhead critical habitat within the action area include freshwater rearing habitat and freshwater migration corridors. The features of the PBFs essential to the conservation of the CV spring-run Chinook ESU, Sacramento River winter-run Chinook ESU, and CCV steelhead DPS include the following: sufficient water quantity and floodplain connectivity to form and maintain physical habitat conditions necessary for salmonid development and mobility, sufficient water quality, food and nutrients sources, natural cover and shelter, migration routes free from obstructions, no excessive predation, holding areas for juveniles and adults, and shallow water areas and wetlands. Habitat within the action area is primarily utilized for freshwater rearing and migration by CCV steelhead, CV spring-run Chinook salmon, and Sacramento River winter-run Chinook salmon smolts and for adult migration of mainly CCV steelhead. It is possible for adult Sacramento River winter-run and CV spring-run Chinook to pass the area on their way to their spawning grounds, but the levee repair is not on the most direct path for upstream migration. No spawning of CCV steelhead, CV spring-run Chinook salmon, or Sacramento River winter-run Chinook salmon occurs within the action area.

In regards to the designated critical habitat for the sDPS green sturgeon, the action area includes PBFs which provide: adequate food resources for all life stages utilizing the Delta; water flows sufficient to allow adults, sub-adults, and juveniles to orient to flows for migration and normal behavioral responses; water quality sufficient to allow normal physiological and behavioral responses; unobstructed migratory corridors for all life stages utilizing the Delta; a broad spectrum of water depths to satisfy the needs of the different life stages present in the Delta and estuary; and sediment with sufficiently low contaminant burdens to allow for normal physiological and behavioral responses to the environment.

The general condition and function of the aquatic habitat has already been described in this section above. The substantial degradation over time of several of the essential critical elements has diminished the function and condition of the freshwater rearing and migration habitats in the action area. Even though the habitat has been substantially altered and its quality diminished through years of human actions, its conservation value remains high for the Sacramento River winter-run Chinook salmon ESU, the CV spring-run Chinook salmon ESU, the CCV steelhead DPS, and the sDPS green sturgeon. A number of juvenile and adults representing these DPSs and ESUs likely pass the site and spend some time there on their way to or from the ocean.

2.4.7 Mitigation Banks and the Environmental Baseline

The levee repair project occurs within the service areas of four conservation or mitigation banks approved by NMFS. These include:

Fremont Landing Conservation Bank: Established in 2006, the Fremont Landing Conservation Bank is a 100-acre floodplain site along the Sacramento River at the confluence of the Feather River (Sacramento River Mile 80) and is approved by NMFS to provide credits for impacts to Sacramento River winter-run Chinook salmon, CV spring-run Chinook salmon, and CCV steelhead. There are off-channel shaded aquatic habitat credits, riverine shaded aquatic habitat credits, and floodplain credits available. To date, there have been 49.213 of 100 credits sold and the ecological value (increased rearing habitat for juvenile salmonids) of the sold credits are part of the environmental baseline. All features of this bank are designated critical habitat for the species analyzed in this BO.

Liberty Island Conservation Bank: Established in 2008. The Liberty Island Mitigation Bank is a 186-acre conservation bank, with credits available for the preservation, restoration, and creation of anadromous salmonid habitat. Liberty Island Conservation Bank is approved by NMFS to provide credits for impacts to Sacramento River winter-run Chinook salmon, CV spring-run Chinook salmon, and CCV steelhead, and their critical habitats, and Essential Fish Habitat of Pacific salmon. To date, there have been 56.63 of 139.11 credits sold and the ecological value (increased rearing habitat for juvenile salmonids) of the sold credits are part of the environmental baseline. All features of this bank are designated critical habitat for the species analyzed in this BO.

Cosumnes Floodplain Mitigation Bank: Established in 2009. The Cosumnes Floodplain Mitigation Bank is a 472-acre floodplain site located at the confluence of the Cosumnes and Mokelumne rivers and is approved by NMFS to provide credits for impacts to CV steelhead and Essential Fish Habitat of Pacific salmon. To date, there have been 28.2 of 100 credits sold and the ecological value (increased rearing habitat for juvenile salmonids) of the sold credits are part of the environmental baseline. All features of this bank are designated critical habitat for the species analyzed in this BO.

