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 PCTS No: WCR-2018-8887

June 26, 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 and Magnuson-Stevens Fishery Conservation and Management Act Essential Fish Habitat Response for the LD-1 Emergency Levee Repair

Dear Ms. Haley:

Thank you for your letter received on November 27, 2017, requesting initiation of consultation with NOAA's National Marine Fisheries Service (NMFS) regarding your permitting of emergency work pursuant to section 7 of the Endangered Species Act of 1973 (16 U.S.C. 1531 et seq.) for the LD-1 Emergency Levee Repair on the Feather River.

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

The enclosed biological opinion, based on the biological assessment, and best available scientific and commercial information, concludes that the project is not likely to jeopardize the continued existence of the Federally listed threatened Central Valley spring-run Chinook salmon Evolutionarily Significant Unit (*Oncorhynchus tshawytscha*), the threatened California Central Valley steelhead Distinct Population Segment (DPS) (*O. mykiss*), and the threatened Southern DPS of North American green sturgeon (*Acipencer medirostris*), and is not likely to destroy or adversely modify their designated critical habitats.

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,

Maria Rea

for Barry A. Thom
Regional Administrator

Enclosure

cc: To the File: ARN 151422-WCR2017-SA00393

Mr. Zachary Fancher, Regulatory Division, U.S. Army Corps of Engineers, Sacramento District, 1325 J Street, Sacramento, California 95814

Mr. David Wheeldon, California Department of Water Resources, 3310 El Camino Avenue, Suite 100, Sacramento, California 95821

Mr. Jeff Scheutte, California Department of Water Resources, 3310 El Camino Avenue, Suite 100, Sacramento, California 95821

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

LD-1 Emergency Levee Repair Project

NMFS Consultation Number: PCTS No: WCR-2018-8887 / ARN: 151422-WCR2017-SA00394

Action Agency: U.S. Army Corps of Engineers

Affected Species and NMFS' Determinations:

ESA-Listed Species	Status	Is Action Likely to Adversely Affect Species or Critical Habitat?	Is Action Likely To Jeopardize the Species?	Is Action Likely To Destroy or Adversely Modify Critical Habitat?
CV spring-run Chinook salmon ESU (*Oncorhynchus tshawytscha*)	Threatened	Yes	No	No
California CV steelhead DPS (*O. mykiss*)	Threatened	Yes	No	No
Southern DPS of North American green sturgeon (*Acipenser medirostris*)	Threatened	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 26, 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.

The following provides some background information regarding the need for the project:
A series of storms struck Northern California from early January 2017, to March 2017. A Federal Disaster Declaration was issued by President Trump on April 1, 2017, for thirty-four California counties for the storms and resultant flooding, mudslides, and landslides. As a result of these storms, a number of levees in the Central Valley sustained significant damage. To repair these levees, the California Department of Water Resources (DWR) performed emergency levee repairs to prevent the loss of life and property. During these repairs, DWR sent out a regular email to agency representatives listing all the locations levee work was being conducted. NMFS first received basic information on the repair that is the subject of this consultation through one of these emails, received on May 10, 2017. During the summer of 2017, the DWR held a series of site visits for the United States Army Corps of Engineers (USACE) and resource agency staff (including NMFS) to locations where the levees were damaged and/or repaired during the previous winter's storms, including the levee repair in this consultation.

On October 23, 2017, the USACE contacted NMFS via email to alert them the repair had occurred and to request information on the consultation procedures. NMFS responded via email on October 24, 2017, with a request that the USACE describe any measures DWR took to avoid and minimize adverse effects to ESA-listed species and critical habitat during the repair. On November 9, 2017, DWR provided some information on the avoidance and minimization measures taken during the repair, and NMFS responded on November 15, 2017, with a request for additional details.

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

1.2 Consultation History

On November 27, 2017, NMFS received a request via mail for formal consultation from the USACE for project effects to Central Valley (CV) spring-run Chinook salmon, California Central Valley (CCV) steelhead, and the Southern distinct population segment (DPS) of North American green sturgeon (sDPS green sturgeon) and the critical habitats for these species.

On January 29, 2018, NMFS reiterated its request via email for more details on the impacts of the project and any avoidance and minimization measures taken during the repair. NMFS received this information and initiated consultation on January 30, 2018.

On June 7, 2018, NMFS requested an extension to complete the formal consultation. The USACE granted the requested extension to July 31, 2018.

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).

The USACE proposes to approve an after-the-fact permit for the LD-1 Emergency Levee Repair, allowing the material placed during the emergency to be permanently retained. This constitutes the "proposed action." The repair occurred on the Feather River in Yuba City, California. During a storm event in February 2017, erosion cut into the levee prism at this location, and subsequent fluctuating flows continued to erode the waterside levee slope. DWR's Flood Operations Center determined that the levee erosion was an imminent threat to human life and property due to uncertainty of flows in the Feather River, overall historical performance of this site, and the proximity to an urbanized area. Construction was started on May 8, 2017, and was completed on May 20, 2017. The repair is 1,000 feet long and totals 1.55 acres. A total of 0.29 acres of rock placement and removal of riparian habitat occurred below the ordinary high water mark (OHWM), and 1.26 acres of rock placement and removal of riparian habitat occurred above the OHWM. The exact acreage of vegetation retained and lost within this 1.55 acre footprint is unknown, as the emergency nature of the repair prevented the completion of any vegetation surveys.

DWR environmental staff was onsite for the entire effort and worked with the construction inspector and directly with the contractor throughout the project to provide best management practices and avoidance and minimization measures as feasible. Staff coordinated on minimizing tree trimming and vegetation removal as was feasible for construction. The contractor was able to create a temporary riprap bench in the water for the excavator to work around the trees to reduce the amount of tree impacts. Tree protection measures were implemented such as wrapping tree trunks with coir blankets and/or coir blankets with wooden two-by-fours to reduce riprap placement impacts. However, impacts to a 50 linear foot band of trees and other riparian vegetation were unavoidable, and this vegetation was impacted by trimming and removal.

To compensate for impacts to salmonids resulting from the repair, off-site mitigation credits for salmon and steelhead will be purchased from the Fremont Landing Conservation Bank, a NMFS-approved conservation bank that has a service area that includes the levee repair project. The credit purchase will be at a 3:1 ratio for impact to riparian habitat and the placement of rock revetment, for a total purchase of 4.65 credits (3 x 1.55).

1.3.1 Interrelated and Interdependent Actions

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

2. ENDANGERED SPECIES ACT: ANALYSIS OF EFFECTS

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.

2.1 Analytical Approach

This BO includes both a jeopardy analysis and an adverse modification analysis. The jeopardy analysis relies upon the regulatory definition of "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 proposed 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 Conservation Banking in the Context of the ESA 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, evaluates the value of the various watersheds and coastal and marine environments that make up the designated area, and discusses the current function of the essential PBFs that help to form that value for the conservation of the listed species.

2.2.1 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)

Detailed information regarding ESU listing and critical habitat designation history, designated critical habitat, and ESU life history can be found in NMFS' Recovery Plan for the Evolutionarily Significant Units of Sacramento River Winter-Run Chinook salmon, Central Valley Spring-Run Chinook salmon, and the Distinct Population Segment of California Central Valley steelhead (NMFS 2014), and in the recent 5-year Status Review (NMFS 2016b).

The Feather River spring-run Chinook population is considered to be a "Core 2" population by NMFS recovery plan for the species (NMFS 2014). Core 2 populations meet, or have the potential to meet, the biological recovery standard for moderate risk of extinction. These watersheds have lower potential to support viable populations, due to lower abundance, or amount and quality of habitat. These populations provide increased life history diversity to the ESU/DPS and are likely to provide a buffering effect against local catastrophic occurrences that could affect other nearby populations, especially in geographic areas where the number of Core 1 populations is lowest.

2.2.1.1 Description of VSP Parameters

Abundance

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, now blocked by dams) of the San Joaquin, American, Yuba, Feather, Sacramento, McCloud and Pit rivers, with smaller populations in most tributaries with sufficient habitat for over-summering adults (Stone 1872, Rutter 1904, Clark 1929).

The Central Valley drainage as a whole is estimated to have supported spring-run Chinook salmon runs as large as 600,000 fish between the late 1880s and 1940s (CDFG 1998). The San Joaquin River historically supported a large run of spring-run Chinook salmon, suggested to be one of the largest runs of any Chinook salmon on the West Coast with estimates averaging 200,000 – 500,000 adults returning annually (CDFG 1990). Construction of Friant Dam on the San Joaquin River began in 1939, and when completed in 1942, blocked access to all upstream habitat.

The Feather River Fish Hatchery (FRFH) spring-run Chinook salmon population represents a remaining evolutionary legacy of the spring-run Chinook salmon populations that once spawned above Oroville Dam, and has been included in the ESU based on its genetic linkage to the natural spawning population, and the potential development of a conservation strategy for the hatchery program.

Abundance from 1993 to 2004 were consistently over 4,000 (averaging nearly 5,000), while 2005 to 2016 were lower, averaging just under 400 [California Department of Fish and Wildlife (CDFW) 2017a].

Monitoring of the Sacramento River mainstem during spring-run Chinook salmon spawning timing indicates some spawning occurs in the river. Here, the lack of physical separation of spring-run Chinook salmon from fall-run Chinook salmon is complicated by overlapping migration and spawning periods. Significant hybridization with fall-run Chinook salmon makes identification of spring-run Chinook salmon in the mainstem difficult to determine, but counts of Chinook salmon redds in September are typically used as an indicator of spring-run Chinook salmon abundance. Fewer than 15 Chinook salmon redds per year were observed in the Sacramento River from 1989 to 1993, during September aerial redd counts [U.S. Fish and Wildlife Service (USFWS) 2003]. Redd surveys conducted in September between 2001 and 2011 have observed an average of 36 Chinook salmon redds from Keswick Dam downstream to the Red Bluff Diversion Dam (RBDD), ranging from 3 to 105 redds; in 2012 zero redds were observed, and in 2013, 57 redds were observed in September 2014 (CDFW 2015). Therefore, even though physical habitat conditions can support spawning and incubation, spring-run Chinook salmon depend on spatial segregation and geographic isolation from fall-run Chinook salmon to maintain genetic diversity. With the onset of fall-run Chinook salmon spawning occurring in the same time and place as potential spring-run Chinook salmon spawning, it is likely extensive introgression between the populations has occurred (CDFG 1998). For these reasons, Sacramento River mainstem spring-run Chinook salmon are not included in the following discussion of ESU abundance trends.

