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

Refer to NMFS No: WCR-2018-9436

September 27, 2018

Zachary Simmons
Senior Project Manager
Enforcement/ Special Projects Branch
United States Army Corps of Engineers
Sacramento District
1325 J Street
Sacramento, California 95814

Re: Endangered Species Act Section 7(a)(2) Biological Opinion and Magnuson-Stevens Fishery Conservation and Management Act Essential Fish Habitat Response for the 2017 Storm Damage Department of Water Resources Emergency Rehabilitation Phase 3 Project in the northern Sacramento-San Joaquin River Delta (SPK-2018-00170, SPK-2018-00171, SPK-2018-00172, SPK-2018-00173, SPK-2018-00174, and SPK-2018-00175)

Dear Mr. Simmons:

Thank you for your letter received on March 2, 2018, requesting initiation of consultation with NOAA's National Marine Fisheries Service (NMFS) pursuant to section 7 of the Endangered Species Act of 1973 (16 U.S.C. 1531 et seq.) for the *2017 Storm Damage Department of Water Resources (DWR) Emergency Rehabilitation Phase 3 Project* (Project). The Project will implement repairs to nine levee sites in the northern Sacramento-San Joaquin River Delta (Delta).

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 endangered Sacramento River winter-run Chinook salmon (*Oncorhynchus tshawytscha*) Evolutionarily Significant Unit (ESU), the threatened Central Valley spring-run Chinook salmon (*O. tshawytscha*) ESU, the threatened California Central Valley steelhead (*O. mykiss*) Distinct Population Segment (DPS), and the threatened Southern DPS of the North American green sturgeon (*Acipenser medirostris*). NMFS has also concluded that the Project is not likely to destroy or adversely modify the designated critical habitats for CV spring-run Chinook salmon, CCV steelhead, and sDPS green sturgeon that occur within the action area. NMFS has included an incidental take statement with reasonable and prudent measures and non-discretionary terms and conditions that are necessary and appropriate to avoid, minimize, or monitor incidental take of listed species associated with the Project.

This letter also transmits NMFS' essential fish habitat (EFH) conservation recommendations for Pacific salmon as required by the Magnuson-Stevens Fishery Conservation and Management Act (MSA) as amended (16 U.S.C. 1801 *et seq.*).

The EFH consultation concludes that the proposed action would adversely affect the EFH of Pacific salmon in the action area. The EFH consultation adopts the ESA reasonable and prudent measures and associated terms and conditions from the BO and includes additional conservation recommendations specific to the adverse effects to Pacific salmon EFH in the action area as described in Amendment 18 of the Pacific Coast Salmon Plan.

The U.S. Army Corps of Engineers (Corps) has a statutory requirement under section 305(b)(4)(B) of the MSA to submit a detailed written response to NMFS within 30 days of receipt of these conservation recommendations, and 10 days in advance of any action, that includes a description of measures adopted by the Corps for avoiding, minimizing, or mitigating the impact of the Project on EFH (50 CFR 600.920(j)). If unable to complete a final response within 30 days, the Corps should provide an interim written response within 30 days before submitting its final response. In the case of a response that is inconsistent with our recommendations, the Corps must explain its reasons for not following the recommendations, including the scientific justification for any disagreements with NMFS over the anticipated effects of the Lower San Joaquin River Feasibility Study and the measures needed to avoid, minimize, or mitigate such effects.

Please contact Jeffrey Stuart in NMFS' West Coast Region, California Central Valley Office at (916) 930-3607 or via email at J.Stuart@noaa.gov if you have any questions concerning this section 7 consultation, or if you require additional information.

Sincerely,

for Barry A. Thom
Regional Administrator

Enclosure

cc: To the File ARN 151422-WCR2017-SA00356
Mr. David Wheeldon, California Department of Water Resources, Dave.Wheeldon@water.ca.gov
Mr. Jeff Schuette, California Department of Water Resources, Jeff.Schuette@water.ca.gov
Ms. Erica Hironaka, California Department of Water Resources, Erica.Hironaka@water.ca.gov

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

2017 Storm Damage Department of Water Resources Emergency Rehabilitation Phase 3 Project

National Marine Fisheries Service Consultation Number: WCR-2018-9436

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?
Sacramento River winter-run Chinook salmon Evolutionarily Significant Unit (ESU) *(Oncorhynchus tshawytscha*)	Endangered	Yes	No	No
Central Valley spring-run Chinook salmon ESU (*O. tshawytscha*)	Threatened	Yes	No	No
California Central Valley steelhead Distinct Population Segment (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:

Barry A. Thom
Regional Administrator

Date: **SEPTEMBER 27, 2018**

Table of Contents

1. INTRODUCTION

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

1.1 Background

The National Marine Fisheries Service (NMFS) prepared the biological opinion (opinion) and incidental take statement 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.

More specifically, high flow conditions occurring during the winter of 2016/2017 resulted in erosion and other damage to levees and facilities throughout the State. Levees at multiple sites were damaged to such an extent that the flood control performance of the levees was likely compromised and thus there was a very high likelihood of failure during the next high water event. Failure of any one of the levees would result in catastrophic flooding, property damage, and loss of life within the area protected by the levee. Therefore, an emergency rehabilitation program was needed to make the necessary levee repairs prior to the 2017/2018 winter season. In response, the California Department of Water Resources (DWR) implemented the 2017 Storm Damage DWR Rehabilitation Program at several critical rehabilitation sites. In addition to the sites repaired during fall of 2017, nine additional critical rehabilitation sites were identified for emergency repair during the summer of 2018 (Phase 3 of the Program; hereafter referred to as the Project or Proposed Action). The Project is authorized and sponsored by DWR's Division of Flood Management, Flood Maintenance Office.

NMFS is treating this Project as an emergency consultation. In emergency matters, NMFS follows ESA emergency consultation procedures as defined by the Code of Federal Regulations (50 CFR§ 402.05). An "emergency" is a situation involving acts of God, disasters, casualties, national defense or security emergencies, or response activities necessary to prevent imminent loss of human life or property. NMFS fully recognizes that public safety is of paramount importance, and nothing should compromise swift action to protect human life or safety. In order to accommodate the requests of DWR to perform their emergency levee rehabilitation actions, NMFS will conduct its formal consultation under the ESA concurrently with the implementation of the Project.

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 (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[1]). A complete record of this consultation is on file at California Central Valley Area Office.

1.2 Consultation History

Since January 2017, DWR has provided NMFS, the U.S. Fish and Wildlife Service (USFWS), and the California Department of Fish and Wildlife (CDFW) with 75 Flood Operations Center (FOC) status updates, covering 72 total incidents, of which 39 incidents were identified as levee repair activities. Notifications for the 39 incidents constituted a request for emergency consultation pursuant to 50 CFR § 402.05.

On March 8, 2018, NMFS received a request from the U.S. Army Corps of Engineers (Corps) to initiate formal Section 7 consultation under the ESA for the Project. The Corps determined that the Project may affect but is not likely to adversely affect (NLAA) California Central Valley (CCV) steelhead, Central Valley (CV) spring-run Chinook salmon, Sacramento River (SR) winter-run Chinook salmon, the southern DPS (sDPS) of North American green sturgeon and their designated critical habitat. The Corps also determined that the Project may adversely affect EFH for Pacific salmon under the MSA.

On March 26, 2018, NMFS received a letter from the Corps modifying their effects determination for the Project. The Corps changed the effects determination for CCV steelhead, SR winter-run Chinook salmon, and sDPS green sturgeon from a NLAA determination to a likely to adversely affect determination. The Corps determination for the Project's effects to designated critical habitat for these three species also was modified to a likely to adversely affect determination. The Corps' determination for CV spring-run Chinook salmon and its designated critical habitat remained unchanged from the March 8, 2018 letter.

On April 6, 2018, NMFS received the Project's biological assessment (BA; ESA 2018) electronically from the Corps.

On April 12, 2018, NMFS received an email from the Corps in which the determination for CV spring-run Chinook salmon and its designated critical habitat was modified from the initial NLAA determination to a likely to adversely affect determination. This is the date on which the consultation package was considered complete and the consultation was initiated.

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[1] Once on the PCTS homepage, use the following PCTS tracking number within the Quick Search column: WCR-2018-9436, or search for the project by name: 2017 Storm Damage Department of Water Resources Emergency Rehabilitation Phase 3 Project

On April 24, 2018, the Corps sent via email changes to the Project design drawings and the areas impacted by the levee construction actions.

On April 26, 2018, NMFS responded to the Corps' request for emergency consultation via letter. NMFS indicated that it would follow the emergency consultation procedures found in 50 CFR § 402.05 for Section 7 consultations. NMFS provided several discretionary minimization measures to reduce the Project impacts.

On April 27, 2018, the Corps sent via electronic mail revised tables of the areas impacted by levee rehabilitations.

On May 1, 2018, the Corps sent out via electronic mail updated tables and an Excel spreadsheet regarding the areas affected by levee repairs.

On August 20, 2018, NMFS requested a three-week extension to the 135-day consultation period to September 14, 2018. The Corps agreed to this extension to the consultation period.

1.3 Proposed 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 proposed Federal action conducted by the Corps is to permit proposed activities described in the Project description under the jurisdiction of USC Title 33, Chapter 9, Subchapter 1, Section 404 of the Clean Water Act (CWA). In connection with this Federal action, the Corps will initiate ESA Section 7 consultation with NMFS for the proposed Project. The proposed Project includes construction actions at nine individual sites in the northern Sacramento-San Joaquin Delta region (Delta) which will require authorization under the Corps' Nationwide Permit (NWP) #13 (Bank Stabilization). The nine sites have been divided into six NWP authorizations based on location and proximity to each other. Each individual permit authorization has been given a separate Corps identification number (Table 1).

Table 1: U.S. Army Corps of Engineers Nationwide Permit Information for the 2017 Storm Damage DWR Emergency Rehabilitation Phase 3 Project.