2.5 Effects of the Action

Under the ESA, “effects of the action” means the direct and indirect effects of an action on the species or critical habitat, together with the effects of other activities that are interrelated or interdependent with that action, that will be added to the environmental baseline (50 CFR 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 this levee repair, NMFS examined the potential effects of the proposed action. We analyzed construction-related impacts and the fish response to habitat alterations. We also reviewed and considered the BIMID’s proposed conservation measures. This assessment relied heavily on the information from the BIMID’s biological assessment for this project.

Our assessment will consider the nature, duration, and extent of the proposed actions relative to the spawning, rearing, and migration timing, behavior, and habitat requirements of all life stages of Federally listed fish in the action area. Effects of the levee repair on aquatic resources include both short- and long-term impacts. Short-term effects, which are related primarily to construction activities (*i.e.*, increased suspended sediment and turbidity, noise, etc.), may last several hours to several weeks. Long-term impacts may last months or years and generally involve physical alteration of the riverbank.

The levee repair will also contribute to the continued confinement of the riverine system that in turn negatively impacts listed fish species and their designated critical habitat. This analysis also evaluates the long-term impacts of the levee repair on fish species and their critical habitat.

2.5.1 Construction Impact Analysis for Salmonids and Green Sturgeon

Adult and juvenile Sacramento River winter-run Chinook salmon, CV spring-run Chinook salmon, CCV steelhead, and green sturgeon are likely to be occur in the action area, however, only CCV steelhead and green sturgeon are likely to be present during the in-water construction work window, and only in low numbers. No spawning habitat for CCV steelhead, CV spring-run Chinook salmon, winter-run Chinook salmon, or green sturgeon is present in the action area, therefore no adverse effects to spawning adults or incubating eggs are expected.

Direct effects associated with in-river construction work will involve equipment and activities that will produce underwater noise and vibration, thereby temporarily altering in-river conditions. These changes can also impair feeding behaviors, which in turn impact their ability to grow and survive. Juvenile fish are the most vulnerable to these changes, since adults are better able to quickly swim away from the construction sites and escape injury. Construction disturbance can cause injury or harm by increasing the susceptibility of some individuals to predation by temporarily disrupting normal sheltering behaviors. Only those fish that are holding adjacent to or migrating past the levee repair site will be directly exposed or affected by construction activities. Those fish that are exposed to the effects of construction activities will encounter short-term (*i.e.*, minutes to hours) construction-related noise and physical disturbance. Construction-related noise has the potential to disrupt behavior of any CCV steelhead or green sturgeon present in the action area, causing them to travel away from the disturbance to adjacent areas with similar habitats. This could result in temporary displacement from rearing habitat. However, CCV steelhead and green sturgeon are expected to avoid the work area, and based on salvage and DJFMP monitoring data, we expect that fish will either be present at extremely low numbers or not present at all. Additionally, green sturgeon are expected to be present in benthic environments and closer to the mid-channel of the river, and not the shallow, near-bank habitats. Therefore, listed fish species are unlikely to be adversely affected by the low levels of noise produced during construction activities.

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 could potentially injure listed salmonids and green sturgeon. Petroleum products also tend to form oily films on the water surface that can reduce DO available to aquatic organisms. The exposure to these substances can kill fish directly in high enough concentrations through acute toxicity or suffocation from lack of oxygen. These chemicals may also kill the prey of listed fish species, reducing their ability to feed and therefore grow and survive. However, due to adherence of BMPs that dictate the use, containment, and cleanup of contaminants, the use of toxic substances at the construction site is not likely to result in adverse effects to listed fish species.

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 harm salmonids by temporarily burying submerged aquatic vegetation that supports invertebrates for feeding juvenile fish, leading to reduced growth and survival. High turbidity can also damage a fish's gills, interfere with cues necessary for orientation in homing and migration, and reduce available spawning habitat (Bash *et al.* 2001). However, BMPs for the project will minimize the amount of turbidity caused by the project, such that turbidity levels are not likely to result in adverse effects to listed fish species.

Approximately 1.7 acres of scrub shrub and 1.5 acres of riparian forest will be removed from the land side of the levee. The levee repair on Piper Slough will not require the removal of any shrubs or trees on the waterside of the levee. Riparian forests provide habitat for adult terrestrial insects once they emerge from the water. Salmonids prey on the aquatic life stage of these insects. Removal of riparian forests can impact an important food source for salmonids. However, since the area of disturbance is not immediately adjacent to the water, is small in size, and there are surrounding areas with similar habitat type, the removal of 1.5 acres of riparian forest is not expected to impact the population of aquatic insects in the action area.