For many decades, CV spring-run Chinook salmon were considered extirpated from the Southern Sierra Nevada diversity group in the San Joaquin River Basin, despite their historical numerical dominance in the Basin (Fry 1961, Fisher 1994). More recently, there have been reports of adult Chinook salmon returning in February through June to San Joaquin River tributaries, including the Mokelumne, Stanislaus, and Tuolumne rivers (Franks 2014, Workman 2003, FishBio 2015). These spring-running adults have been observed in several years and exhibit typical spring-run life history characteristics, such as returning to tributaries during the springtime, over-summering in deep pools, and spawning in early fall (Franks 2014, Workman 2003, FishBio 2015). For example, 114 adult were counted on the video weir on the Stanislaus River between February and June in 2013 with only 7 individuals without adipose fins (FishBio 2015). Additionally, in 2014, implementation of the spring-run Chinook salmon reintroduction plan into the San Joaquin River has begun, which if successful will benefit the spatial structure, and genetic diversity of the ESU. These reintroduced fish have been designated as a nonessential experimental population under ESA section 10(j) when within the defined boundary in the San Joaquin River (78 FR 79622; December 31, 2013). Furthermore, while the San Joaquin River Restoration Program (SJRRP) is managed to imprint CV spring-run Chinook salmon to the mainstem San Joaquin River, we do anticipate that the reintroduced spring-run Chinook salmon are likely to stray into the San Joaquin tributaries at some level, which will increase the likelihood for CV spring-run Chinook salmon to repopulate other Southern Sierra Nevada diversity group rivers where suitable conditions exist.

Sacramento River tributary populations in Mill, Deer, and Butte creeks are likely the best trend indicators for CV spring-run Chinook salmon as a whole because these streams contain the majority of the abundance, and are currently the only independent populations within the ESU. Generally, these streams have shown a positive escapement trend since 1991, displaying broad fluctuations in adult abundance, ranging from 1,013 in 1993 to 23,788 in 1998 (Table 1). Escapement numbers are dominated by Butte Creek returns, which averaged over 7,000 fish from 1995 to 2005, but then declined in years 2006 through 2011 with an average of just over 3,000 (although 2008 was nearly 15,000 fish). During this same period, adult returns on Mill and Deer creeks have averaged over 2,000 fish total and just over 1,000 fish total, respectively.

Additionally, in 2002 and 2003, mean water temperatures in Butte Creek exceeded 21ºC for 10 or more days in July (Williams 2006). These persistent high water temperatures, coupled with high fish densities, precipitated an outbreak of Columnaris (*Flexibacter columnaris*) and Ichthyophthiriasis (*Ichthyophthirius multifiis*) diseases in the adult spring-run Chinook salmon over-summering in Butte Creek. In 2002, this contributed to a pre-spawning mortality of approximately 20 to 30 percent of the adults. In 2003, approximately 65 percent of the adults succumbed, resulting in a loss of an estimated 11,231 adult spring-run Chinook salmon in Butte Creek due to the diseases. In 2015, Butte Creek again experienced severe temperature conditions, with nearly 2,000 fish entering the creek, only 1,081 observed during the snorkel survey, and only 413 carcasses observed, which indicates a large number of pre-spawn mortality.

Declines in abundance from 2005 to 2011, placed the Mill Creek and Deer Creek populations in the high extinction risk category due to the rates of decline, and in the case of Deer Creek, also the level of escapement (NMFS 2011a) . Butte Creek has sufficient abundance to retain its low extinction risk classification, but the rate of population decline in years 2006 through 2011 was nearly sufficient to classify it as a high extinction risk based on this criteria. Nonetheless, the watersheds identified as having the highest likelihood of success for achieving viability/low risk of extinction include Butte, Deer and Mill creeks (NMFS 2011a). Some other tributaries to the Sacramento River, such as Clear Creek and Battle Creek have seen population gains in the years from 2001 to 2009, but the overall abundance numbers have remained low. 2012 appeared to be a good return year for most of the tributaries with some, such as Battle Creek, having the highest return on record (799). Additionally, 2013 escapement numbers increased, in most tributary populations, which resulted in the second highest number of spring-run Chinook salmon returning to the tributaries since 1998.

However, numbers of adult returns have remained quite low in recent years due to the drought. 2014 abundance was lower, with just over 5,000 fish for the tributaries combined, which indicates a highly fluctuating and unstable ESU abundance. Even more concerning was returns for 2015, which were record lows for some populations. In Butte Creek for example, 569 adults were observed in the carcass surveys, and 1,651 in the snorkel surveys (CDFW 2017a). 2016 returns were higher for some populations such as Butte Creek where approximately 10,000 fish were estimated by snorkel surveys and nearly 6,000 by carcass surveys, although returns in some creeks were low (Mill Creek for example, had 127 adults; CDFW 2017a). Preliminary data suggests 2017 returns are extremely low for many tributary populations.

Productivity

The productivity of a population (*i.e.,* production over the entire life cycle) can reflect conditions (*e.g.,* environmental conditions) that influence the dynamics of a population and determine abundance. In turn, the productivity of a population allows an understanding of the performance of a population across the landscape and habitats in which it exists and its response to those habitats (McElhany et al. 2000). In general, declining productivity equates to declining population abundance. McElhany et al. (2000) suggested criteria for a population's natural productivity should be sufficient to maintain its abundance above the viable level (a stable or increasing population growth rate). In the absence of numeric abundance targets, this guideline is used. Cohort replacement rates (CRR) are indications of whether a cohort is replacing itself in the next generation.

From 1993 to 2007 the 5-year moving average of the CV spring-run Chinook salmon tributary population CRR remained over 1.0, but then declined to a low of 0.47 in years 2007 through 2011 (Table 1). The productivity of the Feather River and Yuba River populations and contribution to CV spring-run Chinook salmon currently is unknown; however, the FRFH currently produces 2,000,000 juveniles each year. The CRR for the 2012 combined tributary population was 3.84, and 8.68 in 2013, due to increases in abundance for most populations. Although 2014 returns were lower than the previous two years, the CRR was still positive (1.85). However, 2015 returns were very low, with a CRR of 0.14, when using Butte Creek snorkel survey numbers, the lowest on record. Using the Butte Creek carcass surveys, the 2015 CRR for just Butte Creek was only 0.02.

Table 1. Central Valley spring-run Chinook salmon population estimates from CDFW Grand Tab (2015) with corresponding cohort replacement rates for years since 1986.

Year	Sacramento River Basin Escapement Run Size[a]	FRFH Population	Tributary Populations	5-Year Moving Average Tributary Population Estimate	Trib CRR[b]	5-Year Moving Average of Trib CRR	5-Year Moving Average of Basin Population Estimate	Basin CRR	5-Year Moving Average of Basin CRR
1986	3,638	1,433	2,205						
1987	1,517	1,213	304						
1988	9,066	6,833	2,233						
1989	7,032	5,078	1,954		0.89			1.93	
1990	3,485	1,893	1,592	1,658	5.24		4,948	2.30	
1991	5,101	4,303	798	1,376	0.36		5,240	0.56	
1992	2,673	1,497	1,176	1,551	0.60		5,471	0.38	
1993	5,685	4,672	1,013	1,307	0.64	1.55	4,795	1.63	1.22
1994	5,325	3,641	1,684	1,253	2.11	1.79	4,454	1.04	1.18
1995	14,812	5,414	9,398	2,814	7.99	2.34	6,719	5.54	1.83
1996	8,705	6,381	2,324	3,119	2.29	2.73	7,440	1.53	2.03
1997	5,065	3,653	1,412	3,166	0.84	2.77	7,918	0.95	2.14
1998	30,533	6,746	23,787	7,721	2.53	3.15	12,888	2.06	2.23
1999	9,838	3,731	6,107	8,606	2.63	3.26	13,791	1.13	2.24
2000	9,201	3,657	5,544	7,835	3.93	2.44	12,669	1.82	1.50
2001	16,865	4,135	12,730	9,916	0.54	2.09	14,300	0.55	1.30
2002	17,212	4,189	13,023	12,238	2.13	2.35	16,730	1.75	1.46
2003	17,691	8,662	9,029	9,287	1.63	2.17	14,161	1.92	1.43
2004	13,612	4,212	9,400	9,945	0.74	1.79	14,916	0.81	1.37
2005	16,096	1,774	14,322	11,701	1.10	1.23	16,295	0.94	1.19
2006	10,828	2,061	8,767	10,908	0.97	1.31	15,088	0.61	1.21
2007	9,726	2,674	7,052	9,714	0.75	1.04	13,591	0.71	1.00
2008	6,162	1,418	4,744	8,857	0.33	0.78	11,285	0.38	0.69
2009	3,801	989	2,812	7,539	0.32	0.69	9,323	0.35	0.60
2010	3,792	1,661	2,131	5,101	0.30	0.53	6,862	0.39	0.49
2011	5,033	1,969	3,064	3,961	0.65	0.47	5,703	0.82	0.53
2012	14,724	3,738	10,986	4,747	3.91	1.10	6,702	3.87	1.16
2013	18,384	4,294	14,090	6,617	6.61	2.36	9,147	4.85	2.06
2014	8,434	2,776	5,658	7,186	1.85	2.66	10,073	1.68	2.32
2015	3,074	1,586	1,488	7,057	0.14	2.63	9,930	0.21	2.28
Median	9,775	3,616	6,159	6,541	1.97	1.89	10,220	1.00	1.46

[a] NMFS is only including the escapement numbers from the Feather River Fish Hatchery (FRFH) and the Sacramento River tributaries in this table. Sacramento River Basin run size is the sum of the escapement numbers from the FRFH and the tributaries.
[b] Abbreviations: CRR = Cohort Replacement Rate, Trib = tributary

Spatial Structure

Spatial structure refers to the arrangement of populations across the landscape, the distribution of spawners within a population, and the processes that produce these patterns. Species with a restricted spatial distribution and few spawning areas are at a higher risk of extinction from catastrophic environmental events (*e.g.*, a single landslide) than are species with more widespread and complex spatial structure. Species or population diversity concerns the phenotypic (morphology, behavior, and life-history traits) and genotypic (DNA) characteristics of populations. Phenotypic diversity allows more populations to use a wider array of environments and protects populations against short-term temporal and spatial environmental changes. Genotypic diversity, on the other hand, provides populations with the ability to survive long-term changes in the environment. To meet the objective of representation and redundancy, diversity groups need to contain multiple populations to survive in a dynamic ecosystem subject to unpredictable stochastic events, such as pyroclastic events or wild fires.