Site #	LMA #	Corps ID #	Waterbody	Location
31	LMA-119	SPK-2018-00170	Elk Slough	38.348267º, -121.572436º
32	LMA-122	SPK-2018-00170	Elk Slough	38.356385º, -121.561968º
33	LMA-139	SPK-2018-00171	Elk Slough	38.395955º, -121.537086º
34	LMA-140	SPK-2018-00171	Elk Slough	38.396403º, -121.535965º
35	LMA-216	SPK-2018-00172	Cache Slough	38.290645º, -121.731522º
36	LMA-191	SPK-2018-00173	Lindsey Slough	38.251125º, -121.717245º
37	LMA-147	SPK-2018-00174	Steamboat Slough	38.302430º, -121.579612º
38	LMA-283	SPK-2018-00175	Shag Slough	38.361087º, -121.694184º
39	LMA-285	SPK-2018-00175	Shag Slough	38.359592º, -121.694206º

DWR, as the Project applicant, will oversee the actual rehabilitation of the levees, including all construction actions. Construction activities will take place at each site throughout the summer and fall of 2018, with a proposed in-water work window of July 1 through October 31. It is estimated that each site will require approximately 2 to 4 weeks of active construction to complete the proposed rehabilitation of the damaged levee. All work, including construction activities, will take place during daylight hours, thus no nighttime lighting will be required for any of the project sites. DWR anticipates that the levee rehabilitation will require the use of heavy equipment such as, but not limited to: front loaders, bull dozers, cranes, barges, dump trucks, excavators, compactors, and water trucks. The proposed construction activities can be grouped into the following stages:

1. Mobilization – site access and staging areas
2. Site preparation
3. Construction process, staging, sequencing, and equipment
4. Demobilization – restoration and cleanup of rehabilitation sites

The following sections describe these stages.

1.3.1 Mobilization – Site Access and Staging Areas

Mobilization will take place at each levee rehabilitation site. Mobilization includes creation of temporary access roads, if needed; securing the site with perimeter fencing; and transporting equipment and materials to the site for the later repair phases (e.g., clearing and grubbing, and construction of the repair). Access to rehabilitation sites will occur primarily along existing paved public roads, levee crown roads, or unpaved private farm roads. Where existing roads are not adequate for site access, temporary access roads may be constructed for hauling equipment and materials to and from the site. Staging areas (approximately 0.25 to 0.5 acres in size) will be located close to the repair area and will avoid sensitive habitats. The staging areas will be selected so that removal of native trees or shrubs will not occur to the greatest extent practicable, and previously disturbed areas will be preferred over undisturbed areas. For waterside repairs, staging areas will be preferentially located along the levee crown or landside, where these areas are of sufficient size and free of woody vegetation. However, some repairs may only have the waterside berm available for staging, but the designated areas will be outside of the active stream bed and measures will be implemented to minimize impacts to water quality. Larger landside staging areas are frequently required for stockpiling of materials and equipment. For landside and certain waterside repairs, staging areas may require construction easements from the landowners adjacent to the repair site. Activities that will occur within staging areas would include: storing necessary imported materials (e.g., rock, soil); parking, refueling, and servicing of construction equipment; establishing a temporary restroom for workers; and parking lot construction for staff transportation vehicles.

1.3.2 Site Preparation

Clearing and grubbing will be the first step in preparing each site for construction. Vegetation clearing may include the removal of submerged instream woody debris and fallen trees on the waterside levee slope. A turbidity curtain will be installed in the river channel prior to any in-water work occurring, including the clearing of in-water vegetation. The repair work limits and staging areas will be fenced to prevent vehicles and equipment from approaching the waterside edge of the existing bank (where applicable) and to identify disturbance area limits.

All existing vegetation within the repair area will be removed during project construction except for trees or shrubs identified and marked for protection prior to construction. Prior to site clearing and grubbing, box protection or other appropriate methods would be installed to protect the marked trees or shrubs from damage. Some trees that have been designated for protection may need to be trimmed or removed to allow access to the work site. Trees that require trimming or removal will have that work done under the guidance of a certified arborist. A qualified biologist will document all tree and sensitive plant trimming or removal. Mechanized equipment will be used to clear the construction site of grasses, ground cover, trash, or any other undesirable materials during the site preparation process.

1.3.3 Construction Process, Staging, Sequencing, and Equipment

Once each site is cleared and grubbed, each site typically will be excavated of existing rock and levee soils disturbed by the failure and transition zones at a 1:1 horizontal to vertical slope ratio (H:V). The final slope of the repaired levee face at each rehabilitation site will be graded to a 1.5H: 1V slope unless otherwise specified in the design drawings. At each rehabilitation site, a key trench will be excavated at the toe of the levee slope for clean launch rock placement. All excavated material will be hauled off-site for storage, re-use, or disposal.

Geotextile fabric and rock material will be placed in the excavated areas as specified in the design drawings. Geotextile fabric will to be used as a filter separator between the natural ground horizon and the overlying rock slope protection, (i.e. rockfill, launch rock, and soil filled rockfill) both above and below standing or flowing water surfaces. Geotextile fabric will also be used to separate soil filled rockfill from launch rock/rockfill to prevent the smaller diameter soil filled rockfill from infiltrating into the coarser launch rock/rock fill layer. The repair area slope will be graded to provide a smooth, uniform surface. The newly excavated 1H:1V slope will be cleared of debris or sharp objects that may tear or damage the fabric during installation. Geotextile fabric will be placed loosely upon the surface to prevent damage to the fabric when placing rock slope protection. Geotextile fabric placed above the water surface will be covered with rock slope protection within 72 hours of placement.

Launch rock or soil-filled rock will be placed at the rehabilitation site by using either a long-arm bucket excavator from the levee crown or from the water using a barge mounted crane. Clean launch rock will be placed in the water at the toe of the bank and added in lifts until it is approximately 1 foot above the high tide line at the time of construction. The final slope of the underwater launch rock typically will be 1.5H: 1V as described in the engineering drawings.

Soil-filled rockfill will be placed in 2-foot lifts starting at the top of the launch rock and continuing upwards to the completed elevation of the design drawings for each repair site, and the voids will be filled with clean soil. The finished slope will also be 1.5H: 1V as specified in the engineering design drawings. In locations utilizing earthfill, 0.5 feet of clean topsoil will be placed above the earthfill, and covered with erosion fabric to stabilize the bank. Once construction is completed at the rehabilitation site, all remaining disturbed soil on the repair site will be seeded with a native erosion control seed mix per the Project's planting specifications.

1.3.4 Demobilization, Restoration, and Cleanup

Following levee rehabilitation construction, all equipment and materials will be removed from the repair site and excess materials will be disposed of at the appropriate facilities. Staging areas and temporary access roads, if constructed, will be ripped to loosen the compacted soil surface and then seeded with a native grass mix to promote revegetation and minimize soil erosion. These areas would be restored to pre-project conditions. Any damage as a result of the construction, including haul route roads and property fencing, would be repaired. All areas would be cleaned and cleared of rubbish and left in a safe and suitable condition.

The following table summarizes the physical dimensions of the rehabilitation sites as proposed by DWR. The table includes the length of the repair site along the channel margin, the area of the repair, the area of the site below the ordinary high water mark (OHWM) affected by the repair, and the area above the OHWM affected by the repair at each repair site (Table 2).

Table 2: Physical Dimensions of the 2017 Storm Damage DWR Emergency Rehabilitation Phase 3 Project's Critical Rehabilitation sites within the Delta.

Site #	LMA #	Waterbody	Length (linear feet)	Area of Repair (acres)	Area Below OHWM (acres)	Area above OHWM (acres)
31	LMA-119	Elk Slough	105	0.179	0.064	0.115
32	LMA-122	Elk Slough	145	0.109	0.066	0.043
33	LMA-139	Elk Slough	130	0.126	0.067	0.059
34	LMA-140	Elk Slough	138	0.137	0.049	0.088
35	LMA-216	Cache Slough	81	0.110	0.035	0.075
36	LMA-191	Lindsey Slough	100	0.080	0.030	0.050
37	LMA-147	Steamboat Slough	190	0.284	0.211	0.073
38	LMA-283	Shag Slough	380	0.329	0.128	0.201
39	LMA-285	Shag Slough	927	0.672	0.280	0.392

1.3.5 Conservation Measures

The applicant (DWR) has provided conservation measures to avoid and minimize the effects of the proposed Project. All of the following conservation measures will become part of the proposed Project through their incorporation into the description of the proposed action as Project elements.

1.3.5.1 General Biological Resources

DWR will minimize disturbances at the emergency rehabilitation sites by implementing the following measures as described in the Project's BA (ESA 2018):

1. DWR will submit to USFWS, CDFW, and NMFS in writing the name, qualifications, business address, and contact information of a biologist(s) (qualified biologist) and obtain agency approval of the biologist(s) before starting emergency repairs. DWR shall ensure that the qualified biologist is knowledgeable and experienced in the biology and natural history of the fish or wildlife species that are listed under either the California or Federal ESA and may potentially be present in the action area (i.e., special status species). The qualified biologist shall be responsible for monitoring emergency repairs to help minimize and fully mitigate or avoid the incidental take of individual listed species and to minimize the disturbance of listed species' habitat(s).

2. Prior to the initiation of emergency repair activities, a qualified biologist will conduct a preconstruction survey to identify any listed species and associated habitat. Surveys will be conducted within the project footprint, laydown area, and adjacent haul route. If required, species and/or buffers will be marked in the field by a qualified biologist using temporary fencing, high-visibility flagging, or other means that are equally effective.

3. DWR will provide environmental awareness training by a qualified biologist to the DWR construction lead, construction foreman, crew leader, and any contractor personnel working on the construction sites. Environmental awareness training will include descriptions of all special-status fish and wildlife species potentially occurring in the project area for activity specific training, their habitats, and methods of identification, including visual aids as appropriate. The training will also describe activity-specific measures that will be followed to avoid impacts. Hardcopies of environmental permits and training materials will be provided to the DWR construction lead, construction foreman, crew leader, and any contractors participating in emergency activities.

4. Use existing staging sites, maintenance toe roads, and levee crown roads to the extent practicable for staging and site access to avoid affecting previously undisturbed areas.

5. Limit the number of access routes and the size of staging and work areas to the minimum necessary to conduct the activity.

6. Where feasible and practicable (e.g., based on the size of the repair area and repair to be performed), clearly mark work area boundaries (e.g., with flagging or fencing), including access roads; staging and equipment storage areas; stockpile areas for soil, spoil disposal, and construction materials; fueling and concrete washout areas; and equipment exclusion zones. Work will occur only within the marked limits. This measure is intended to apply to emergency repair activities occurring in discrete areas as opposed to activities occurring over an extensive area where flagging work limits would be infeasible.