The waterside slope currently consists of riprap and grass. A total of, 0.29 acres of habitat below the OHWM will be covered with new riprap along a 5,000-foot stretch. A 2,000-foot waterside bench will be created within the 5,000-foot repair. With the exception of the levee toe below the waterline, all the new riprap will be mixed with soil at a 70:30 riprap to soil ratio, with a 1-foot layer of soil on top, which will be planted with native vegetation, which may have beneficial effects such as aquatic cover and decreased water temperature. Riprap placed below the OHWM will provide habitat for bass and other predators that feed on out-migrating smolts. We expect there to be adverse effects in the form of harm from significant habitat degradation and death from predation along 5,000 feet (0.29 acres) of shoreline below the OHWM for a period of at least 50 years, which is the standard engineered life expectancy of a levee repair project.

2.5.2 Project Effects on Critical Habitat

The levee repair is located within critical habitat for CCV steelhead and sDPS green sturgeon. The repair is expected to cause a reduction in critical habitat by installing rock revetment. Revetment will be placed along a total of 5,000 linear feet along Piper Slough. Approximately 0.3 acres of riprap will be placed below the OHWM, creating an area of unproductive, low quality habitat along the interface of the channel bottom and the bank slope. The effects of the project will result in continued fragmentation of existing habitat, and conversion of nearshore aquatic to simplified habitats that have adverse effects on salmonids and green sturgeon. This project is expected to adversely impact several of the PBFs of critical habitat for CCV steelhead, including freshwater rearing habitat and migration corridors for juvenile steelhead. Implementing the proposed repair may affect freshwater rearing sites due to the installation of riprap, which reduces natural cover and support of juvenile growth and mobility.

The PBF of migratory corridors for adults is not expected to be impacted, as migrating adult steelhead are unlikely to use the nearshore habitat that will be affected by the project, since they tend to stay in deeper waters. Furthermore, the site will not install any features that are expected to block or impede juvenile or adult migration. No spawning habitat for CCV steelhead is present in the action area, therefore no adverse effects to spawning adults or incubating eggs are expected.

The project is expected to adversely impact several of the PBFs of critical habitat for sDPS green sturgeon, including food resources and substrate. The PBF of food resources, which refers to the availability of prey items for juvenile, sub-adult, and adult life stages, is expected to be adversely affected by the installation of 5,000 linear feet of rock revetment at the levee repair site. The installation of rock revetment below OHWM will impair green sturgeon foraging habitat, thereby reducing the availability of prey. Similarly, the PBF of sediment quality will also be adversely affected, as part of the natural substrate will be permanently covered with large rocks and will no longer be available as foraging habitat. The levee repair is not expected to permanently impact the PBFs of water flow or water quality, migration corridors (*i.e.*, pathways necessary for the safe and timely passage of all life stages), or depth (*i.e.*, availability of deep pools for use as holding habitat), since the site will not install any features that are expected to block or impede juvenile or adult migration, alter any deep pools, or permanently alter water quality. No spawning habitat for green sturgeon is present in the action area, therefore no adverse effects to spawning adults or incubating eggs are expected.

Native vegetation, including a variety of trees, shrubs, and herbaceous plants, will be installed in the soil-filled riprap section of the repair and the 2,000-foot waterside bench in 2018. The lag time between the placement of the riprap and the installation of the plantings means that site will remain devoid of vegetation for at least a year. However, minimal vegetation currently exists on the levee, so the addition of native vegetation will improve conditions and part of the affected area will recover some of the habitat values lost.

The action, through the purchase of compensatory mitigation credits, will restore and preserve in perpetuity, 0.9 acres of designated critical habitat for all species analyzed in this BO. Although the banks technically do not include green sturgeon credits (only salmonid credits), we expect that green sturgeon will benefit from the purchase of these credits. Since the mitigation banks are en route to green sturgeon spawning grounds, improved floodplain and rearing habitats are likely to improve growth and survival of juveniles and adults, as well as increase food production, provide shelter from predators, and restore beneficial flow.