The Central Valley Technical Review Team estimated that historically there were 18 or 19 independent populations of CV spring-run Chinook salmon, along with a number of dependent populations, all within four distinct geographic regions, or diversity groups (Figure 1). 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 [California Department of Fish and Game (CDFG) 1998]. Most historical populations in the basalt and porous lava diversity group and the southern Sierra Nevada diversity group have been extirpated; Battle Creek in the basalt and porous lava diversity group has had a small persistent population in Battle Creek since 1995, and the upper Sacramento River may have a small persisting population spawning in the mainstem river as well. The northwestern California diversity group did not historically contain independent populations, and currently contains two small persisting populations, in Clear Creek, and Beegum Creek (tributary to Cottonwood Creek) that are likely dependent on the northern Sierra Nevada diversity group populations for their continued existence. Construction of low elevation dams in the foothills of the Sierras on the San Joaquin, Mokelumne, Stanislaus, Tuolumne, and Merced rivers, has thought to have extirpated CV spring-run Chinook salmon from these watersheds of the San Joaquin River, as well as on the American River of the Sacramento River basin. However, observations in the last decade suggest that perhaps spring-running populations may currently occur in the Stanislaus and Tuolumne rivers (Franks 2014).

With only one of four diversity groups currently containing independent populations, the spatial structure of CV spring-run Chinook salmon is severely reduced. Butte Creek spring-run Chinook salmon adult returns are currently utilizing all available habitat in the creek; and it is unknown if individuals have opportunistically migrated to other systems. The persistent populations in Clear Creek and Battle Creek, with habitat restoration projects completed and more underway, are anticipated to add to the spatial structure of CV spring-run Chinook salmon if they can reach viable status in the basalt and porous lava and northwestern California diversity group areas. The spatial structure of CV spring-run Chinook salmon would still be lacking due to the extirpation of all San Joaquin River basin spring-run Chinook salmon populations; however, recent information suggests that perhaps a self-sustaining population of spring-run Chinook salmon is occurring in some of the San Joaquin River tributaries, most notably the Stanislaus and the Tuolumne rivers.

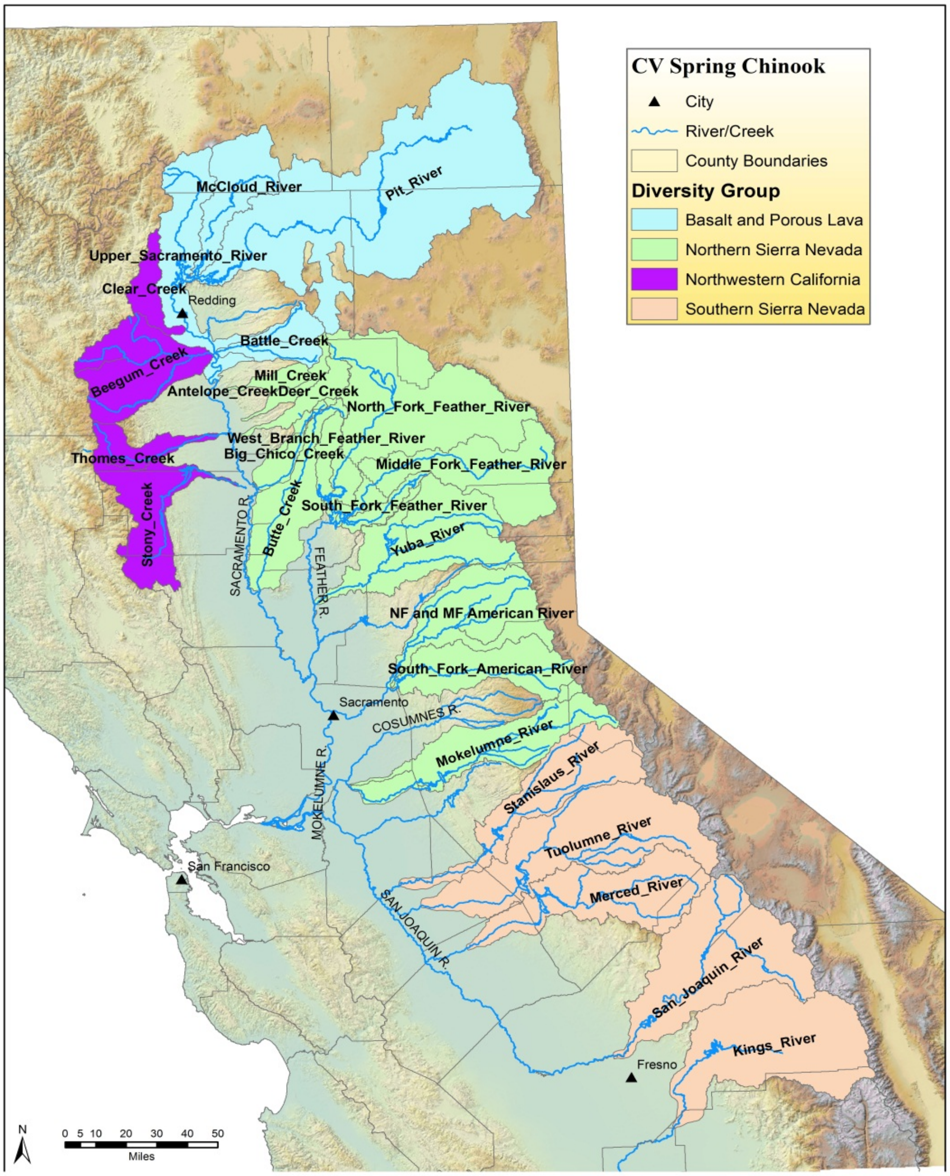

Figure 1. Diversity Groups for the Central Valley spring-run Chinook salmon ESU (from Lindley et al. 2004).

A Federal Register Notice was published to designate a nonessential experimental population of CV spring-run Chinook salmon to allow reintroduction of the species below Friant Dam on the San Joaquin River as part of the SJRRP (78 FR 79622; December 31, 2013). Pursuant to ESA section 10(j), with limited exceptions, each member of an experimental population shall be treated as a threatened species. The rule includes protective regulations under ESA section 4(d) that provide specific exceptions to prohibitions for taking CV spring-run Chinook salmon within the experimental population area, and in specific instances elsewhere. The first release of CV spring-run Chinook salmon juveniles into the San Joaquin River occurred in April, 2014. Releases have continued annually during the spring. The SJRRP's future long-term contribution to CV spring-run Chinook salmon has yet to be determined.

Snorkel surveys (Kennedy and Cannon 2005) conducted between October 2002 to October 2004 on the Stanislaus River identified adults in June 2003 and 2004, as well as observed Chinook fry in December of 2003, which would indicate spring-run Chinook salmon spawning timing. In addition, monitoring on the Stanislaus since 2003 and on the Tuolumne since 2009 has indicated upstream migration of adult spring-run Chinook salmon (Anderson et al. 2007), and 114 adult were counted on the video weir on the Stanislaus River between February and June in 2013 with only 7 individuals without adipose fins (FishBio 2015). Finally, rotary screw trap data provided by Stockton USFWS corroborates the spring-run Chinook salmon adult timing, by indicating that there are a small number of fry migrating out of the Stanislaus and Tuolumne at a period that would coincide with spring-run juvenile emigration (Franks 2014). Although there have been observations of springtime running Chinook salmon returning to the San Joaquin tributaries in recent years, there is insufficient information to determine the specific origin of these fish, and whether or not they are straying into the basin or returning to natal streams. Genetic assessment or natal stream analyses of hard tissues could inform our understanding of the relationship of these fish to the ESU.

Lindley et al. (2007) described a general criteria for “representation and redundancy” of spatial structure, which was for each diversity group to have at least two viable populations. More specific recovery criteria for the spatial structure of each diversity group have been laid out in the NMFS Central Valley Salmon and Steelhead Recovery Plan (2014). According to the criteria, one viable population in the Northwestern California diversity group, two viable populations in the basalt and porous lava diversity group, four viable populations in the northern Sierra Nevada diversity group, and two viable populations in the southern Sierra Nevada diversity group, in addition to maintaining dependent populations, are needed for recovery. It is clear that further efforts will need to involve more than restoration of currently accessible watersheds to make the ESU viable. The NMFS Central Valley Salmon and Steelhead Recovery Plan calls for reestablishing populations into historical habitats currently blocked by large dams, such as the reintroduction of a population upstream of Shasta Dam, and to facilitate passage of fish upstream of Englebright Dam on the Yuba River (NMFS 2014).

Diversity

Diversity, both genetic and behavioral, is critical to success in a changing environment. Salmonids express variation in a suite of traits, such as anadromy, morphology, fecundity, run timing, spawn timing, juvenile behavior, age at smolting, age at maturity, egg size, developmental rate, ocean distribution patterns, male and female spawning behavior, and physiology and molecular genetic characteristics (including rate of gene-flow among populations). Criteria for the diversity parameter are that human-caused factors should not alter variation of traits. The more diverse these traits (or the more these traits are not restricted), the more adaptable a population is, and the more likely that individuals, and therefore the species, would survive and reproduce in the face of environmental variation (McElhany et al. 2000). However, when this diversity is reduced due to loss of entire life history strategies or to loss of habitat used by fish exhibiting variation in life history traits, the species is in all probability less able to survive and reproduce given environmental variation.