7. Inspect under all vehicles and heavy equipment for the presence of wildlife before the start of each workday when equipment is staged overnight. Additionally, look for wildlife in all pipes, culverts, and similar structures that have been stored on-site for one or more nights before being buried, capped, or moved.

8. Ensure that all project related trash items, such as wrappers, cans, bottles, and food scraps, are collected in closed containers, removed from emergency rehabilitation sites each day, and disposed of at an appropriate off-site location to minimize attracting wildlife to work areas.

9. To the greatest extent practicable, keep the clearing and grubbing of vegetation to the minimum necessary for temporary vehicle access. This especially applies to minimizing the clearing of native riparian vegetation and native oaks.

10. Where feasible, avoid removal of native trees with trunks greater than 4 inches diameter at breast height (4.5 feet above the ground). Work will be done in a manner that ensures, to the extent feasible, that living native riparian vegetation within the vegetation-clearing zones is avoided and left undisturbed. This will be done where it can reasonably be accomplished without compromising emergency repair requirements.

11. Trees within the repair area identified for protection and outside the work limit may require trimming or removal for equipment clearance, excavation, or due to severely diminished tree health. Trees that require trimming or removal will be done so under the guidance of a certified arborist. A qualified biologist will document all tree and sensitive plant trimming or removal.

12. If erosion control fabrics are used, products will not be used with plastic monofilament or cross-joints in the netting that are bound/stitched (such as straw wattles, fiber rolls, or erosion control blankets), which could trap Giant Garter Snakes and other wildlife.

13. DWR will install erosion control materials that minimize soil or sediment from entering adjacent waterways and wetlands. DWR will monitor the erosion control materials for effectiveness and maintain them throughout the emergency repairs and monitoring. DWR will immediately repair or replace any erosion control barrier that is not functioning effectively.

14. The amount of revetment and similar materials used for bank protection and other emergency repair activities will be limited to the amount necessary to ensure proper flood protection system integrity and function.

15. DWR will remove temporary fill, construction debris, and refuse, and properly dispose of these materials following completion of any emergency repair activities.

16. Habitats, including sensitive natural communities, will be restored to pre-project conditions wherever feasible. Restoration could include re-contouring by grading and disking, revegetating with native seeds and plants reflective of the target plant

community, decompacting soil, and installing appropriate erosion control measures to return the disturbed on-site habitat to pre-activity conditions.

17. DWR will implement measures to minimize the potential for invasive plants to be introduced or spread during rehabilitation activities. Measures will be created and approved for each site prior to implementation by a qualified biologist.

18. DWR will provide USFWS, NMFS, California Regional Water Quality Control Board (Regional Board), and/or CDFW (i.e., natural resource agencies) staff with reasonable access to all emergency rehabilitation sites and shall otherwise fully cooperate with the natural resource agencies' efforts to verify compliance with, or effectiveness of, conservation measures.

19. The qualified biologist will be authorized to stop emergency rehabilitation repair activities that, in the biologist's opinion, threaten to cause unanticipated and/or unpermitted adverse effects on special-status wildlife. If emergency rehabilitation repair activities are stopped, the qualified biologist will consult with CDFW, USFWS and/or NMFS, as appropriate, to determine appropriate measures that DWR will implement to avoid further adverse effects. Buffers will be maintained until there is no longer a threat of disturbance to the sensitive biological resource, as determined by a qualified biologist.

20. DWR will immediately notify the qualified biologist if a species is taken or injured by a Project-related activity, or if a species is otherwise found dead or injured within the vicinity of the Project. The qualified biologist shall provide initial notification to USFWS, NMFS and/or CDFW by contacting the appropriate agencies. The initial notification shall include information regarding the location, species, and number of animals taken or injured, and Project site number. Following initial notification, DWR will send a written report within two calendar days to the natural resource agencies. The report shall include the date and time of the finding or incident, location of the animal or carcass, and if possible provide a photograph, explanation as to cause of take or injury, and any other pertinent information.

21. No later than 45 days after completion of the emergency rehabilitation repairs, DWR will provide the natural resources agencies with a Final Mitigation Report. The qualified biologist shall prepare the Final Mitigation Report which shall include, at a minimum: (1) notes showing when each of the mitigation measures was implemented; (2) all available information about Project-related incidental take of species; (3) information about other Project impacts on the species; (4) beginning and ending dates of the emergency rehabilitation repair; (5) an assessment of the effectiveness of conservation measures in minimizing and fully mitigating Project impacts on the species; (6) recommendations on how mitigation measures may be changed to more effectively minimize take and mitigate the impacts of future projects on the species; and (7) any other pertinent information.

1.3.5.2 Special Status Fish

When conducting emergency rehabilitation repair activities that could impact special-status fish or habitat, DWR will implement the following mitigation measures:

1. Areas of suitable habitat should be surveyed, quantified, avoided (whenever possible), or mitigated when avoidance is not possible.

2. In-water work should occur during standard in-water work windows:
   a. Delta and Longfin Smelt: August through November
   b. Salmon and steelhead: July through October

1.3.5.3 Sensitive Habitats

1. Prior to the initiation of emergency rehabilitation repair activities, a qualified biologist will identify potential areas of riparian habitat, wetlands, waters of the U.S. or State, shallow water habitat, shaded riverine aquatic (SRA) cover, and native oaks. Where feasible, DWR will mark the boundaries of these areas using temporary fencing, high-visibility flagging, or other means that are equally effective in clearly delineating the habitat boundaries. When feasible, emergency repair activities will be excluded from these areas. In many situations, equipment can be operated to avoid disturbing isolated riparian trees or low-height riparian scrub habitat.

2. Trees that are designated to be protected in place will be protected using tree-wrap protection or other techniques as designated by the qualified biologist.

1.3.5.4 Water Quality

DWR will implement appropriate construction best management practices (BMPs) to reduce the potential release of pollutants or sediment into receiving waters adjacent to the rehabilitation sites. DWR has stated that it will comply with all applicable water quality permits issued by regulatory agencies. BMPs may include the following measures:

1. Conduct environmental awareness training for all contractors on the proper use of BMPs and applicable permit requirements to protect receiving water quality.

2. Install erosion control BMPs, such as the use of straw bales, silt fences, fiber rolls, or equally effective measures, at project locations adjacent to stream channels, drainage canals, and wetlands, or other waterways as needed.

3. Install turbidity curtains or similar technology during any in-water work to control the dispersion of suspended sediments in the water column, as needed.

4. Minimize ground and vegetation disturbances related to the Project by establishing designated equipment staging areas, access routes, spoils and soil stockpile areas, and equipment exclusion zones prior to the commencement of any rehabilitation activity.

5. DWR will use and store hazardous materials, such as vehicle fuels and lubricants, in designated staging areas located away from stream channels and wetlands according to local, state, and federal regulations, as applicable. DWR will ensure that any hazardous materials needed for the Project's actions will be stored at these designated staging areas, with an impermeable membrane placed between the ground and the hazardous material containers and covering the entire area used for hazardous materials storage. The storage area will be surrounded by an earthen berm sized to contain any spill of hazardous materials and prevent the discharge of any pollutants to groundwater or surface runoff water. Should any fuel or hazardous waste leaks or spills occur, DWR will immediately stop Project activities and, pursuant to pertinent state and federal statutes and regulations, arrange for repair of the leak, and subsequent cleanup of the spilled material(s) by qualified individuals at the time of the spill, or as soon as it is safe to do so. DWR will notify USFWS, CDFW, and NMFS within 24 hours of any leaks or spills. DWR will properly contain and dispose of any unused or leftover hazardous products off-site at an appropriate receiving facility.

6. Construction vehicles and equipment will be checked daily for leaks and will be properly maintained to prevent contamination of soil or water from external grease and oil or from leaking hydraulic fluid, fuel, oil, and grease.

1.3.5.5 Mitigation/ Compensation for Adverse Effects

The following actions have been proposed by DWR as mitigation and/or compensation for the effects of the Project's actions on habitat utilized by listed fish species including salmonids and green sturgeon.

1. If impacts to wetlands or waters of the U.S. cannot be feasibly avoided, then DWR will implement one of the following measures:

    a. Pay in-lieu fees for wetlands or waters of the U.S. that are permanently impacted by activities authorized by the Corps through the in-lieu fee program of the Sacramento District of the Corps and administered by the National Fish and Wildlife Foundation, at a ratio of 2 acres of aquatic resource credits for 1 acre of permanently impacted wetlands or waters of the U.S.

    b. Secure credits at a Corps-approved mitigation bank for permanent impacts to wetlands or waters of the U.S. at the emergency rehabilitation sites, at a ratio of 1 acre credit for 1 acre of permanently impacted wetlands or waters of the U.S.

2. Restore riparian habitat (and/or SRA habitat) at an onsite or an adjacent offsite location by planting native riparian tree and shrub species at a ratio of 3:1 acres for each acre of

impacted native riparian habitat (or SRA) according to a plan developed in coordination with the appropriate resource agencies (e.g., CDFW, NMFS, and/or USFWS; see Table 3).

a. Secure native riparian (and SRA) habitat credits or acres at a mitigation bank approved by CDFW (NMFS for SRA) for impacts at the project area at a ratio of 3 acres credit for 1 acre impacted native riparian habitat.

3. If shallow water habitat cannot be feasibly avoided and is filled or otherwise impacted, then DWR will implement the following measure:

a. Secure shallow water habitat (smelt) credits at a USFWS- and CDFW-approved mitigation bank for impacts at emergency rehabilitation sites, at a ratio of either 1:1 or 3:1 depending on site-specific conditions, as proposed below (Table 3).

4. To offset the permanent loss of tidally-influenced riverine habitat (shallow water habitat) due to emergency rehabilitation site repairs, DWR will compensate for the loss at a ratio of either 1:1 or 3:1 depending on site-specific conditions, as proposed below (Table 3). Credits shall be purchased at a mitigation bank (Liberty Island Conservation Bank) approved by the resource agencies (e.g., USFWS and CDFW) for selling shallow water habitat credits.

Table 3: Compensatory mitigation acreage for impacted habitat resulting from critical repairs associated with the 2017 Storm Damage DWR Emergency Rehabilitation Phase 3 Project.