2.5.3 Mitigation/Conservation Bank Credit Purchases

To address permanent impacts to riparian and aquatic habitats, the proposed action includes purchase of mitigation bank credits at a 3:1 ratio for permanent riparian impacts and a 3:1 ratio for permanent aquatic habitat impacts. Both the riparian and aquatic habitat impacts are on designated critical habitat. The purchase of mitigation credits will address the loss of ecosystem functions due to the modification of the riverbank. These credit purchases are ecologically relevant to the impacts and the species affected because both banks include shaded riparian aquatic, riparian forest and floodplain credits with habitat values that are already established and meeting performance standards. Also, the banks are located in areas that will benefit the ESUs/DPSs affected.

The purchase of credits provides a high level of certainty that the benefits of a credit purchase will be realized because each of the NMFS approved banks considered in this opinion have mechanisms in place to ensure credit values are met over time. Such mechanisms include legally binding conservation easements, long-term management plans, detailed performance standards, credit release schedules that are based on meeting performance standards, monitoring plans and annual monitoring reporting to NMFS, non-wasting endowment funds that are used to manage and maintain the bank and habitat values in perpetuity, performance security requirements, a remedial action plan, and site inspections by NMFS. In addition, each bank has a detailed credit schedule and credit transactions and credit availability are tracked on the Regulatory In-lieu Fee and Bank Information Tracking System (RIBITS). RIBITS was developed by the USACE with support from the Environmental Protection Agency, the U.S. Fish and Wildlife Service, the Federal Highway Administration, and NMFS to provide better information on mitigation and conservation banking and in-lieu fee programs across the country. RIBITS allows users to access information on the types and numbers of mitigation and conservation bank and in-lieu fee program sites, associated documents, mitigation credit availability, service areas, as well information on national and local policies and procedures that affect mitigation and conservation bank and in-lieu fee program development and operation.

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 2.2.4.

2.6.1 Agricultural Practices

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

2.6.2 Aquaculture and Fish Hatcheries

More than 32-million fall-run Chinook salmon, 2-million spring-run Chinook salmon, 1-million late fall-run Chinook salmon, 0.25-million winter-run Chinook salmon, and 2-million steelhead are released annually from six hatcheries producing anadromous salmonids in the Feather River. 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-escapement 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 that 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 suspending contaminated sediments and degrading areas of submerged vegetation. This in turn will reduce habitat quality for the invertebrate forage base required for the survival of juvenile salmonids and green sturgeon moving through the system. Increased recreational boat operation is anticipated to result in more contamination from the operation of gasoline and diesel powered engines on watercraft entering the associated water bodies.

2.6.4 Rock Revetment and Levee Repair Projects

Cumulative effects include non-Federal riprap projects. Depending on the scope of the action, some non-Federal riprap projects carried out by state or local agencies do not require Federal permits. These types of actions and illegal placement of riprap occur within the Feather 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 implementing the proposed action. In this section, we add the effects of the action (Section 2.5) to the environmental baseline (Section 2.4) and the cumulative effects (Section 2.6), taking into account the status of the species and critical habitat (Section 2.2), to formulate the agency's biological opinion as to whether the proposed action is likely to: (1) Reduce appreciably the likelihood of both the survival and recovery of a listed species in the wild by reducing its numbers, reproduction, or distribution; or (2) appreciably diminishes the value of designated or proposed critical habitat for the conservation of the species.

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

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). The NMFS 2016 5-year Status Review of winter-run Chinook salmon ESU demonstrated that SR winter-run Chinook salmon ESU has further declined, and that continued loss of historical habitat and the degradation of remaining habitat continue to be major threats to the SR winter-run Chinook salmon ESU (NMFS 2016a). NMFS concludes that winter-run ESU remains at high risk of extinction.

The population to be impacted by the PACR program is considered a Core 1 population by NMFS 2014 recovery plan for the ESU, meaning it has the potential to support a viable population, and recovery of the population through threat abatement efforts and recover actions should be considered a high priority (NMFS 2014). Given the high priority nature of the population to recovery, harm to this population through the PACR program is considered especially detrimental to the ESU.