CV spring-run Chinook salmon is comprised of two known genetic complexes. Analysis of natural and hatchery CV 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. The Feather River spring-run Chinook salmon have introgressed with the Feather River fall-run Chinook salmon, and it appears that the Yuba River spring-run Chinook salmon population may have been impacted by FRFH fish straying into the Yuba River (and likely introgression with wild Yuba River fall-run has occurred). Additionally, the diversity of CV spring-run Chinook salmon has been further reduced with the loss of the majority if not all of the San Joaquin River basin spring-run Chinook salmon populations. Efforts like the SJRRP, to reintroduce a spring-run population below Friant Dam, which are underway, are needed to improve the diversity of CV spring-run Chinook salmon.

Summary of ESU Viability

Since the populations in Butte, Deer and Mill creeks are the best trend indicators for ESU viability, we can evaluate risk of extinction based on VSP parameters in these watersheds. Lindley et al. (2007) indicated that the spring-run Chinook salmon populations in the Central Valley had a low risk of extinction in Butte and Deer creeks, according to their population viability analysis (PVA) model and other population viability criteria (*i.e.*, population size, population decline, catastrophic events, and hatchery influence, which correlate with VSP parameters abundance, productivity, spatial structure, and diversity). The Mill Creek population of spring-run Chinook salmon was at moderate extinction risk according to the PVA model, but appeared to satisfy the other viability criteria for low-risk status. However, CV spring-run Chinook salmon failed to meet the "representation and redundancy rule" since there are only demonstrably viable populations in one diversity group (northern Sierra Nevada) out of the three diversity groups that historically contained them, or out of the four diversity groups as described in the NMFS Central Valley Salmon and Steelhead Recovery Plan (NMFS 2014). Over the long-term, these three remaining populations are considered to be vulnerable to catastrophic events, such as volcanic eruptions from Mount Lassen or large forest fires due to the close proximity of their headwaters to each other.

In 2012 and 2013, most tributary populations increased in returning adults, averaging over 13,000. However, 2014 returns were lower again, just over 5,000 fish, indicating the ESU remains highly fluctuating. The most recent status review conducted in 2015 (NMFS 2016b) 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 highs. 2016 returns were higher for some populations such as Butte Creek where 4,450fish were estimated by snorkel surveys and nearly 5,731 by carcass surveys, although returns in some creeks were low (Mill Creek for example, had 127 adults). 2017 returns were higher for Mill Creek (258) but much lower for Butte Creek (982 during snorkel survey and 565 during carcass survey) (CDFW 2017a).

The recent drought impacts on Butte Creek can be seen from the lethal water temperatures in traditional and non-traditional spring-run Chinook salmon holding habitat during the summer. Pre-spawn mortality was observed during the 2007 to 2009 drought with an estimate of 1,054 adults dying before spawning (Garman 2015). A large number of adults (903 and 232) also were estimated to have died prior to spawning in the 2013 and 2014 drought, respectively (Garman 2015). In 2015, late arriving adults in the Chico vicinity experienced exceptionally warm June air temperatures coupled with the PG&E flume shutdown resulting in a fish die off. Additionally, adult spring-run Chinook salmon in Mill, Deer, and Battle creeks were exposed to warm temperatures, and pre-spawn mortality was observed. Thus, while the independent CV spring-run Chinook populations have generally improved since 2010, and are considered at moderate (Mill and Deer) or low (Butte Creek) risk of extinction, these populations are likely to deteriorate over the next 3 years due to drought impacts, which may in fact result in severe declines.

In summary, the status of CV spring-run Chinook salmon, until 2015, has probably improved since the 2010 status review. The largest improvements are due to extensive restoration, and increases in spatial structure with historically extirpated populations trending in the positive direction. Improvements, evident in the moderate and low risk of extinction of the three independent populations, however, are certainly not enough to warrant the delisting of the ESU. The recent declines of many of the dependent populations, high pre-spawn and egg mortality during the 2012 to 2015 drought, uncertain juvenile survival during the drought, and ocean conditions, as well as the level of straying of FRFH spring-run Chinook salmon to other CV spring-run Chinook salmon populations are all causes for concern for the long-term viability of CV spring-run Chinook salmon.

2.2.1.2 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). 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).

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.

2.2.2 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)

Detailed information regarding the Distinct Population Segment (DPS) listing and critical habitat designation history, designated critical habitat, and DPS life history can be found in NMFS 2014 Recovery Plan for the Evolutionarily Significant Units of Sacramento River Winter-Run Chinook salmon, Central Valley Spring-Run Chinook salmon, and the Distinct Population Segment of California Central Valley steelhead (NMFS 2014), and the and in the recent 5-year Status Review (NMFS 2016a).

The Feather River steelhead population is considered to be a "Core 2" population by NMFS recovery plan for the species (NMFS 2014). Core 2 populations meet, or have the potential to meet, the biological recovery standard for moderate risk of extinction. These watersheds have lower potential to support viable populations, due to lower abundance, or amount and quality of habitat. These populations provide increased life history diversity to the ESU/DPS and are likely to provide a buffering effect against local catastrophic occurrences that could affect other nearby populations, especially in geographic areas where the number of Core 1 populations is lowest.

2.2.2.1 Description of VSP Parameters

Abundance

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 steelhead run size had declined to about 40,000 adults (McEwan 2001). Hallock et al. (1961) estimated an average of 20,540 adult steelhead through the 1960s in the Sacramento River upstream of the Feather River. Steelhead counts at the RBDD declined from an average of 11,187 for the period from 1967 to 1977, to an average of approximately 2,000 through the early 1990s, with an estimated total annual run size for the entire Sacramento-San Joaquin system, based on RBDD counts, to be no more than 10,000 adults (McEwan and Jackson 1996). Steelhead escapement surveys at RBDD ended in 1993 due to changes in dam operations, and comprehensive steelhead population monitoring has not taken place in the Central Valley since then, despite 100 percent marking of hatchery steelhead smolts since 1998. Efforts are underway to improve this deficiency, and a long-term adult escapement monitoring plan was developed by CDFW (Eilers et al. 2010).

Current abundance data are limited to returns to hatcheries and redd surveys conducted on a few rivers. The hatchery data is the most reliable, as redd surveys for steelhead are often made difficult by high flows and turbid water usually present during the winter-spring spawning period.

Coleman National Fish Hatchery (CNFH) operates a weir on Battle Creek, where all upstream fish movement is blocked August through February, during the hatchery spawning season. Counts of steelhead captured at and passed above this weir represent one of the better data sources for the CCV DPS. Steelhead returns to CNFH have fluctuated greatly over the years. From 2003 to 2012, the number of hatchery origin adults has ranged from 624 to 2,968. Since 2003, adults returning to the hatchery have been classified as wild (unclipped) or hatchery produced (adipose clipped). Natural-origin adults counted at the hatchery each year represent a small fraction of overall returns, but their numbers have remained relatively steady, typically

200-500 fish each year, although numbers the past 5 years have been lower, ranging from 185 to 334 (NMFS 2016a).

Redd counts are conducted in the American River, with an average of 142 redds counted on the American River from 2002-2015 (data from Hannon and Deason 2008, Hannon et al. 2003, Chase 2010), with only 58 counted in 2015, a new low for this survey (NMFS 2016a).

The East Bay Municipal Utilities District (EBMUD) has included steelhead in their redd surveys on the Lower Mokelumne River since the 1999-2000 spawning season, and the overall trend was a slight increase from 2000 to 2010. Between 2011 and 2015, the number of steelhead observed by EBMUD passing under the Woodbridge Irrigation District Dam has remained steady (EBMUD 2017). However, it is generally believed that most of the *O. mykiss* spawning in the Mokelumne River are resident fish (Satterthwaite et al. 2010), which are not part of the CCV steelhead DPS. In the most recent 5-year status review, NMFS did not to include the Mokelumne River steelhead population in the DPS (NMFS 2016a).

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, 1797, and 1505 fish returning in 2012, 2013 and 2014, respectively. Almost all these fish are hatchery fish, and stocking levels have remained fairly constant, suggesting that smolt and/or ocean survival was poor for age classes that showed poor returns in the late 2000s.

The Clear Creek steelhead population appears to have increased in abundance since Saeltzer Dam was removed in 2000, as the number of redds observed in surveys conducted by the USFWS has steadily increased since 2001. The average redd index from 2001 to 2011 is 157, representing somewhere between 128 and 255 spawning adult steelhead on average each year. From 2011 through 2015, an average of 231 redds has been observed in Clear Creek. The vast majority of these steelhead are natural-origin fish, as no hatchery steelhead are stocked in Clear Creek, and adipose fin clipped steelhead are rarely observed in Clear Creek (NMFS 2016a).

Catches of steelhead at the fish collection facilities in the southern Delta are another source of information on the relative abundance of CCV steelhead, as well as the proportion of wild steelhead relative to hatchery steelhead. The overall catch of steelhead at these facilities has been highly variable since 1993. The percentage of unclipped steelhead in salvage has also fluctuated, but has generally declined since 100 percent clipping started in 1998. The number of stocked hatchery steelhead has remained relatively constant overall since 1998, even though the number stocked in any individual hatchery has fluctuated.

Overall, steelhead returns to hatcheries have fluctuated so much from 2001 to 2016 that no clear trend is present, other than the fact that the numbers are still far below those seen in the 1960s and 1970s, and only a tiny fraction of the historical estimate. Returns of natural origin fish are very poorly monitored, but the little data available suggest that the numbers are very small, though perhaps not as variable from year to year as the hatchery returns.

Productivity

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). The Mossdale trawls on the San Joaquin River conducted annually by CDFW and USFWS capture steelhead smolts, although usually in very small numbers. These steelhead recoveries, which represent migrants from the Stanislaus, Tuolumne, and Merced rivers, suggest that the productivity of CCV steelhead in these tributaries is very low. In addition, the Chipps Island midwater trawl dataset from the USFWS provides information on the trend (Williams et al. 2011). Nobriga and Cadrett (2001) used the ratio of adipose fin-clipped (hatchery) to unclipped (wild) steelhead smolt catch ratios in the 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.

Analysis of data from the Chipps Island midwater trawl conducted by the USFWS indicates that natural steelhead production has continued to decline, and that hatchery origin fish represent an increasing fraction of the juvenile production in the Central Valley. Beginning in 1998, all hatchery produced steelhead in the Central Valley have been adipose fin clipped (ad-clipped). Since that time, the trawl data indicates that the proportion of ad-clipped steelhead juveniles captured in the Chipps Island monitoring trawls has increased relative to wild juveniles, indicating a decline in natural production of juvenile steelhead. The proportion of hatchery fish exceeded 90 percent in 2007, 2010, and 2011. Because hatchery releases have been fairly consistent through the years, this data suggests that the natural production of steelhead has been declining in the Central Valley.