Site #	LMA #	Waterbody	Delta Smelt Mitigation Shallow Water Impact (acres)	Delta Smelt Mitigation Compensatory Mitigation (acres)	Anadromous Fish Mitigation Impact (acres)	Anadromous Fish Mitigation Compensatory Mitigation (2:1 or 3:1)[a] in acres
31	LMA-119	Elk Slough	0.064	0.064	0.0179	0.422
32	LMA-122	Elk Slough	0.066	0.066	0.109	0.284
33	LMA-139	Elk Slough	0.067	0.067	0.126	0.319
34	LMA-140	Elk Slough	0.049	0.049	0.137	0.323
35	LMA-216	Cache Slough	0.035	0.105	N/A	N/A
36	LMA-191	Lindsey Slough	0.030	0.090	0.080	0.190
37	LMA-147	Steamboat Slough	0.211	0.663	0.284	0.779
Site #	LMA #	Waterbody	0.522	1.074	0.915	2.317

[a] Mitigation ratios will be 2:1 for areas above the OHWM and 3:1 for areas below the OHWM

1.3.5.6 Interrelated and Interdependent Actions

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

2. ENDANGERED SPECIES ACT
BIOLOGICAL OPINION AND INCIDENTAL TAKE STATEMENT

The ESA establishes a national program for conserving threatened and endangered species of fish, wildlife, plants, and the habitat upon which they depend. As required by section 7(a)(2) of the ESA, Federal agencies must ensure that their 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 habitat. If incidental take is expected, section 7(b)(4) requires NMFS to provide an incidental take statement (ITS) that specifies the impact of any incidental taking and includes non-discretionary reasonable and prudent measures (RPMs) and terms and conditions to minimize such impacts.

2.1 Analytical Approach

This biological opinion 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 opinion 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 opinion, we use the term PBF to mean PCE or essential feature, as appropriate for the specific critical habitat.

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

- Identify the rangewide status of the species and critical habitat likely to be adversely affected by the proposed action.
- Describe the environmental baseline in the action area.

- Analyze the effects of the proposed action on both species and their habitat using an “exposure-response-risk” approach.
- Describe any cumulative effects in the action area.
- Integrate and synthesize the above factors to assess the risk that the proposed action poses to species and critical habitat.
- Reach jeopardy and adverse modification conclusions.
- If necessary, define a reasonable and prudent alternative 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 Opinion.

2.2 Rangewide Status of the Species and Critical Habitat

This opinion 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 opinion also examines the condition of critical habitat throughout the designated area, evaluates the conservation value of the various watersheds and coastal and marine environments that make up the designated area, and discusses the current function of the essential PBFs that help to form that value for the conservation of the listed species.

The following Federally listed species evolutionarily significant units (ESU), distinct population segment (DPS) and designated critical habitat occur in the action area and have the potential to be affected by the action (Table 4):

Table 4. ESA Listing History.

Species	ESU or DPS	Original Final FR Listing	Current Final Listing Status	Critical Habitat Designated
Chinook salmon (*O. tshawytscha*)	Sacramento River winter-run ESU	1/4/1994 59 FR 440 Endangered	6/28/2005 70 FR 37160 Endangered	6/16/1993 58 FR 33212
Chinook salmon (*O. tshawytscha*)	Central Valley spring-run ESU	9/16/1999 64 FR 50394 Threatened	6/28/2005 70 FR 37160 Threatened	9/2/2005 70 FR 52488
Steelhead (*O. mykiss*)	California Central Valley DPS	3/19/1998 63 FR 13347 Threatened	1/5/2006 71 FR 834 Threatened	9/2/2005 70 FR 52488
Green sturgeon (*Acipenser medirostris*)	Southern DPS	4/7/2006 71 FR 17757 Threatened	4/7/2006 71 FR 17757 Threatened	10/9/2009 74 FR 52300

2.2.1 Sacramento River Winter-run Chinook Salmon

First listed as threatened (54 FR 32085; August 4, 1989)

Reclassified as endangered (59 FR 440; January 4, 1994); reaffirmed as endangered (70 FR 37160; June 28, 2005)

Designated critical habitat (58 FR 33212; June 16, 1993)

The federally listed ESU of Sacramento River winter-run Chinook salmon occur in the action area and may be affected by the proposed action. Designated critical habitat does not occur in the waterways contained within the action area for this ESU, as only the main stem of the Sacramento River was designated as critical habitat in the northern Delta, without designating any of the distributaries or sloughs that are also present and connected to the Sacramento River as critical habitat. Detailed information regarding ESU listing and critical habitat designation history, designated critical habitat, ESU life history, and viable salmonid population (VSP) parameters can be found in 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 (2014 Recovery Plan; NMFS 2014), and in the most recent 5-year status review for SR winter-run Chinook salmon (NMFS 2016a).

Historically, Sacramento River winter-run Chinook salmon population estimates were as high as 120,000 fish in the 1960s, but declined to less than 200 fish by the 1990s (CDFG 2005, NMFS 2011a). In recent years, since carcass surveys began in 2001, the highest adult escapement occurred in 2005 and 2006 with counts of 15,839 and 17,296 fish, respectively (CDFW 2018).

However, from 2007 to 2013, the population has shown a precipitous decline, averaging 2,486 returning adults during this period, with a low of 827 adults in 2011 (CDFW2018). This recent declining trend is likely due to a combination of factors such as poor ocean productivity (Lindley et al. 2009), drought conditions from 2007 to 2009 and again from 2012 to 2016, and low in-river survival rates (NMFS 2016a). In 2014 and 2015, the population was approximately 3,000 adults, slightly above the 2007 to 2012 average, but below the high (17,296) for the last 10 years (CDFW 2018). Since 2015, the adult escapement population has declined, dropping to 1,546 adults in 2016 and 975 adults in 2017 (CDFW 2018).

The year 2014 was the third year of a drought that increased water temperatures in the upper Sacramento River, and egg-to-fry survival to the Red Bluff Diversion Dam (RBDD) was approximately 5 percent (NMFS 2016a). Due to the anticipated lower than average survival in 2014, hatchery production from Livingston Stone National Fish Hatchery (LSNFH) was tripled (i.e., 612,056 juvenile hatchery winter-run Chinook salmon released) to offset the impact of the drought (CVP and SWP Drought Operations Plan and Operational Forecast 2014a). In 2014, hatchery production represented 83 percent of the total in-river juvenile production. In 2015, egg-to-fry survival was the lowest on record (approximately 4 percent) due to the inability to release cold water from Shasta Dam in the fourth year of a drought. As expected, winter-run Chinook salmon returns in 2016 were low (1,546 fish), as they showed the impact of the drought related warm water temperatures on fry survival from brood year (BY) 2013 (NMFS 2016a, Voss and Poytress 2017). Adult returns in water year 2017 from the BY 2014 juveniles were also low (975 fish) (CDFW 2018). In 2014, egg-to-fry survival was estimated to be 6 percent (Poytress 2016).

Although impacts from hatchery fish (i.e., reduced fitness, weaker genetics, smaller size, less ability to avoid predators) are often cited as having deleterious impacts on natural in-river populations (Matala et al. 2012), the winter-run Chinook salmon conservation program at LSNFH is strictly controlled by the USFWS to reduce such impacts. The average annual hatchery production at LSNFH is approximately 176,348 fish per year (2001 to 2010 average) compared to the estimated natural production that passes RBDD, which is 4.7 million per year based on the 2002 to 2010 average (Poytress and Carrillo 2011). Therefore, hatchery production typically represents approximately 3 to 4 percent of the total in-river juvenile winter-run production in any given year. However, the average over the last 12 years (about four generations) is 13 percent, with the most recent generation at 20 percent hatchery influence, making the population at a moderate risk of extinction based on VSP parameters (Lindley et al 2007).

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

The greatest risk factor for winter-run Chinook salmon lies within its spatial structure (Lindley et al 2007, NMFS 2011a, 2016a). The winter-run Chinook salmon ESU is comprised of only one population that spawns below Keswick Dam. The remnant and remaining population cannot access 95 percent of their historical spawning habitat and therefore must be artificially maintained in the Sacramento River tailwater section below Keswick Dam by spawning gravel augmentation, hatchery supplementation, and regulation of the finite cold water pool behind Shasta Dam to reduce water temperatures.

Since winter-run Chinook salmon spawn in the spring and summer, they require cold water temperatures in the summer that simulate their historical upper river basin habitats for the proper incubation of eggs and rearing of alevins and fry. They are more likely to be exposed to the impacts of drought in a lower elevation river basin environment where ambient air temperatures drive water temperatures above hospitable thermal levels for the incubation of eggs, and rearing of alevins, and fry. Battle Creek is currently the most feasible opportunity for the ESU to expand its spatial structure, but restoration is not scheduled to be completed until 2020. In 2018, juvenile hatchery winter-run from the captive brood stock program were released into Battle Creek to initiate the reintroduction program. The 2014 Recovery Plan includes criteria for recovering the winter-run Chinook salmon ESU, including re-establishing a population into historical habitats in Battle Creek as well as upstream of Shasta Dam (NMFS 2014).

Winter-run Chinook salmon embryonic and larval life stages that are most vulnerable to warmer water temperatures occur during the summer, which makes this ESU of Chinook salmon particularly at risk from climate warming. The only remaining population of winter-run Chinook salmon relies on the cold water pool in Shasta Reservoir to supply suitable incubation and rearing water temperatures in the tailwater stretch of the Sacramento River below Keswick Dam. This cold water pool buffers the effects of very warm summertime air temperatures (~90 – 110ºF) on the ambient tailwater river temperatures in most years. The exception occurs during drought years, which are predicted to occur more often with climate change (Yates et al. 2008). The long-term projection of how the CVP and SWP will operate incorporates the effects of climate change in three possible forms: less total precipitation; a shift to more precipitation in the form of rain rather than snow; or, earlier spring snow melt (Reclamation 2014b). Additionally, air temperature appears to be increasing at a greater rate than what was previously analyzed (Lindley et al 2009, Beechie et al. 2012, Dimacali 2013). These factors will compromise the quantity and/or quality of winter-run Chinook salmon habitat available downstream of Keswick Dam. It is imperative that additional populations of winter-run Chinook salmon be re-established into historical habitat in Battle Creek and above Shasta Dam for the long-term viability of the ESU (NMFS 2014).