2.7.2 Status of the CV Spring-Run Chinook Salmon ESU

In the 2016 status review, NMFS found, with a few exceptions, CV spring-run Chinook salmon populations have increased through 2014 returns since the last status review (2010/2011), which moved the Mill and Deer creek populations from the high extinction risk category, to moderate, and Butte Creek remaining in the low risk of extinction category. Additionally, the Battle Creek and Clear Creek populations continued to show stable or increasing numbers in that period, putting them at moderate risk of extinction based on abundance. Overall, the Southwest Fisheries Science Center concluded in their viability report that the status of CV spring-run Chinook salmon (through 2014) had probably improved since the 2010/2011 status review and that the ESU's extinction risk may have decreased. However, the 2015 returning fish were extremely low (1,488), with additional pre-spawn mortality reaching record lows. Since the effects of the 2012 to 2015 drought have not been fully realized, NMFS anticipates at least several more years of very low returns, which may result in severe rates of decline (NMFS 2016b).

2.7.3 Status of the CCV Steelhead DPS

The 2016 status review (NMFS 2016c) concluded that overall, the status of CCV steelhead appears to have changed little since the 2011 status review 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 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 (NMFS 2010).

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 (NMFS 2010).

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

The *Cumulative Effects* and *Environmental Baseline* sections of this BO describe how past and present actions such as discharge of point and non-point source chemical contaminant discharges, aquaculture and hatcheries, flood control, water diversions 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.

The action area, which encompasses the banks of Piper Slough and associated floodplains and riparian areas at and adjacent to the levee repair, functions primarily as a rearing and migratory habitat for Sacramento River winter-run Chinook salmon, CV spring-run Chinook salmon and CCV steelhead smolts. The Delta serves as an important migratory corridor for adults during their spawning migrations, and as year round rearing habitat for juveniles. Even though the habitat has been substantially altered and its quality diminished through years of human actions, its conservation value remains high for the Sacramento River winter-run Chinook salmon ESU, the CV spring-run Chinook salmon ESU, the CCV steelhead DPS, and the sDPS green sturgeon. A number of juvenile and adults representing these DPSs and ESUs likely pass the site and spend some time there on their way to or from the ocean.

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

1. *Temporary Construction-Related Effects*

Construction activities are expected to result in impacts to anadromous ESA-listed fish species due to noise, turbidity, or predation related to displacement of individuals away from the shoreline or at the margins or turbidity plumes. However, since these construction actions will occur during the July 1 to October 31 in-water work window, when the abundance of individual salmon, steelhead, and green sturgeon is low, and with the implementation of conservation measures, impacts are not expected to reach the level where fish are adversely affected.

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

For outmigrating juvenile Chinook salmon and steelhead, the proposed action will result in some short-term and long-term adverse effects to individuals that are exposed to the project features along Piper Slough. Riparian vegetation will only be removed on the landside of the levee. No vegetation is proposed for removal below the OHWM. The soil-filled riprap will be planted with native riparian vegetation, however, the toe of the repair will remain bare rock. The loss of aquatic habitat in existing riprap is expected to decrease food availability, reduce cover and increase temperatures in the action area, resulting in reduced growth and survival.

Migrating adult Chinook salmon and steelhead residents (post spawning steelhead adults) will not be impacted because adult salmonids are unlikely to use the nearshore habitat that will be affected by this project since they tend to remain in deeper waters instead of shallow areas. Furthermore, the project will not cause an increase in predation on adults or install any structural features that might impede adult migration. For adult Chinook salmon, the project is not on the most direct route to their spawning ground, although it is possible for them to pass the site if they were to stray from the most direct path. The project is in the migration corridor steelhead take to their spawning grounds. No spawning occurs in the action area, therefore eggs and fry will not be impacted by the project.

For fry and juvenile rearing sDPS green sturgeon, shoreline habitat conditions are negatively impacted compared to the environmental baseline. The worsened conditions begins immediately after construction, but will gradually recover as the plantings on the waterside slope mature and soil accumulates on top of the riprap. The project will permanently cover some benthic substrate that provides food resources of juvenile and adult green sturgeon, although this area covered represents a very small fraction of the adjacent habitat available in the Delta. The loss of benthic substrate is expected to reduce food availability to juvenile and adult green sturgeon, resulting in decreased growth and survival.