Salvage of juvenile steelhead at the Central Valley Project (CVP) and State Water Project (SWP) fish collection facilities also indicates a reduction in the natural production of steelhead. The percentage of unclipped juvenile steelhead collected at these facilities declined from 55 percent to 22 percent over the years 1998 to 2010 (NMFS 2011b).

In contrast to the data from Chipps Island and the CVP and SWP fish collection facilities, some populations of wild CCV steelhead appear to be improving (Clear Creek) while others (Battle Creek) appear to be better able to tolerate the recent poor ocean conditions and dry hydrology in the Central Valley compared to hatchery produced fish (NMFS 2011b). Since 2003, fish returning to the CNFH have been identified as wild (adipose fin intact) or hatchery produced (ad-clipped). Returns of wild fish to the hatchery have remained fairly steady at 200-300 fish per year, but represent a small fraction of the overall hatchery returns. Numbers of hatchery origin fish returning to the hatchery have fluctuated much more widely; ranging from 624 to 2,968 fish per year. The Mokelumne River steelhead population is supplemented by Mokelumne River Hatchery production.

Spatial Structure

About 80 percent of the historical spawning and rearing habitat once used by anadromous *O. mykiss* in the Central Valley is now upstream of impassible dams (Lindley et al. 2006). The extent of habitat loss for steelhead most likely was much higher than that for salmon because steelhead were undoubtedly more extensively distributed.

Steelhead are well-distributed throughout the Central Valley below the major rim dams (Good et al. 2005, NMFS 2011b). Zimmerman et al. (2009) used otolith microchemistry to show that *O. mykiss* of anadromous parentage occur in all three major San Joaquin River tributaries, but at low levels, and that these tributaries have a higher percentage of resident *O. mykiss* compared to the Sacramento River and its tributaries.

The low adult returns to the San Joaquin tributaries and the low numbers of juvenile emigrants typically captured suggest that existing populations of CCV steelhead on the Tuolumne, Merced, and lower San Joaquin rivers are severely depressed. The loss of these populations would severely impact CCV steelhead spatial structure and further challenge the viability of the CCV steelhead DPS.

The NMFS Central Valley Salmon and Steelhead Recovery Plan (NMFS 2014), includes recovery criteria for the spatial structure of the DPS which provide one viable population in the Northwestern California diversity group, two viable populations in the basalt and porous lava diversity group, four viable populations in the northern Sierra Nevada diversity group, and two viable populations in the southern Sierra Nevada diversity group, in addition to maintaining dependent populations, are needed for recovery.

Efforts to provide passage of salmonids over impassable dams have the potential to increase the spatial diversity of Central Valley steelhead populations if the passage programs are implemented for steelhead. In addition, the SJRRP calls for a combination of channel and structural modifications along the San Joaquin River below Friant Dam, releases of water from Friant Dam to the confluence of the Merced River, and the reintroduction of spring-run and fall-run Chinook salmon. If the SJRRP is successful, habitat improved for CV spring-run Chinook salmon could also benefit CCV steelhead (NMFS 2011b).

Diversity

a. Genetic Diversity: 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 also 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, which likely comprise the majority of the annual spawning runs, placing the natural population at a high risk of extinction (Lindley et al. 2007). There are four hatcheries (CNFH, FRFH, Nimbus Fish Hatchery, and Mokelumne River Fish Hatchery) in the Central Valley, which combined release approximately 1.6 million yearling steelhead smolts each year. These programs are intended to mitigate for the loss of steelhead habitat caused by dam construction, but hatchery origin fish now appear to constitute a major proportion of the total abundance in the DPS. Two of these hatchery stocks (Nimbus and Mokelumne River hatcheries) originated from outside the DPS (primarily from the Eel and Mad rivers) and are not presently considered part of the DPS.

b. Life-History Diversity: Steelhead in the Central Valley historically consisted of both summer-run and winter-run migratory forms, based on their state of sexual maturity at the time of river entry and the duration of their time in freshwater before spawning.

Only winter-run (ocean maturing) steelhead currently are found in California Central Valley rivers and streams (Moyle 2002, McEwan and Jackson 1996). Summer-run steelhead have been extirpated due to a lack of suitable holding and staging habitat, such as cold-water pools in the headwaters of CV streams, presently located above impassible dams (Lindley et al. 2006).

Juvenile steelhead (parr) rear in freshwater for one to three years before migrating to the ocean as smolts (Moyle 2002). Hallock et al. (1961) aged 100 adult steelhead caught in the Sacramento River upstream of the Feather River confluence in 1954, and found that 70 had smolted at age-2, 29 at age-1, and one at age-3. Seventeen of the adults were repeat spawners, with three fish on their third spawning migration, and one on its fifth. Age at first maturity varies among populations. In the Central Valley, most steelhead return to their natal streams as adults at a total age of two to four years (Hallock et al. 1961, McEwan and Jackson 1996). In contrast to the upper Sacramento River tributaries, Lower American River juvenile steelhead have been shown to smolt at a very large size (270 to 350 mm FL), and nearly all smolt at age-1 (Sogard et al. 2012).

2.2.2.2 *Summary of DPS Viability*

All indications are that natural CCV steelhead have continued to decrease in abundance and in the proportion of natural fish over the past 25 years (NMFS 2016a); the long-term trend remains negative. Hatchery production and returns are dominant over natural fish. Continued decline in the ratio between naturally produced juvenile steelhead to hatchery juvenile steelhead in fish monitoring efforts indicates that the wild population abundance is declining. Hatchery releases (100 percent adipose fin-clipped fish since 1998) have remained relatively constant over the past decade, yet the proportion of adipose fin-clipped hatchery smolts to unclipped naturally produced smolts has steadily increased over the past several years.

Although there have been recent restoration efforts in the San Joaquin River tributaries, CCV steelhead populations in the San Joaquin Basin continue to show an overall very low abundance, and fluctuating return rates. Lindley et al. (2007) developed viability criteria for Central Valley salmonids. Lindley et al. (2007) found that data through 2005 were insufficient to determine the status of any of the naturally-spawning populations of CCV steelhead, except for those spawning in rivers adjacent to hatcheries, which were likely to be at high risk of extinction due to extensive spawning of hatchery-origin fish in natural areas.

The widespread distribution of wild steelhead in the Central Valley provides the spatial structure necessary for the DPS to survive and avoid localized catastrophes. However, as described in the recent 5-year Status Review (NMFS 2016a), most wild CCV populations are very small, are not monitored, and may lack the resiliency to persist for protracted periods if subjected to additional stressors, particularly widespread stressors such as climate change. The genetic diversity of CCV steelhead has likely been impacted by low population sizes and high numbers of hatchery fish relative to wild fish. The life-history diversity of the DPS is mostly unknown, as very few studies have been published on traits such as age structure, size at age, or growth rates in CCV steelhead.

2.2.2.3 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). 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.

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.

2.2.3 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)

Detailed information regarding DPS listing and critical habitat designation history, designated critical habitat, and DPS life history can be found in the NMFS Green Sturgeon Recovery Plan (NMFS 2017, In Review).

Green sturgeon are known to range from Baja California to the Bering Sea along the North American continental shelf. During late summer and early fall, subadults and non-spawning adult green sturgeon can frequently be found aggregating in estuaries along the Pacific coast (Emmett et al. 1991, Moser and Lindley 2006). Using polyploid microsatellite data, Israel et al. (2009) found that green sturgeon within the Central Valley of California belong to the sDPS.

Additionally, acoustic tagging studies have found that green sturgeon found spawning within the Sacramento River are exclusively sDPS green sturgeon (Lindley et al. 2011). In waters inland from the Golden Gate Bridge in California, sDPS green sturgeon are known to range through the estuary and the Delta and up the Sacramento, Feather, and Yuba rivers (Israel et al. 2009, Bergman et al. 2011, Seesholtz et al. 2014). It is unlikely that green sturgeon utilize areas of the San Joaquin River upriver of the Delta with regularity, and spawning events are thought to be limited to the upper Sacramento River and its tributaries. There is no known modern usage of the upper San Joaquin River by green sturgeon, and adult spawning has not been documented there (Jackson and Van Eenennaam 2013).

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

Trends in abundance of sDPS green sturgeon have been estimated from two long-term data sources: (1) salvage numbers at the state and Federal pumping facilities (CDFW 2017b), and (2) by incidental catch of green sturgeon by the CDFW's white sturgeon sampling/tagging program (Dubois and Harris 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, and the Tracy Fish Collection Facility. 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 2010b). Other indicators of productivity such as data for cohort replacement ratios and spawner abundance trends are not currently available for sDPS green sturgeon.

2.2.3.1 Summary of Southern Distinct Population Segment Green Sturgeon 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 2010a). Although threats due to habitat alteration are thought to be high and indirect evidence suggests a decline in abundance, there is much uncertainty regarding the scope of threats and the viability of population abundance indices (NMFS 2010a). Lindley et al. (2008), in discussing winter-run Chinook salmon, states that an ESU (or DPS) represented by a single population at moderate risk of extinction is at high risk of extinction over a large timescale; this would apply to the sDPS for green sturgeon. The most recent 5-year status review for sDPS green sturgeon found that some threats to the species have recently been eliminated such as take from commercial fisheries and removal of some passage 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).

2.2.3.2 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). 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.

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.

2.2.4 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.

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

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. 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.

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 action.

This repair starts at the 5th Street Bridge in Yuba City, California and extends 1,000 feet north along the banks of the Feather River. For projects with in-water construction activities, such as installation of riprap, the downstream extent of the action area is defined by the distance of potential 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 repair likely occurred 100 feet from the shoreline and up to 400 feet downstream of any in-water construction activities. Therefore, the action area includes an approximate 0.92 acre area (40,000 square feet) of the Feather River.

Since DWR plans to purchase mitigation credits from a conservation bank, the action area also includes the area affected by the Fremont Landing Conservation Bank, which has a service area relevant to the project. 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).