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

There are several criteria that would qualify the winter-run Chinook salmon population at moderate risk of extinction (continued low abundance, a negative growth rate over two complete generations, significant rate of decline since 2006, increased hatchery influence on the population, and increased risk of catastrophe), and because there is still only one extant population that spawns below Keswick Dam (which is outside of its historical spawning region), the Sacramento River winter-run Chinook salmon ESU is at a high risk of extinction in the long term. The extinction risk for the winter-run Chinook salmon ESU has increased from moderate risk to high risk of extinction since 2005, and several listing factors have contributed to the recent decline, including drought, poor ocean conditions, and hatchery influence (NMFS 2016a). Thus, large-scale fish passage and habitat restoration actions are necessary for improving the winter-run Chinook salmon ESU viability (NMFS 2014, 2016a).

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

The critical habitat designation for Sacramento River winter-run Chinook salmon lists the PBFs (58 FR 33212, June 16, 1993), which are described in the 2014 Recovery Plan (NMFS 2014). This designation includes the following waterways, including the channel bottom and water column of the waterways, and adjacent riparian zones: the Sacramento River from Keswick Dam (river mile (RM) 302) to Chipps Island (RM 0) at the westward margin of the Delta; all waters from Chipps Island westward to the Carquinez Bridge, including Honker Bay, Grizzly Bay, Suisun Bay, and the Carquinez Strait; all waters of San Pablo Bay westward of the Carquinez Bridge; and all waters of San Francisco Bay north of the San Francisco-Oakland Bay Bridge from San Pablo Bay to the Golden Gate Bridge (58 FR 33212; June 16, 1993). NMFS clarified that “adjacent riparian zones” are limited to only those areas above a stream bank that provide cover and shade to the nearshore aquatic areas (58 FR 33212, June 16, 1993). Although the bypasses (e.g., Yolo, Sutter, and Colusa) are not currently designated critical habitat for winter-run Chinook salmon, NMFS recognizes that they may be utilized when inundated with Sacramento River flood flows and are important rearing habitats for juvenile winter-run. Furthermore, sloughs and secondary channels within the Delta that are not part of the main channel of the Sacramento River are considered rearing habitat for juvenile winter-run Chinook salmon although they are not designated as critical habitat. Finally, juvenile winter-run Chinook salmon may use tributaries of the Sacramento River for non-natal rearing (Maslin et al. 1997, Pacific States Marine Fisheries Commission 2014a, Phillis et al. 2018).

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

Currently, many of the PBFs of winter-run Chinook salmon critical habitat are degraded and provide limited high quality habitat. Factors that lessen the quality of migratory corridors for juveniles include unscreened diversions, altered flows in the Delta, and the lack of floodplain habitat. In addition, water operations that limit the extent of cold water below Shasta Dam have reduced the available spawning habitat (based on water temperature). Although the current conditions of winter-run Chinook salmon critical habitat are significantly degraded, the spawning habitat, migratory corridors, and rearing habitat that remain are considered to have high intrinsic value for the conservation of the species.

2.2.2 Central Valley Spring-run Chinook salmon

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

The Federally listed ESU of Central Valley (CV) spring-run Chinook salmon and designated critical habitat for this ESU occurs in the Action Area and may be affected by the proposed action. Detailed information regarding ESU listing and critical habitat designation history, designated critical habitat, ESU life history, and VSP parameters can be found in NMFS' 2014 Recovery Plan (NMFS 2014).

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

Monitoring of the Sacramento River mainstem during spring-run Chinook salmon spawning timing indicates some spawning occured in the river (CDFW 2018), but has been essentially non-existent since 2008/2009. Genetic introgression has likely occurred here due to lack of physical separation between spring-run and fall-run Chinook salmon populations (CDFG 1998). Sacramento River tributary populations in Mill, Deer, and Butte creeks are likely the best trend indicators for the CV spring-run Chinook salmon ESU. Generally, these streams have shown a positive escapement trend since 1991, displaying broad fluctuations in adult abundance (CDFW 2018). The Feather River Fish Hatchery (FRFH) spring-run Chinook salmon population represents an evolutionary legacy of populations that once spawned above Oroville Dam. The FRFH population is included in the ESU based on its genetic linkage to the natural spawning population, and the potential for development of a conservation strategy (June 28, 2005, 70 FR 37160).

The Central Valley Technical Review Team (TRT) estimated that historically there were 18 or 19 independent populations of CV spring-run Chinook salmon, along with a number of dependent populations, all within four distinct geographic regions, or diversity groups (Lindley *et al.* 2004). Of these populations, only three independent populations currently exist (Mill, Deer, and Butte creeks tributary to the upper Sacramento River) and they represent only the northern Sierra Nevada diversity group. Additionally, smaller populations are currently persisting in Antelope and Big Chico creeks, and the Feather and Yuba rivers in the northern Sierra Nevada diversity group (CDFG 1998). In the San Joaquin River basin, observations in the last decade suggest that spring-running populations may currently occur in the Stanislaus and Tuolumne rivers (Franks 2013).

The CV spring-run Chinook salmon ESU is comprised of two known genetic complexes. Analysis of natural and hatchery spring-run Chinook salmon stocks in the Central Valley indicates that the northern Sierra Nevada diversity group spring-run Chinook salmon populations in Mill, Deer, and Butte creeks retain genetic integrity as opposed to the genetic integrity of the Feather River population, which has been somewhat compromised by introgression with the fall-run ESU (Good *et al.* 2005, Garza *et al.* 2008, Cavallo *et al.* 2011).

Because the populations in Butte, Deer and Mill creeks are the best trend indicators for ESU viability, we can evaluate the risk of extinction based on VSP parameters in these watersheds. Over the long term, these three remaining populations are considered to be vulnerable to anthropomorphic and naturally occurring catastrophic events. The viability assessment of CV spring-run Chinook salmon conducted during NMFS' 2010 status review (NMFS 2011b), found that the biological status of the ESU had worsened since the last status review (2005) and recommended that the species status be reassessed in two to three years as opposed to waiting another five years, if the decreasing trend continued. In 2012 and 2013, most tributary populations increased in returning adults, averaging approximately 19,000 fish in-river (CDFW 2018). However, 2014 returns were lower again, just over 7,000 fish in -river, indicating the ESU population remains highly fluctuating. The most recent status review was conducted in 2015 (NMFS 2016b), which looked at promising increasing populations for the period between 2012-2014. However, the 2015 returning in-river adult fish escapement was extremely low (1,195 fish), with additional pre-spawn mortality reducing populations even more. Since the effects of the 2012-2015 drought have not been fully realized, we anticipate at least several more years of very low returns, which may result in severe rates of decline (NMFS 2016b). Adult escapements for in-river adult spring-run escapement is 6,453 fish for 2016, but only 1,105 fish for 2017 (CDFW 2018). These returns are substantially lower than the cohort returns three years earlier.

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).

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

In summary, the recent 5-year Status Review described the extinction risk for the CV spring-run Chinook salmon ESU as remaining at moderate risk of extinction (NMFS 2016b). Based on the severity of the drought and the low escapements as well as increased pre-spawn mortality in Butte, Mill, and Deer creeks in 2015, there is concern that these CV spring-run Chinook salmon strongholds will deteriorate into high extinction risk in the coming years based on the population size or rate of decline criteria (NMFS 2016b). This postulate is supported by the sharp declines in adult escapement for the years 2014 through 2017 for each cohort (CDFW 2018).

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

The critical habitat designation for CV spring-run Chinook salmon lists the PBFs (June 28, 2005, 70 FR 37160), which are described in NMFS' 2014 Recovery Plan (NMFS 2014). In summary, the PBFs include freshwater spawning sites, freshwater rearing sites, freshwater migration corridors, and estuarine habitat. The geographical range of designated critical habitat includes stream reaches of the Feather, Yuba, and American rivers, Big Chico, Butte, Deer, Mill, Battle, Antelope, and Clear creeks, and the Sacramento River, as well as portions of the northern Delta (June 28, 2005, 70 FR 37160). Waterways described in the northern Delta and lower Sacramento River include the action area.

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

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

2.2.3 California Central Valley Steelhead

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

The Federally listed DPS of CCV steelhead and designated critical habitat for this DPS occurs in the Action Area and may be affected by the proposed action. Detailed information regarding DPS listing and critical habitat designation history, designated critical habitat, DPS life history, and VSP parameters can be found in the NMFS' 2014 Recovery Plan (NMFS 2014).

Historic CCV steelhead run sizes are difficult to estimate given the paucity of data, but may have approached one to two million adults annually (McEwan 2001). By the early 1960s the CCV steelhead run size had declined to about 40,000 adults (McEwan 2001). Current abundance data for CCV steelhead is limited to returns to hatcheries and redd surveys conducted on a few rivers. The hatchery data is the most reliable because redd surveys for steelhead are often made difficult by high flows and turbid water usually present during the winter-spring spawning period.

Overall CCV steelhead returns to CNFH, which includes both wild and hatchery origin fish, have increased over the four-year period, 2011 to 2014. After hitting a low of only 790 fish in 2010, the last two years prior to the most recent 5-year review, 2013 and 2014, have averaged 2,895 fish. Wild adults counted at the hatchery each year represent a small fraction of overall returns, but their numbers have remained relatively steady, typically 200–300 fish each year. Numbers of wild adults returning each year have ranged from 252 to 610 from 2010 to 2014.

Redd counts are conducted in the American River and in Clear Creek (Shasta County). An average of 143 redds have been counted on the American River from 2002–2015 [data from Hannon *et al.* (2003), Hannon and Deason (2008), Chase (2010), Cramer Fish Sciences 2015, NMFS 2016c]. An average of 178 redds have been counted in Clear Creek from 2001 to 2015 following the removal of Saeltzer Dam, which allowed steelhead access to additional spawning habitat. The Clear Creek redd count data ranges from 100-1,023 and indicates an upward trend in abundance since 2006 (NMFS 2016c).