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

The PBFs of freshwater rearing habitat and migration corridors for juvenile salmon and steelhead is expected to be affected by the removal of degraded riprap with established benthic substrate and the permanent installation of bare riprap at the toe of the repair. These activities are expected to reduce the quality of this habitat for rearing and migrating juvenile salmonids. The PBF of migratory corridors for adults will not be impacted, as migrating adult Chinook salmon and steelhead are unlikely to use the nearshore habitat that will be affected by this project, as they tend to stay in deeper waters. Furthermore, the site will not install any features that expected to block or impede juvenile or adult migration.

Green sturgeon PBFs of substrate type/size and food resources will both be adversely affected by the proposed project, as project features will cover the soft benthic substrate where green sturgeon forage for food within riprap, reducing food availability. However, the amount of benthic substrate lost is small compared to the amount of available habitat in Piper Slough. Some of the riprap will be mixed with soil and planted with riparian vegetation, which is expected to lessen the impacts of the project in the long-term.

As compensatory mitigation for these impacts, the BIMID plans to purchase credits from a NMFS-approved conservation bank at a 3:1 ratio for habitat. Although the conservation banks within the service area are located upstream of the proposed project, they benefit the same juvenile CV spring-run and CCV steelhead that use the construction portion of the action area by providing suitable rearing habitat. Cosumnes Floodplain Mitigation Bank, Liberty Island Conservation Bank, and Fremont Landing Conservation Bank all have adequate mechanisms in place to track credits and debits and ensure that more debits are not sold then credits that are available, and overall habitat improvement for CCV steelhead, Sacramento winter-run Chinook salmon, and CV spring-run Chinook salmon is expected. Although the banks technically do not include green sturgeon credits (only salmonid credits), we expect that individual green sturgeon in the Delta will benefit from the purchase of these credits, as the banks provide areas with soft benthic substrate where juvenile and adult green sturgeon can forage. The purchase of credits at these banks benefit green sturgeon in the same DPS. A description of these tracking mechanisms can be found in the respective banking instruments for Fremont Landing (Wildlands Inc. 2006), Cosumnes (Westervelt Ecological Services 2009) and Liberty Island (Wildlands Inc. 2010).

2.7.8 Summary

Although there are some permanent impacts from the proposed project, when added to the environmental baseline and cumulative effects, the impacts from the proposed project in the action area are small, and in some cases occur during seasons when fish abundance is low. As compensatory mitigation for the effects of the project, the BIMID plans to install riparian plantings on the landside stability berm and along the 2,000-foot waterside bench, and purchase mitigation credits off-site at a 3:1 ratio below the OHWM. This is a substantially greater amount of restoration and preservation than the spatial footprint of the levee repair. In addition, the compensatory mitigation serves as a form of advanced mitigation because the habitat at the bank was restored between eight years (Liberty Island Conservation Bank) and twelve years (Fremont Landing Conservation Bank) before the impact of the levee repair. Therefore, the project is not expected to reduce appreciably the likelihood of either the survival and recovery of a listed species in the wild by reducing their numbers, reproduction, or distribution; or appreciably diminish the value of designated or proposed critical habitat 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, 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 Sacramento River winter-run Chinook salmon, CV spring-run Chinook salmon, CCV steelhead, or the sDPS green sturgeon, or destroy or adversely modify designated critical habitats 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).

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 green sturgeon in the action area through alteration of habitat conditions in a manner that may significantly disrupt normal behavior. Because of proposed project timing, actual numbers of fish adversely affected are expected to be low. 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 due to the variability and uncertainty associated with the long-term 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 harassed, 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 adverse effects to listed species, that are more predictable and/or measurable, with the ability to monitor those surrogates to determine the extent of take that is occurring.

The most appropriate threshold for incidental take is an ecological surrogate of habitat degradation, which includes the degradation of aquatic habitat, through the placement of rock revetment below the OHWM. The behavioral modifications or fish responses that result from the habitat disturbance are described below. NMFS anticipates annual take will be limited to the following forms:

1. Take in the form of harm to rearing juvenile Sacramento River winter-run Chinook salmon, CV spring-run Chinook salmon, CCV steelhead, and adult and juvenile sDPS green sturgeon from the degradation of aquatic habitat from the placement of 0.29 acres of riprap below to OHWM along 5,000 feet of levee. This loss will affect juvenile Sacramento River winter-run Chinook salmon, CV spring-run Chinook salmon, CCV steelhead, and juvenile and adult sDPS green sturgeon through displacement, increased predation, and loss of food, resulting in decreased growth and survival for a period of up to 50 years, which is the standard engineered life expectancy of rock revetment placed on a levee project.