2.4 Environmental Baseline

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

The Feather River has undergone many changes from its historical condition. These changes began in earnest with the California Gold Rush, and continued with the development of manmade dams and other structures to control the flow, storage, and transport of water, and the development of hydroelectric power. The Feather River flows approximately 60 miles north to south before entering the Sacramento River at Verona. The river is almost entirely contained within a series of levees as it flows through the agricultural lands of the Sacramento Valley. Flows are regulated for water supply and flood control through releases at Oroville Dam, and to a lesser extent flows are regulated to maximize production of hydroelectric power. The action area for this project is found in the lower Feather River, which is generally considered as that portion of the Feather River and its watershed that lies downstream of Oroville Dam, extending to the confluence with the Sacramento River at Verona.

The action area, which encompasses the Feather River and associated floodplains and riparian areas at and adjacent to the repair, functions primarily as a rearing and migratory habitat for CV spring-run Chinook salmon and CCV steelhead. The sDPS green sturgeon uses the area as a migration corridor for juveniles and adults.

The action area is within designated critical habitat for CV spring-run Chinook salmon and CCV steelhead. Habitat requirements for these species are similar. The PBFs of salmonid habitat within the action area include: freshwater rearing habitat and freshwater migration corridors. The essential features of these PBFs include adequate substrate, water quality, water quantity, water temperature, water velocity, shelter, food, riparian vegetation, space, and safe passage conditions. The intended conservation roles of habitat in the action area are to provide appropriate freshwater rearing and migration conditions for juveniles and unimpeded freshwater migration conditions for adults. The area is outside of spawning habitat for CV spring-run Chinook salmon and CCV steelhead. The conservation condition and function of this habitat in the action area and throughout the Feather River has been severely impaired through several factors, described below.

Dams have eliminated access to historic holding, spawning, and rearing habitat and have resulted in CV spring-run Chinook salmon and fall-run Chinook salmon spawning and rearing in the same areas, at the same times. This has resulted in increased competition, superimposition of redds, and interbreeding of the two populations. Oroville Dam has also modified the hydrograph of the river, which has led to reduced lateral movement of the channel. This, and the loss of sediment and large wood transport downstream of Oroville Dam, has resulted in decreases in habitat value for salmonid spawning and rearing.

Mining, levee and dike construction, and removal of riparian vegetation have also resulted in adverse effects to habitat for spawning and rearing salmonids. Bank modification (the construction of levees and bank armoring) has changed the geomorphic processes affecting the lower Feather River. Riparian vegetation is important to aquatic habitats because it provides overhanging cover for rearing fish, streamside shading, and a source of terrestrial and aquatic invertebrate contributions to the fish food base. Riparian vegetation is also an important source of future large woody material contributions to the aquatic system. Removal of vegetation through bank modification has reduced habitat quality and the productivity of the lower Feather River. Also, unscreened water diversion may entrain salmonids and result in the loss of a significant number of CV spring-run Chinook salmon and CCV steelhead. The result of these changes has been the reduction in quantity and quality of several essential features of migration and rearing habitat required by juveniles to grow and survive. In spite of the degraded condition of this habitat, the intrinsic value of the action area for the conservation of the species is high as it is used by two Federally listed salmonids in the Central Valley.

The Feather River population of CV spring-run Chinook salmon continues to have high returns (1,000-20,000), but is heavily influenced by the FRFH. The population spawning in-river is difficult to determine because they are not counted when entering, and monitoring during spawning results in difficulties distinguishing between races. The returns to the FRFH collected for propagation have remained fairly consistent, generally between 1,000 to 4,000 fish. The proportion of hatchery-origin spring- or fall-run Chinook salmon contributing to the natural spawning spring-run Chinook salmon population on the Feather River remains unknown due to overlap in the spawn timing of spring-run and fall-run Chinook salmon, and lack of physical separation. However, carcass surveys indicate a large percentage of these are likely of hatchery origin (NMFS 2016b).

Escapement of CCV steelhead at the FRFH seems to be quite variable over the years, generally averaging about 1,100 fish. Currently, nearly all the steelhead that return to the Feather River Hatchery are hatchery-origin fish, indicating that spawning and/or rearing habitat for steelhead in the Feather River is very poor and natural production is limited (NMFS 2016a).

The action area is also within designated critical habitat for sDPS green sturgeon. PBFs for sDPS green sturgeon within freshwater riverine systems include food resources, substrate type/size, flow, water quality, migration corridors free of passage impediments, depth (holding pools), and sediment quality. As is the case with salmonids, PBFs in the area have been severely impaired through several anthropogenic factors. The loss of potential upstream habitat from Oroville Dam, altered hydrograph, altered temperature regime, other changed or degraded environmental or habitat conditions, overfishing, poaching, diversions of water, predation, ocean survival, and other factors have greatly impacted the sDPS green sturgeon in the Feather River.

A migratory corridor that is attractive to sDPS green sturgeon is necessary for sDPS green sturgeon to access spawning grounds and to access other tributaries such as the Yuba River. Presently, a rock weir at Sunset Pumps is believed to impair upstream fish passage of sDPS green sturgeon at low flows. Additionally, habitat conditions necessary to support a healthy population of sDPS green sturgeon in the Feather River are influenced by a variety of other impacts such as sport fishing regulations, water diversions, contributions from tributaries such as the Yuba River, levee maintenance and construction. DIDSON surveys from 2011-2013 documented variable numbers of green sturgeon present in the Feather River, but at least 3 were present each year, with 1 year confirming 21-28 sturgeon present. Green sturgeon have also been observed spawning in the Feather River (NMFS 2015). Utilization of the area by several green sturgeon life stages means the habitat is still of high value for the conservation of the species.

High flows occurred in the Feather River during the winter of 2016-17. These have impacted survival of ESA-listed salmonids, and adversely impacted designated critical habitat in the

Feather River. These high flows resulted in juvenile salmonids being stranded, eggs being scoured out of the gravel, and juvenile fish prematurely being moved downstream. The high flows have resulted in large changes in the rivers, with erosion of the river banks and high loads of sediment being deposited into the rivers. Although the changes were likely overall negative, high flows may have benefited critical habitat through the recruitment of large woody material. The negative effects of the high flows in the winter of 2016-17, coupled with the drought conditions from 2012 through 2016, have likely impacted the recovery of ESA-listed salmonids. It is likely that the numbers of ESA-listed salmonids has declined, and the critical habitat has degraded in the Feather River since the most recent status reviews for CV spring-run Chinook salmon and CCV steelhead. At this time, it unclear if there were negative impacts to green sturgeon, due to the high flows. Adult green sturgeon were present in the Feather River in 2017, in good numbers (25-30 in the Feather River at the Fish Barrier Dam).

2.4.1 Mitigation Banks and the Environmental Baseline

The levee repair project occurred within the service area of one conservation bank approved by NMFS, with available credits for purchase:

Fremont Landing Conservation Bank: Established in 2006, the Fremont Landing Conservation Bank is 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.

2.5 Effects of the Action

Under the ESA, "effects of the action" means the direct and indirect effects of an action on the species or critical habitat, together with the effects of other activities that are interrelated or interdependent with that action, that will be added to the environmental baseline (50 CFR 402.02). Indirect effects are those that are caused by the proposed action and are later in time, but still are reasonably certain to occur.

To evaluate the effects of the emergency levee repair, NMFS examined the effects of the action. We analyzed construction-related impacts and the fish response to habitat modifications. We also reviewed and considered the DWR's conservation measures taken during the repair.

Our assessment considers the nature, duration, and extent of the action 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 included both short- and long-term impacts. Short-term impacts include the impacts of construction during the repair. Long-term impacts include the permanent physical alteration of the river bank and riparian vegetation, which will last for many years.

The purchase of 4.65 acres of mitigation credit from a NMFS-approved bank with an applicable service area creates beneficial effects that will restore and protect floodplain and riparian habitat and improve juvenile rearing habitat for all species analyzed in this BO. Although the banks technically do not include green sturgeon credits (only salmonid credits), we expect that individual Feather River green sturgeon will benefit from the purchase of these credits. Since the mitigation bank is 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. Enhanced riparian vegetation along the shorelines is expected to reduce water temperatures, and improve water quality by reducing contaminants and urban runoff, which may benefit all life stages of green sturgeon and salmonids.

2.5.1 Construction Impact Analysis for Salmonids and Green Sturgeon

Juvenile CCV steelhead, adult and juvenile CV spring-run Chinook salmon, and adult and juvenile green sturgeon may have been migrating or rearing in the action area during construction activities. No spawning habitat for CCV steelhead, spring-run Chinook salmon or green sturgeon is present in the action area, therefore no adverse effects to incubating eggs or fry occurred.

Noise

Direct effects associated with in-river construction work involved equipment and activities that can produce pressure waves, and create underwater noise and vibration, thereby temporarily altering in-river conditions. Only those fish that were holding adjacent to or migrating past the levee repair site would have been directly exposed or affected by construction activities. Fish that were exposed to the effects of construction activities encountered short-term (*i.e.*, minutes to hours) construction-related noise and physical disturbance. Noise can cause a change in behavior that may lead to increased susceptibility of some individuals to predation by temporarily disrupting normal sheltering behaviors. These changes can also impair feeding behaviors, which in turn impact their ability to grow and survive.

Rock Placement

Any fish that did not relocate during construction had the potential to be injured by construction equipment, rock, or personnel. Fish, especially adults, typically respond to construction activities by quickly swimming away from the construction activity, resulting in escaping injury. Juvenile fish may have been susceptible to predation during rock placement due to disorientation caused by physical placement of rock. Rock placed below the OHWM will also provide habitat for bass and other predators that feed on out-migrating smolts. We expect that there were adverse effects in the form of harm from significant habitat degradation and from construction activities along 1,000 feet (0.29 acres) of shoreline below the OHWM. The placement of rock revetment has the potential to affect migratory behavior, however, it is not expected to have prevented salmonids and sturgeon from passing upstream or downstream because the work only occurred through the day, and not at night, when the majority of fish migrate.

Contaminants

Toxic substances used at construction sites, including gasoline, lubricants, and other petroleum-based products can enter the waterway as a result of spills or leakage from machinery and injure listed salmonids and green sturgeon. Petroleum products also tend to form oily films on the water surface that can reduce DO 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, it is likely that if a spill did occur, it would have been observed by construction crew and the spill would have been attempted to be cleaned up. There were no known spills of toxic substances during construction, and therefore, impacts due to toxic substances are not expected to reach the level where take of listed species would have occurred.