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

An estimated 100,000 to 300,000 naturally produced juvenile CCV steelhead are estimated to leave the Central Valley annually, based on rough calculations from sporadic catches in trawl gear (Good *et al.* 2005). Nobriga and Cadrett (2001) used the ratio of adipose fin-clipped (hatchery) to unclipped (wild) CCV steelhead smolt catch ratios in the USFWS Chipps Island trawl from 1998 through 2000 to estimate that about 400,000 to 700,000 CCV steelhead smolts are produced naturally each year in the Central Valley. Trawl data indicate that the level of natural production of CCV steelhead has remained very low since the 2011 status review (NMFS

2016c), suggesting a decline in natural production based on consistent hatchery releases. Catches of CCV steelhead at the fish collection facilities in the southern Delta are another source of information on the production of wild CCV steelhead relative to hatchery CCV steelhead (CDFW data: ftp.delta.dfg.ca.gov/salvage). The overall catch of CCV steelhead has declined dramatically since the early 2000s, with an overall average of 2,705 in the last 10 years. The percentage of wild (unclipped) fish in salvage has fluctuated, but has leveled off to an average of 36 percent since a high of 93 percent in 1999. In 2018 (as of 5/22/18), the total number of unclipped steelhead observed in salvage is 1,037. The number of clipped steelhead observed in salvage is728 fish, which may indicate that 2017 (a wet year) had a strong year class for wild steelhead production.

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

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

CCV steelhead will experience similar effects of climate change as do Chinook salmon in the Central Valley, as they are also blocked from the vast majority of their historic spawning and rearing habitat. The effects may be even greater in some cases, as juvenile steelhead need to rear in their natal 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.

2.2.3.1 Summary of California Central Valley Steelhead DPS viability

All indications are that natural CCV steelhead have continued to decrease in abundance and in the proportion of natural fish over the past 25 years (NMFS 2016c); the long-term trend remains negative. Hatchery production and returns are the dominant components of the Central Valley population structure. Most wild CCV populations are very small and may lack the resiliency to persist for protracted periods if subjected to additional stressors, particularly widespread stressors such as climate change. The genetic diversity of CCV steelhead has likely been impacted by low population sizes and high numbers of hatchery fish relative to wild fish.

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

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

The critical habitat designation for CCV steelhead lists the PBFs (June 28, 2005, 70 FR 37160), which are described in NMFS' 2014 Recovery Plan (NMFS 2014). In summary, the PBFs include freshwater spawning sites; freshwater rearing sites; freshwater migration corridors; and estuarine areas. The geographical extent of designated critical habitat includes: the Sacramento, Feather, and Yuba rivers, and Deer, Mill, Battle and Antelope creeks in the Sacramento River basin; the San Joaquin River, including its tributaries but excluding the mainstem San Joaquin River above the Merced River confluence; and the waterways of the Delta.

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

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

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

2.2.4 Southern Distinct Population Segment (sDPS) of North American Green Sturgeon

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

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

Green sturgeon are known to range from Baja California to the Bering Sea along the North American continental shelf. During late summer and early fall, subadults and non-spawning adult green sturgeon can frequently be found aggregating in estuaries along the Pacific coast (Emmett *et al.* 1991, Moser and Lindley 2006). Using polyploid microsatellite data, Israel *et al.* (2009) found that green sturgeon within the Central Valley of California belong to the sDPS. Additionally, acoustic tagging studies have found that green sturgeon found spawning within the Sacramento River are exclusively sDPS green sturgeon (Lindley *et al.* 2011). In waters inland from the Golden Gate Bridge in California, sDPS green sturgeon are known to range through the estuary and the Delta and up the Sacramento, Feather, and Yuba rivers (Israel *et al*. 2009, Bergman *et al.* 2011, Seesholtz *et al.* 2014). It is unlikely that green sturgeon utilize areas of the San Joaquin River upriver of the Delta with regularity, and spawning events are thought to be limited to the upper Sacramento River and its tributaries. There is no known modern usage of the San Joaquin River upstream of the Delta by green sturgeon, and adult spawning has not been documented there (Jackson and Van Eenennaam 2013). However, a confirmed sighting of a green sturgeon based on visual observation, video documentation and positive eDNA samples occurred in the fall of 2017 on the Stanislaus River (FishBio 2017). This sighting helps to corroborate reports of green sturgeon being caught by anglers on the San Joaquin River upstream of the Delta on the CDFW's sturgeon report cards which are required for the sport fishing of sturgeon in California (Gleason et al 2008, DuBois et al 2009, DuBois 2010, Dubois et al 2011, DuBois 2012, DuBois 2013, DuBois 2014, DuBois and Harris 2015, DuBois and Harris 2016, DuBois and Danos 2017, and DuBois and Danos 2018)

Recent research indicates that the sDPS is composed of a single, independent population, which principally spawns in the mainstem Sacramento River and also breeds opportunistically in the Feather River and possibly even the Yuba River (Bergman *et al.* 2011, Seesholtz *et al.* 2014).

Concentration of adults into a very few select spawning locations makes the species highly vulnerable to poaching and catastrophic events. The apparent, but unconfirmed, extirpation of spawning populations from the San Joaquin River narrows the available habitat within their range, offering fewer habitat alternatives. Whether sDPS green sturgeon display diverse phenotypic traits such as ocean behavior, age at maturity, and fecundity, or if there is sufficient diversity to buffer against long-term extinction risk is not well understood. It is likely that the diversity of sDPS green sturgeon is low, given recent abundance estimates (NMFS 2015).

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

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

The parameters of green sturgeon population growth rate and carrying capacity in the Sacramento Basin are poorly understood. Larval count data shows enormous variance among sampling years. In general, sDPS green sturgeon year class strength appears to be highly variable with overall abundance dependent upon a few successful spawning individuals (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.

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

2.2.4.1 Summary of Green Sturgeon sDPS viability

The viability of sDPS green sturgeon is constrained by factors such as a small population size, lack of multiple populations, and concentration of spawning sites into just a few locations. The risk of extinction is believed to be moderate (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 2010b). Lindley *et al.* (2007), in discussing Sacramento River winter-run Chinook salmon, states that an ESU (or DPS) represented by a single population at moderate risk of extinction is at high risk of extinction over a large timescale; this would apply to the sDPS for green sturgeon. The most recent 5-year status review for sDPS green sturgeon found that some threats to the species have recently been eliminated, such as take from commercial fisheries and removal of some passage barriers (NMFS 2015). Since many of the threats cited in the original listing still exist, the threatened status of the DPS is still applicable (NMFS 2015).

2.2.4.2 Critical Habitat and Physical or Biological Features for sDPS Green Sturgeon

The critical habitat designation for sDPS green sturgeon lists the PBFs (October 9, 2009, 74 FR 52300), which are described on the NOAA Fisheries West Coast Region's green sturgeon page. In summary, the PBFs include the following for both freshwater riverine systems and estuarine habitats: food resources, water flow, water quality, migratory corridor, depth, and sediment quality. Additionally, for riverine systems, the designation includes substrate type or size. 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,
- Feather River from its confluence with the Sacramento River upstream to Fish Barrier Dam,
- Yuba River from its confluence with the Feather River upstream to Daguerre Point Dam, and,
- the Sacramento-San Joaquin Delta (as defined by California Water Code section 12220, except for listed excluded areas).

In coastal bays and estuaries, the geographical range includes:

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

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

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

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

2.2.5 Global Climate Change

One factor affecting the range-wide status of CCV steelhead, Sacramento River winter-run Chinook salmon, CV spring-run Chinook salmon, and the Southern DPS of the North American green sturgeon, and aquatic habitat at large is climate change.

The world is about 1.3°F warmer today than a century ago and the latest computer models predict that, without drastic cutbacks in emissions of carbon dioxide and other gases released by the burning of fossil fuels, the average global surface temperature may rise by two or more degrees in the 21st century (IPCC 2001, 2007). Much of that increase likely will occur in the oceans, and evidence suggests that the most dramatic changes in ocean temperature are now occurring in the Pacific (Noakes *et al.* 1998). Using objectively analyzed data Huang and Liu (2001) estimated a warming of about 0.9°F per century in the Northern Pacific Ocean.

Sea levels are expected to rise by 0.5 to 1.0 meters in the northeastern Pacific coasts in the next century, mainly due to warmer ocean temperatures, which lead to thermal expansion much the same way that hot air expands. This will cause increased sedimentation, erosion, coastal flooding, and permanent inundation of low-lying natural ecosystems (*e.g.*, salt marsh, riverine, mud flats) affecting listed salmonid and green sturgeon PBFs. Increased winter precipitation, decreased snow pack, permafrost degradation, and glacier retreat due to warmer temperatures will cause landslides in unstable mountainous regions and destroy fish and wildlife habitat, including salmon-spawning streams. Glacier reduction could affect the flow and temperature of rivers and streams that depend on glacier water, with negative impacts on fish populations and the habitat that supports them.

Summer droughts along the West Coast and in the interior Central Valley of California will mean decreased stream flow in those areas, decreasing salmonid survival and reducing water supplies in the dry summer season when irrigation and domestic water use are greatest. Global warming may also change the chemical composition of the water that fish inhabit: the amount of oxygen in the water may decline, while pollution, acidity, and salinity levels may increase. This will allow for more invasive species to overtake native fish species and impact predator-prey relationships (Petersen and Kitchell 2001, Stachowicz *et al.* 2002).

In light of the predicted impacts of global warming, the Central Valley has been modeled to have an increase of between 2 and 7 degrees Celsius by 2100, with a drier hydrology predominated by rainfall rather than snowfall (Dettinger 2004, Hayhoe *et al.* 2004, VanRheenen 2004, Stewart *et al.* 2005). This will alter river runoff patterns and transform the tributaries that feed the Central Valley from a spring and summer snowmelt dominated system to a winter rain dominated system. It can be hypothesized that summer temperatures and flow levels will become unsuitable for salmonid survival. The cold snowmelt that furnishes the late spring and early summer runoff will be replaced by warmer precipitation runoff. This will truncate the period of time that suitable cold-water conditions exist downstream of existing reservoirs and dams due to the warmer inflow temperatures to the reservoir from rain runoff. Without the necessary cold water pool developed from melting snow pack filling reservoirs in the spring and early summer, late summer and fall temperatures downstream of reservoirs, such as Lake Shasta, could potentially rise above thermal tolerances for juvenile and adult salmonids that must hold and/or rear downstream of the dam over the summer and fall periods.

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 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. Specific climate change impacts have already been described in the rangewide status of the species and critical habitat sections for each species (Sections 2.2.1 through 2.2.4).