Incidental take will be exceeded if the amount of habitat disturbance described in the surrogate is exceeded.

2.9.2 Effect of the Take

In this 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 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 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 green sturgeon.
2. Measures shall be taken to ensure that contractors, construction workers, and all other parties involved with this project implement the project as proposed in the biological assessment and this BO.
3. Measures shall be taken to monitor the survival of on-site plantings.

2.9.4 Terms and Conditions

The terms and conditions described below are non-discretionary, and the USACE and the applicant must comply with them in order to implement the reasonable and prudent measures (50 CFR 402.14). The USACE and the applicant have 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. The following terms and conditions implement reasonable and prudent measure 1:

    a. The USACE shall only purchase salmon and steelhead credits from NMFS-approved mitigation banks with service areas that include the proposed action area including the Cosumnes Floodplain Mitigation Bank, Liberty Island Conservation Bank, and the Fremont Landing Conservation Bank. Credits shall be purchased prior to completing the repair.
    b. Construction involving the placement of rock revetment below the OHWM will occur in accordance with the BMPs and conservation measures described in this BO.

2. The following terms and conditions implement reasonable and prudent measure 2:

    a. The USACE shall provide a copy of this BO to the prime contractor, making the prime contractor responsible for implementing all requirements and obligations included in this document and to educate and inform all other contractors involved in the project of the requirements of the 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 the BO.

3. The following terms and conditions implement reasonable and prudent measure 3:

    a. USACE/BIMID shall submit a riparian planting and monitoring plan for on-site plantings to NMFS no later than August 1, 2018. These plantings will be maintained for a minimum of five years, at which point they should achieve a minimum of 80% survivability. Remediation shall occur if the plantings do not meet the survivability requirements at the end of the five year period. All reports for NMFS shall be sent 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) USACE should recommend that BIMID contractors use biodegradable lubricants and hydraulic fluid in construction machinery. The use of petroleum alternatives can greatly reduce the risk of contaminants such as polycyclic aromatic hydrocarbons (PAHs) or heavy metals directly or indirectly entering the aquatic ecosystem.

(2) USACE should make set-back levees integral components of their authorized bank protection or ecosystem restoration efforts.

(3) USACE should conduct or fund studies to identify set-back levee opportunities, at locations where the existing levees are in need of repair or where set-back levees could be built. Removal of the existing riprap from abandoned levees should be considered.

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 Horseshoe Bend Levee Improvement Project.

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 the USACE and descriptions of EFH for Pacific Coast Salmon (PFMC 2014) contained in the Fishery Management Plan (FMP) 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 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, and **(2)** estuaries.

3.2 Adverse Effects on Essential Fish Habitat

The effects of the proposed action on Pacific Coast salmon EFH will be similar to those discussed in the *Effects of the Action* section (2.5) for Chinook salmon. Based on the information provided, NMFS concludes that the proposed action would adversely affect EFH for federally managed Pacific salmon. Adverse effects to HAPCs are appreciably similar to effects to critical habitat, therefore no additional discussion is included. Listed below are the adverse effects on EFH reasonably certain to occur. Affected HAPCs are indicated by number, corresponding to the list in Section 3.1:

1. Sedimentation and Turbidity

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

2. Contaminants and Pollution-related Effects

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

3. Installation of Revetment

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

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 Statutory Response Requirement

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

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

3.4 Supplemental Consultation

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

4. FISH AND WILDLIFE COORDINATION ACT

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

The following recommendations apply to the proposed action:

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

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

This concludes the FWCA portion of this consultation.

5. DATA QUALITY ACT DOCUMENTATION AND PRE-DISSEMINATION REVIEW

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

5.1 Utility

Utility principally refers to ensuring that the information contained in this consultation is helpful, serviceable, and beneficial to the intended users. The intended user of this BO is the USACE. Other interested users could include the United States Fish and Wildlife Service, the California Department of Fish and Wildlife, and the California Department of Water Resources. Individual copies of this BO were provided to the 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.

5.2 Integrity

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

5.3 Objectivity

Information Product Category: Natural Resource Plan

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