Turbidity

Turbidity and sedimentation events likely did not 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, were not likely impacted by the increase in the turbidity levels from the 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, because there was no ground disturbance due to project activities, any temporary sedimentation and turbidity was likely minimal and localized to the area where revetment was placed. Therefore effects due to turbidity on listed fish species were are not expected to reach the level where take of listed species would have occurred.

Environmental staff did not observe any dead or injured fish. The timing and location of the construction avoided the presence of many of the life stages of salmonids and green sturgeon. Impacts to adults of these species were likely avoided because of their preference for deep water and their crepuscular migratory behavior, which enabled them to avoid daytime construction.

2.5.2 Project Effects Estimated Using Loss of Riparian Habitat as an Analytical Surrogate

Complex natural banks are generally characterized by rich habitat diversity with variable water depths and velocities, including shallow, low-velocity areas used by juveniles as refuge from fast currents and predators. Shaded riverine aquatic (SRA) cover is the nearshore aquatic area occurring at the interface between a river and adjacent woody riparian habitat. The principal attributes of SRA include natural, eroding substrates supporting riparian vegetation that either overhangs or protrudes into the water, and the water containing variable amounts of woody debris, such as leaves, logs, branches and roots. Instream woody material (IWM) provides important sources of cover and food for juvenile fishes and other aquatic organisms. In addition to cover and shelter for fish, riparian vegetation provides other important stream ecosystem functions, including channel and streambank stability; inputs of food (*e.g.*, terrestrial insects), organic material, and nutrients; and temperature moderation (Murphy and Meehan 1991).

Riparian habitat, especially the SRA component, is important for rearing and out-migrating juvenile salmon because it provides overhead and instream cover from predation and enhances food production. Terrestrial insects and IWM that fall from riparian plants into the river enhance the aquatic food webs and provide high-value feeding areas for juvenile salmonids. Once in the river channel, the stems, trunks, and branches become very important structural habitat components for aquatic life. Many of the aquatic invertebrates that are primary food sources for juvenile salmon and steelhead live on woody debris. In some cases, the reproductive cycles of macroinvertebrates are tied to IWM, as their eggs are laid and develop inside fallen logs and are eventually eaten by fishes.

Riparian shade can be critical in preventing diurnal thermal maxima from reaching dangerous levels, thereby extending the usable season for small streams (Maslin et al. 1997). Trees and shrubs growing along river banks providing microclimates of cooler water temperatures during the hot summer months where many fishes will congregate to feed and seek cover. In addition, the roots, branches and other submerged plant materials provide cover for young fishes, as well as nutrients and sources of invertebrates. Riparian trees and shrubs will eventually end up in the river channel as floods erode the bank or sweep them from the floodplain. IWM affects the hydraulics of flows around it, resulting in a more complex channel geomorphology and increasing the storage of spawning gravels.

The emergency levee repair on the Feather River may have resulted in harm of ESA-listed species during the placement of rock revetment below the OHWM. The behavioral modifications that are expected to result from disruption of habitat use are the ecological surrogates for adverse effects in the form of harm. There is not a stronger ecological surrogate based on the information available at this time. It is not possible to quantify the exact numbers of individuals that may be affected.

The levee repair required the permanent alteration of 1.55 acres of habitat (1.26 acres above the OHWM and 0.29 acres below) through the removal of vegetation and placement of rock revetment, which will hinder the growth of riparian vegetation at the site. The loss of riparian vegetation will likely reduce food production and feeding rates for juveniles, as well as increase rates of predation. Juveniles may also be negatively impacted by increases in temperature. Given the size of the repair, only a small proportion of each of these listed fish populations present in the Feather River are expected to be impacted. Adult salmonids and green sturgeon will likely not be impacted because adults are unlikely to use the nearshore habitat that will be affected by this project, as they prefer deeper water instead.

The action, through the purchase of compensatory mitigation credits, will restore and preserve in perpetuity, 4.65 acres of floodplain and riparian habitat that benefit the growth and survival of all species analyzed in this BO. Although the bank technically does not include green sturgeon credits (only salmonid credits), we expect that green sturgeon will benefit from the purchase of these credits. Since the mitigation bank is 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 Project Effects on Critical Habitat

The emergency levee repair is expected to cause a reduction in critical habitat by removing riparian vegetation and installing rock revetment. Revetment was placed along a total of 1,000 linear feet of the Feather River. Approximately 0.29 acres of riprap was be placed below the OHWM, permanently creating an area of unproductive, low quality habitat along the interface of the channel bottom and the bank slope. Above the OHWM, the DWR placed 1.26 acres of riprap. The effects of this project result in continued fragmentation of existing habitat, and conversion of nearshore aquatic to simplified habitats that have adverse effects on salmonids and green sturgeon.

The project adversely impacts several of the essential features (PBFs) of critical habitat for CV spring-run Chinook salmon and CCV steelhead, including freshwater rearing habitat and migration corridors for juvenile salmon and steelhead. The repair affected freshwater rearing sites due to the trimming and removal of riparian vegetation, which provides natural cover and supports juvenile growth and mobility.

The PBF of migratory corridors for adult salmonids was not impacted because adult salmonids are unlikely to use the nearshore habitat that were affected by this project, as they prefer deeper water instead. Furthermore, the site did not install any features that blocked or impeded juvenile or adult migration at the time or in the future. No spawning habitat for CCV steelhead, spring-run Chinook salmon or green sturgeon is present in the action area, therefore no adverse effects to spawning habitat occurred.

The project will have long-term impacts to several of the essential features (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, was and will continue to be adversely affected by the installation of 1,000 linear feet of rock revetment at the bank repair site. The installation of rock revetment below ordinary high water impairs green sturgeon foraging habitat, thereby reducing the availability of prey. Similarly, the PBF of substrate type and size will also be adversely affected for many years, as part of the natural river bed 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 did not install any features that block or impede juvenile or adult migration, alter any deep pools, or permanently alter water quality.

2.5.4 Mitigation/Conservation Bank Credit Purchases

To address the long-term effects of the removal of riparian vegetation and placement of rock revetment on listed fish species and their designated critical habitat, the proposed action includes purchase of mitigation bank credits at a 3:1 ratio. This credit purchase is ecologically relevant to the impacts and the species affected because the bank includes shaded riparian aquatic, riparian forest and floodplain credits with habitat values that are already established and meeting performance standards. Also, the bank is located in an area that will benefit the ESUs/DPSs affected and the specific populations that are affected by the action. Although the bank technically does not include green sturgeon credits, we expect that individual Feather River green sturgeon will benefit from the purchase of these credits, as the bank provides areas with soft benthic substrate where juvenile and adult green sturgeon can forage, as well as increase floodplain and riparian habitats. Since the mitigation bank is 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. Enhanced riparian vegetation along the shorelines is expected to reduce water temperatures, and improve water quality by reducing contaminants and urban runoff, which may benefit all life stages of green sturgeon and salmonids.

The purchase of credits provides a high level of certainty that the benefits of a credit purchase will be realized because the NMFS approved bank considered in this BO has 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, measures to ensure more debits are not sold than credits available, performance security requirements, a remedial action plan, and site inspections by NMFS. A description of the tracking mechanisms can be found in the banking instruments for Fremont Landing (Wildlands Inc. 2006), which was consulted on by NMFS in 2009 (SWR-2008-7235).

In addition, the bank has a detailed credit schedule and credit transactions and credit availability is 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 as 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 that utilize the Feather River during some portion of their life. All of these facilities are currently operated to mitigate for natural habits that have already been permanently lost as a result of dam construction. The loss of this available habitat results in dramatic reductions in natural population abundance, which is mitigated for through the operation of hatcheries. Salmonid hatcheries can, however, have additional negative effects on ESA-listed salmonid populations. The high level of hatchery production in the CV can result in high harvest-to-escapements ratios for natural stocks. California salmon fishing regulations are set according to the combined abundance of hatchery and natural stocks, which can lead to over-exploitation and reduction in the abundance of wild populations that are indistinguishable and exist in the same system as hatchery populations. Releasing large numbers of hatchery fish can also pose a threat to wild Chinook salmon and steelhead stocks through the spread of disease, genetic impacts, competition for food and other resources between hatchery and wild fish, predation of hatchery fish on wild fish, and increased fishing pressure on wild stocks as a result of hatchery production. Impacts of hatchery fish can occur in both freshwater and the marine ecosystems. Limited marine carrying capacity has implications for naturally produced fish experiencing competition with hatchery production. Increased salmonid abundance in the marine environment may also decrease growth and size at maturity, and reduce fecundity, egg size, age at maturity, and survival (Bigler et al. 1996). Ocean events cannot be predicted with a high degree of certainty at this time. Until good predictive models are developed, there will be years when hatchery production may be in excess of the marine carrying capacity, placing depressed natural fish at a disadvantage by directly inhibiting their opportunity to recover (NPCC 2003).

2.6.3 Increased Urbanization

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

Increased urbanization also is expected to result in increased recreational activities in the region. Among the activities expected to increase in volume and frequency is recreational boating. Boating activities typically result in increased wave action and propeller wash in waterways. This potentially will degrade riparian and wetland habitat by eroding channel banks and mid-channel islands, thereby causing an increase in siltation and turbidity. Wakes and propeller wash also churn up benthic sediments thereby potentially 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. 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 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. More recent 2017 returns were even lower (2,087 total). 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).

2.7.2 Status of the CCV Steelhead DPS

The 2016 status review (NMFS 2016a) concluded that overall, the status of CCV steelhead appears to have changed little since the 2011 status review when the Technical Recovery Team concluded that the DPS was in danger of extinction. Further, there is still a general lack of data on the status of wild populations. There are some encouraging signs, as several hatcheries in the Central Valley have experienced increased returns of steelhead over the last few years. There has also been a slight increase in the percentage of wild steelhead in salvage at the south Delta fish facilities, and the percentage of wild fish in those data remains much higher than at Chipps Island. The new video counts at Ward Dam show that Mill Creek likely supports one of the best wild steelhead populations in the Central Valley, though at much reduced levels from the 1950s and 1960s. 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.