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 Project will occur on levees bordering waterways of the northern Delta at 9 different locations (Figure 1). Four locations of levee repairs will occur on Elk Slough. These are sites 31, 32, 33, and 34. An additional repair site is located on Steamboat Slough, near its junction with the Sacramento River (site 37). Two more sites are located on Shag Slough (sites 38 and 39). The final two sites are located on Cache Slough (site 35) and on Lindsey Slough (site 36). The latitude and longitude coordinates for each site are given in Table 1 and the physical dimensions of the construction footprint for each repair site are given in Table 2.

For projects with in-water construction activities, such as excavating key trenches at the toe of the levee bank and the installation of launch rock and riprap, the "downstream" extent of the action area is defined by the distance of potential increased turbidity and sediment deposition related to the Project's construction actions and ambient currents. Based on turbidity measurements taken during construction actions for similar bank stabilization projects performed by the Corps, turbidity impacts for the repair are likely to occur up to 100 feet from the shoreline and up to 400 feet downstream of any in-water construction activities due to river currents. However, since these rehabilitation sites are in areas affected by tidal flows, the potential ambient flow in the sloughs may also go upstream on a flood tide. Therefore, the zone of turbidity effects will also extend 400 feet upstream of the rehabilitation sites to account for tidal flow conditions. The total linear lengths of affected river channel for each site are given below:

- Site 31: 905 feet
- Site 32: 945 feet
- Site 33: 930 feet
- Site 34: 938 feet
- Site 35: 881 feet
- Site 36: 900 feet
- Site 37: 990 feet
- Site 38: 1180 feet
- Site 39: 1727 feet

DWR has purchased mitigation credits for the Project's impacts at the Liberty Island Conservation Bank, a 147.91 acre flooded island with riparian and Tule marsh habitat located at the downstream end of the Yolo Bypass adjacent to the Sacramento Deep Water Ship Channel, Cache Slough, and Prospect Slough. The action area will include the 147.91 acre area of the Liberty Island Conservation Bank located at the downstream end of the Yolo Bypass where a total of 2.32 acres of conservation credits have been purchased by DWR as part of the Project's mitigation of impacts. The conservation credits include 0.070 acres of salmonid preservation credits (species/habitat) and 1,957 linear feet of Group: Riparian SRA/ salmonid preservation credits (equivalent to 2.250 credits).

2.4 Environmental Baseline

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

2.4.1 Local and Regional Characteristics

The Project is located in the northern portion of the Sacramento-San Joaquin Delta, between the Sacramento River to the east, and the Cache Slough/ Lindsey Slough complex to the west (Figure 1), with sites distributed along several of the waterways that traverse the region. This predominately freshwater habitat provides critical habitat for CV spring-run Chinook salmon, CCV steelhead, and sDPS green sturgeon. All of the water bodies are tidally influenced, although reversal of flow may not occur in portions of Steamboat, Elk, and Sutter sloughs when Sacramento River flows are elevated. This typically occurs during winter high-flow events on the Sacramento River. Changes in water surface elevations due to tidal variation occurs in all of the waterways that contain rehabilitation sites.

The land within the action area consist primarily of irrigated fields and orchards traversed by irrigation canals and drainage ditches. These canals and ditches seasonally provide water from the Delta via pumps or siphons to the adjoining fields and then provide drainage back to the Delta, using pumps to move water over the levees to the adjoining sloughs. Most of these fields and orchards are at or below sea level in elevation due to subsidence, and are protected by a network of raised levees to protect them from flooding from the adjacent waterways. The water level in these channels can be upwards of 10-12 feet above the elevation of the fields under normal conditions, and can be considerably more during high flow events on the Sacramento River. These existing levees were initially built in the late 1800s and are maintained for agricultural purposes by local Reclamation Districts, but are also part of the Federal Flood Control Project authorized by Congress in 1917, and completed in 1960 by the Corps.

2.4.1.1 Water Development

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

Water withdrawals, for agricultural and municipal purposes have reduced river flows and increased temperatures during the critical summer months, and in some cases, have been of a sufficient magnitude to result in reverse flows in the lower San Joaquin River (Reynolds *et al*. 1993). Direct relationships exist between water temperature, water flow, and juvenile salmonid survival (Brandes and McLain 2001). Elevated water temperatures in the Sacramento River have limited the survival of young salmon in those waters. Juvenile fall-run survival in the Sacramento River is also directly related with June streamflow and June and July Delta outflow (Dettman *et al*. 1987).

Water diversions for irrigated agriculture, municipal and industrial use, and managed wetlands are found throughout the Central Valley. Thousands of small and medium-size water diversions exist along the Sacramento River, San Joaquin River, and their tributaries as well as in the maze of Delta waterways surrounding the intensively farmed islands within the legal Delta boundaries. Although efforts have been made in recent years to screen some of these diversions, many remain unscreened. Depending on the size, location, and season of operation, these unscreened diversions entrain and kill many life stages of aquatic species, including juvenile salmonids and green sturgeon. For example, as of 1997, 98.5 percent of the 3,356 diversions included in a Central Valley database were either unscreened or screened insufficiently to prevent fish entrainment (Herren and Kawasaki 2001).

2.4.1.2 Water Conveyance and Flood Control

The development of the water conveyance system in the Delta has resulted in the construction of more than 1,100 miles of armored levees to increase channel flood capacity elevations and flow capacity of the channels (Mount 1995). Levee development in the Central Valley affects spawning habitat, freshwater rearing habitat, freshwater migration corridors, and freshwater riverine and estuarine habitat PBFs. As Mount (1995) indicates, there is an "underlying, fundamental conflict inherent in this channelization." Natural rivers strive to achieve dynamic equilibrium to handle a watershed's supply of discharge and sediment (Mount 1995). The construction of levees disrupts the natural processes of the river, resulting in a multitude of habitat-related effects; including isolation of the watershed's natural floodplain behind the levee from the active river channel and its fluctuating hydrology.

Many of these levees use angular rock (riprap) to armor the bank from erosive forces. The effects of channelization, and riprapping, include the alteration of river hydraulics and riparian vegetative cover along the bank as a result of changes in bank configuration and structural features (Stillwater Sciences 2006). These changes affect the quantity and quality of nearshore habitat for juvenile salmonids and have been thoroughly studied (USFWS 2000, Schmetterling et al. 2001, Garland et al. 2002). Simple slopes protected with rock revetment generally create nearshore hydraulic conditions characterized by greater depths and faster, more homogeneous water velocities than occur along natural banks. Higher water velocities typically inhibit deposition and retention of sediment and woody debris. These changes generally reduce the range of habitat conditions typically found along natural shorelines, especially by eliminating the shallow, slow-velocity river margins used by juvenile fish as refuge and escape from fast currents, deep water, and predators (Stillwater Sciences 2006).

2.4.1.3 Land Use Activities

Since the 1850s, wetlands reclamation for urban and agricultural development has caused the cumulative loss of 79 and 94 percent of the tidal marsh habitat in the Delta downstream and upstream of Chipps Island, respectively (Conomos *et al.* 1985, Nichols *et al.* 1986, Wright and Phillips 1988, Goals Project 1999). Prior to 1850, approximately 1400 km^2 of freshwater marsh surrounded the confluence of the Sacramento and San Joaquin Rivers, and another 800 km^2 of saltwater marsh fringed San Francisco Bay's margins. Of the original 2,200 km^2 of tidally influenced marsh, only about 125 km^2 of undiked marsh remains today. Even more extensive losses of wetland marshes occurred in the Sacramento and San Joaquin River basins. Little of the extensive tracts of wetland marshes that existed prior to 1850 along the valley's river systems and within the natural flood basins exist today. Most has been "reclaimed" for agricultural purposes, leaving only small remnant patches. Engineered levees have isolated the rivers from their natural floodplains and have resulted in the loss of their ecological functions.

Dredging of river channels to enhance inland maritime trade and to provide raw material for levee construction has significantly and detrimentally altered the natural hydrology and function of the river systems in the Central Valley. Starting in the mid-1800s, the Corps and other private consortiums began straightening river channels and artificially deepening them to enhance shipping commerce. This has led to declines in the natural meandering of river channels and the formation of pool and bar segments. The deepening of channels beyond their natural depth also has led to a significant alteration in the transport of bedload in the riverine system as well as the local flow velocity in the channel (Mount 1995). The Sacramento Flood Control Project at the turn of the nineteenth century ushered in the start of large scale Corps actions in the Delta and along the rivers of California for reclamation and flood control. The creation of levees and the deep shipping channels reduced the natural tendency of the San Joaquin and Sacramento rivers to create floodplains along their banks with seasonal inundations during the wet winter season and the spring snow melt periods. These annual inundations provided necessary habitat for rearing and foraging of juvenile native fish that evolved with this flooding process. The armored riprapped levee banks and active maintenance actions of Reclamation Districts precluded the establishment of ecologically important riparian vegetation, introduction of valuable LWD/ IWM from these riparian corridors, and the productive intertidal mudflats characteristic of the undisturbed Delta habitat.

Urban stormwater and agricultural runoff may be contaminated with pesticides, oil, grease, heavy metals, PAHs, and other organics and nutrients (Regional Board 1998), which can destroy aquatic life necessary for salmonid survival (NMFS 1996a, b) and are also expected to negatively impact the different green sturgeon life stages also present. Point source (PS) and non-point source (NPS) pollution occurs at almost every point that urbanization activity influences the watershed. Impervious surfaces (*i.e.*, concrete, asphalt, and buildings) reduce water infiltration and increase runoff, thus creating greater flood hazard (NMFS 1996a, b). Flood control and land drainage schemes may increase the flood risk downstream by concentrating runoff. A flashy discharge pattern results in increased bank erosion with subsequent loss of riparian vegetation, undercut banks and stream channel widening. In addition to the PS and NPS inputs from urban runoff, juvenile salmonids and green sturgeon are exposed to increased water temperatures as a result of thermal inputs from municipal, industrial, and agricultural discharges.