2.7.3 Status of the Southern DPS Green Sturgeon

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.

2.7.4 Status of the Environmental Baseline and Cumulative Effects in the Action Area

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

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

2.7.5 Summary of Project Effects on CV Spring-run Chinook salmon, CCV steelhead and sDPS Green Sturgeon Individuals

2.7.5.1 Construction-Related Effects

Emergency levee repair work occurred from May 8 to May 20, 2017, and included placement of rock revetment and removal of riparian vegetation. Adverse effects in the form of harm may have resulted from the placement of rock and removal of riparian vegetation. Adult and juvenile fish may have been behaviorally disturbed by the construction activity causing them to relocate to an area away from the noise and physical disturbance. However, both adults and juveniles are more likely to stay in the main channel than near shorelines. Juvenile fish may have also been susceptible to predation during rock placement due to disorientation caused by physical placement of rock.

The amount of riparian habitat lost is unknown. A total of 1.55 acres was disturbed by the placement of rock revetment (0.29 acres below OHWM and 1.26 acres above OHWM). The loss of riparian habitat may have resulted in decreased shelter resulting in increased predation of juvenile fish species, and increased water temperatures in that section of Feather River.

Construction activities associated with the emergency levee repair did not include ground disturbance below the OHWM. Some aquatic sediment may have been disturbed during the placement of rock, but this would not cause conditions that resulted in localized turbidity to the extent that fish were harmed, injured, or killed. Also, construction activities occurred for 13 days during daylight hours, when salmonids are unlikely to be migrating. Therefore, any effects due to turbidity are not expected to have reached the level where take would occur.

In summary, some adult CV spring-run, CCV steelhead, and sDPS green sturgeon may have been behaviorally affected by noise and turbidity during rock placement, and a small number of juvenile CV spring-run and CCV steelhead may be harmed by the permanent habitat degradation and due to predation during the disturbance. The loss of riparian vegetation may cause slightly increased temperatures and reduced shelter along the 1,000-foot stretch of levee repair.

2.7.5.2 Long-term Effects Related to the Presence of Project Features

For juvenile and outmigrating salmon and steelhead, the proposed action will result in some long-term adverse effects to individual salmon and steelhead that are exposed to the project features along the Feather River. Riparian vegetation was removed and replaced with rock revetment. This loss in vegetation decreases food availability, reduces cover and increases temperatures in the action area, resulting in reduced growth and survival. The placement of rip-rap will result in harm to individuals by increasing predator habitat and reducing cover. This habitat modification will reduce the quantity and quality of rearing habitat and by creating conditions that increase the likelihood of predation.

Migrating adult Chinook salmon and steelhead residents (outmigrating post spawning adults) will not be impacted because adult salmonids are unlikely to use the nearshore habitat that is affected by this project, as they prefer deeper water instead. Furthermore, the project will not cause an increase in predation on adults, and no structural features that could impede adult migration were installed.

For juvenile rearing sDPS green sturgeon, shoreline habitat conditions are negatively impacted compared to the environmental baseline. The loss of benthic substrate is expected to reduce food availability to juvenile and adult green sturgeon, resulting in decreased growth and survival. However, the area covered represents a very small fraction of the benthic habitat available in the Feather River.

As compensatory mitigation for these impacts, DWR plans to purchase credits from the NMFS-approved Fremont Landing Conservation Bank at a 3:1 ratio for all habitat impacted. The bank with a service area that includes the site of the levee repair benefits rearing juvenile CV spring-run Chinook salmon of the same ESU and rearing juvenile CCV steelhead of the same DPS, and in the case of Fremont Landing, the same populations of these species. The habitat provided in the bank is the same type of habitat impacted by the levee repair (floodplain and riparian habitat). The floodplains and riparian forest in the bank benefit the growth and survival of rearing salmonids by providing habitat with abundant food in the form of aquatic invertebrates, structural diversity such as IWM, and cooler stream temperatures. Although the bank technically does not include green sturgeon credits (only salmonid credits), we expect that individual Feather River green sturgeon will benefit from the purchase of these credits, as the bank provides areas with soft benthic substrate where juvenile and adult green sturgeon can forage.

2.7.6 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 six 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 are expected to be affected by removal of vegetation and placement of riprap. These activities are expected to reduce the quality of this habitat for rearing and migrating juvenile salmonids. The PBF of migratory corridors for adults is not expected to be impacted, as migrating adult Chinook and steelhead are unlikely to use the nearshore habitat that will be affected by this project, as they prefer deeper water instead. Furthermore, the project did not install any features that expected to block or impede juvenile or adult migration.

The sDPS green sturgeon PBFs of substrate type/size and food resources are expected to both be adversely affected by the project, as project features cover the soft benthic substrate where green sturgeon forage for food with riprap, reducing food availability. However, the amount of benthic substrate lost is small compared to the amount of available habitat in the Feather River.

As discussed in Section 2.7.5 above, as mitigation for these impacts, DWR plans to purchase credits from the Fremont Landing Conservation Bank at a 3:1 ratio for all habitat impacted. The purchase of mitigation credits at this bank is expected to benefit the PBFs of freshwater rearing habitat and migration corridors for juvenile salmon and steelhead by providing suitable floodplain and riparian habitat. Although the bank technically does not include green sturgeon credits, we expect that PBF of food resources will benefit from the purchase of these credits, as the bank provides areas with soft benthic substrate where juvenile and adult green sturgeon can forage.

2.7.7 Summary

Although there are some short-term and permanent impacts from the project, when added to the environmental baseline and cumulative effects, the impacts from the project in the action area are small, and in some cases occur during seasons when fish abundance is low. To mitigate the effects of the project, DWR plans to purchase mitigation credits off-site at a 3:1 ratio to off-set all project impacts, for a total of 4.65 acres purchased. This is a substantially greater amount of restoration and preservation than the spatial footprint of the levee repair. These compensatory mitigation credits serves as a form of advanced mitigation because the habitat at the bank was restored 11 years (Fremont Landing Conservation Bank) before the impact of the levee repair.

The purchase of mitigation bank credits at Fremont Landing Conservation Bank will improve floodplain and shaded aquatic and riverine habitat for CV spring-run and CCV steelhead. Green sturgeon will likely also benefit since they require similar habitats and the mitigation bank is along their migration path. 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 CCV steelhead, CV spring-run Chinook salmon, or sDPS green sturgeon or destroy or adversely modify designated critical habitat of these species.

2.9 Incidental Take Statement

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

The recommendations provided by NMFS during the emergency response function in place of terms and conditions with respect to the incidental take caused by the emergency response, and are incorporated here as terms and conditions of this consultation. Thus, to the extent that the emergency response action was performed in compliance with those recommendations, the associated incidental take is considered exempt from the ESA take prohibition.

NMFS cannot, using the best available information, quantify the incidental take of individual fish because of the variability and uncertainty associated with the population size of the species, annual variations in the timing of migration, uncertainties regarding individual habitat use of the project area, and response to the effects of the project. However, it is possible to designate as ecological surrogates, those measurable elements of the project that are expected to result in take and to monitor those surrogates to estimate the level of take that may have occurred.

Accordingly, NMFS is quantifying take of juvenile CV spring-run Chinook salmon, CCV steelhead, and sDPS green sturgeon incidental to the action resulting from short-term construction impacts, as well as long-term impacts to habitat of the levee repair project. The most appropriate threshold for take is an ecological surrogate of habitat disturbance due to rock placement below the OHWM and loss of SRA habitat.

The amount and extent of take described below is in the form of harm due to habitat impacts through displacement, increased predation, and loss of food resources, resulting in decreased growth and survival for a period of up to 50 years (the standard engineered life expectancy of rock revetment placed on a levee project). Due to a lack of site-specific fish data, the exact number of fish that were affected is unknown. NMFS anticipates the following level of incidental take from emergency levee repair activities:

Incidental Take Associated with Construction and Habitat Loss:

(1) Harm of juvenile CV spring-run Chinook salmon, CCV steelhead, and sDPS green sturgeon from habitat-related disturbances from the placement of 0.29 acres of riprap below the OHWM. Take will be in the form of harm to the species through modification or degradation of the PBFs for rearing and migration that reduces the carrying capacity of habitat.

(2) Harm of juvenile CCV steelhead is expected from the long-term loss of riparian and SRA habitat removed during project implementation. The loss of SRA habitat may cause behavior modification of juvenile fish avoiding the disturbed areas and experiencing reduced growth and survival. Reduction in SRA cover may lead to increased predation by predatory fishes, birds, or mammals. Loss of SRA may reduce food availability, which may result in increased competition and an increased susceptibility to predation.

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) thermal refugia.

3.2 Adverse Effects on Essential Fish Habitat

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

<u>1. Sedimentation and Turbidity</u>

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

<u>2. Contaminants and Pollution-related Effects</u>

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

<u>3. Installation of Revetment</u>

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

<u>4. Removal of Riparian Vegetation</u>

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

3.3 Essential Fish Habitat Conservation Recommendations

The following conservation recommendations are necessary to avoid, mitigate, or offset the impact of the project on EFH:

1. NMFS recommends vegetating the site by installing a layer of soil over the rock that was placed as part of the repair and planting the soil with willows and shrubs. This will help the site recover faster and over time the site will provide some of the habitat values that were lost from the removal of riparian vegetation and placement of rock revetment.

Fully implementing the above EFH conservation recommendation would avoid and minimize the adverse effects to designated EFH for Pacific Coast Salmon.

3.4 Statutory Response Requirement

As required by section 305(b)(4)(B) of the MSA, USACE must provide a detailed response in writing to NMFS within 30 days after receiving an EFH Conservation Recommendation. Such a response must be provided at least 10 days prior to final approval of the action if the response is inconsistent with any of NMFS' EFH Conservation Recommendations unless NMFS and the Federal agency have agreed to use alternative time frames for the Federal agency response. The response must include a description of measures proposed by the agency for avoiding, 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.

3.5 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. DATA QUALITY ACT DOCUMENTATION AND PRE-DISSEMINATION REVIEW

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

4.1 Utility

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

4.2 Integrity

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

4.3 Objectivity

Information Product Category: Natural Resource Plan

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

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

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

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

5. REFERENCES

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