2.4.1.4 Water Quality

The water quality of the Delta has been negatively impacted over the last 150 years. Increased water temperatures, decreased DO levels, and increased turbidity and contaminant loads have degraded the quality of the aquatic habitat for the rearing and migration of salmonids and sDPS green sturgeon. Some common pollutants include effluent from wastewater treatment plants and chemical discharges such as dioxin from San Francisco Bay petroleum refineries (McEwan and Jackson 1996). In addition, agricultural drain water, another possible source of contaminants, can contribute up to 30 percent of the total inflow into the Sacramento River during the low-flow period of a dry year. The Regional Board, in its 1998 Clean Water Act §303(d) list characterized the Delta as an impaired waterbody having elevated levels of chlorpyrifos, dichlorodiphenyltrichlor (*i.e.* DDT), diazinon, electrical conductivity, Group A pesticides [aldrin, dieldrin, chlordane, endrin, heptachlor, heptachlor epoxide, hexachlorocyclohexanes (including lindane), endosulfan and toxaphene], mercury, low DO, organic enrichment, and unknown toxicities (Regional Board 1998, 2001, 2010).

In general, water degradation or contamination can lead to either acute toxicity, resulting in death when concentrations are sufficiently elevated, or more typically, when concentrations are lower, to chronic or sublethal effects that reduce the physical health of the organism, and lessens its survival over an extended period of time. Mortality may become a secondary effect due to compromised physiology or behavioral changes that lessen the organism's ability to carry out its normal activities. For example, increased levels of heavy metals are detrimental to the health of an organism because they interfere with metabolic functions by inhibiting key enzyme activity in metabolic pathways, decrease neurological function, degrade cardiovascular output, and act as mutagens, teratogens or carcinogens in exposed organisms (Rand *et al*. 1995, Goyer 1996). For listed species, these effects may occur directly to the listed fish or to its prey base, which reduces the forage base available to the listed species.

In the aquatic environment, most anthropogenic chemicals and waste materials, including toxic organic and inorganic chemicals eventually accumulate in sediment (Ingersoll 1995). Direct exposure to contaminated sediments may cause deleterious effects to listed salmonids and green sturgeon. This may occur if a fish swims through a plume of the resuspended sediments or rests on contaminated substrate and absorbs the toxic compounds through one of several routes: dermal contact, ingestion, or uptake across the gills. Elevated contaminant levels may be found in localized “hot spots” where discharge occurs or where river currents deposit sediment loads. Sediment contaminant levels can thus be significantly higher than the overlying water column concentrations (U.S. Environmental Protection Agency [USEPA] 1994). However, the more likely route of exposure to salmonids or green sturgeon is through the food chain, when the fish feed on organisms that are contaminated with toxic compounds. Prey species become contaminated either by feeding on the detritus associated with the sediments or dwelling in the sediment itself. Therefore, the degree of exposure to the salmonids and green sturgeon depends on their trophic level and the amount of contaminated forage base they consume. Response of salmonids and green sturgeon to contaminated sediments is similar to water borne exposures once the contaminant has entered the body of the fish.

2.4.1.5 Hydrology in the Delta

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

Prior to the construction of dams on the tributaries surrounding the Central Valley, parts of the valley floor hydrologically functioned as a series of natural reservoirs seasonally filling and draining every year with the cycles of rainfall and snow melt in the surrounding watersheds. These reservoirs delayed and muted the transmission of floodwaters traveling down the length of the Sacramento and San Joaquin rivers. Historically, there were at least six distinct flood basins in the Sacramento Valley. These extensive flood basins created excellent shallow water habitat for fish such as juvenile Chinook salmon, steelhead, and sturgeon to grow and rear before moving downstream into the Delta (The Bay Institute 1998). The magnitude of the seasonal flood pulses were reduced before entering the Delta, but the duration of the elevated flows into the Delta were prolonged for several months, thereby providing extended rearing opportunities for emigrating Chinook salmon, steelhead, and green sturgeon to grow larger and acquire additional nutritional energy stores before entering the main Delta and upper estuarine reaches.

Prior to the construction of dams, there were distinct differences in the natural seasonal flow patterns between the northern Sacramento River watershed and the southern San Joaquin River watershed. Furthermore, the natural unimpaired runoff in the Central Valley watersheds historically showed substantial seasonal and inter-annual variability. Watersheds below 5,000 feet in elevation followed a hydrograph dominated by rainfall events with peak flows occurring in late fall or early winter (northern Sierra Nevada, Cascade Range, and most of the western coastal mountains). Conversely, those watersheds with catchment areas above 5,000 feet, such as the Central and Southern Sierras, had hydrographs dominated by the spring snowmelt runoff period and had their highest flows in the late spring/early summer period. Summertime flows on the valley floor were considerably reduced after the seasonal rain and snowmelt pulses were finished (Figure 2), with base flows supported by the stored groundwater in the surrounding alluvial plains (The Bay Institute 1998). Since the construction of the more than 600 dams in the mountains surrounding the Central Valley, the variability in seasonal and inter-annual runoff has been substantially reduced and the peak flows muted, except in exceptional runoff years. Currently, average winter/spring flows are typically reduced compared to natural conditions, while summer/fall flows have been artificially increased by reservoir releases. Wintertime releases are coordinated for preserving flood control space in the valley's large terminal storage dams, and typically do not reach the levels necessary for bed load transport and reshaping of the river channels below the dams. Summertime flows have been scheduled for meeting water quality goals and consumptive water demands downstream (Figures 3 and 4). Mean outflow from the Sacramento River during the later portion of the 19th century has been reduced from nearly 50 percent of the annual discharge occurring in the period between April and June to only about 20 percent of the total mean annual outflow under current dam operations (The Bay Institute 1998). Currently, the highest mean flows occur in January, February, and March. The San Joaquin River has seen its snowmelt flood peak essentially eliminated, and the total discharge to the valley floor portion of the mainstem greatly reduced during the spring. Only in very wet years is there any marked late spring outflow peak (The Bay Institute 1998).

These changes in the hydrographs of the two main river systems in the Central Valley are also reflected in the inflow and outflow of water to the Delta. The operations of the dams and water transfer operations of the CVP and SWP have reduced the winter and spring flows into the Delta, while artificially maintaining elevated flows in the summer and late fall periods. The Delta has thus become a conveyance apparatus to move water from the Sacramento side of the Delta to the southwestern corner of the Delta where the CVP and SWP pumping facilities are located. Releases of water to the Delta during the normally low flow summer period have had several impacts on Delta ecology and hydrology. Since the projects started transferring water through the Delta, the normal variability in the hydrology of the Delta has diminished. Annual incursions of saline water into the Delta still occur each summer, but have been substantially muted compared to their historical levels by the release of summer water from the reservoirs (Herbold and Moyle 1989, Figures 5 and 6). The Delta has become a stable freshwater body, which is more suitable for introduced and invasive exotic freshwater species of fish, plants, and invertebrates than for the native organisms that evolved in a fluctuating and "unstable" Delta environment.

Furthermore, Delta outflow has been reduced by approximately 14 percent from the pre-dam period (1921-1943) when compared to the modern state and federal water project operations period (1968-1994). When differences in the hydrologic year types are accounted for and the "wet" years are excluded, the comparison between similar year types indicates that outflow has been reduced by 30 to 60 percent (The Bay Institute 1998), with most of this "lost" water going to exports. Currently, the Sacramento River contributes roughly 75-80% of the Delta inflow in most years and the San Joaquin River contributes about 10-15%; the Mokelumne, Cosumnes, and Calaveras rivers, which enter into the eastern side of the Delta, contribute the remainder. The sum of the river contributions flow through the Delta and into Suisun Bay, San Pablo Bay, San Francisco Bay, and eventually empties into the Pacific Ocean. Historical annual Delta inflow between 1945 and 1995 (*i.e.*, the period of modern dam operations) averaged approximately 23 million acre-feet (MAF), with a minimum inflow of approximately 6 MAF in 1977 and a maximum of approximately 70 MAF in 1983 (Corps 2015).

Water movement in the Delta responds to four primary forcing mechanisms: (1) freshwater inflows draining to the ocean; (2) Delta exports and diversions; (3) operation of water control facilities such as dams, export pumps, and flow barriers; and (4) the regular tidal movement of seawater into and out of the Delta. In addition, winds and salinity behavior within the Delta can generate a number of secondary currents that, although of low velocity, can be of considerable significance with respect to transporting contaminants and mixing different sources of water. Changes in flow patterns within the Delta, whether caused by export pumping, winds, atmospheric pressure, flow barriers, tidal variations, inflows, or local diversions, can influence water quality at drinking water intakes (Corps 2015).

2.4.1.6 Mitigation Banks and the Environmental Baseline

The action area of the Project is regionally proximal to one of the conservation banks approved by NMFS, which includes the Delta as its service area and has available credits for purchase:

Liberty Island Native Fisheries Conservation Bank: Established in 2010, the Liberty Island Conservation Bank (Bank) is a conservation bank that serves the Delta region. It is located in the southern Yolo Bypass in Yolo County, CA. The Bank consists of 186 acres located on the still leveed northernmost tip of Liberty Island. Approved in July 2010 by the NMFS, USFWS, and CDFW, the Bank provides compensatory mitigation for permitted projects affecting special-status Delta fish species within the region. The Bank provides habitat for all Delta fish species including: Sacramento River winter-run Chinook salmon; Central Valley spring-run Chinook salmon, California Central Valley Steelhead, delta smelt, and Central Valley fall- and late fall-run Chinook salmon. Of the 186 total acres, 139.11 acres can be used for salmonid conservation credits. Of the 139.11 acres available for salmonids, 66.141 acres have been allocated (but not including the 2.32 acres purchased for this Project). The habitat includes tidally influenced shallow freshwater habitat, shaded riparian aquatic (SRA) habitat and Tule Marsh SRA habitat. The increased ecological value of the enhanced rearing habitat for juvenile salmonids (and potentially sDPS green sturgeon) which have already been purchased are part of the environmental baseline for the Project. All features of the bank are designated as critical habitat for CV spring-run Chinook salmon, CCV steelhead, and sDPS green sturgeon.

2.4.1.7 NMFS Salmon and Steelhead Recovery Plan Action Recommendations

The NMFS Recovery Plan that includes Sacramento River winter-run Chinook salmon, CV Spring-run Chinook salmon and CCV steelhead (NMFS 2014) identifies recovery goals for the Sacramento River basin populations that utilize the waterways of the Delta for aspects of their life history. These waterways includes the proposed action area for the Project. Recovery efforts focus on addressing several key stressors that are vital to Sacramento River winter-run Chinook salmon, CV spring-run Chinook salmon, and CCV steelhead: (1) Altered natural riverine flows entering the Delta from the Sacramento and San Joaquin River basins affecting adult and juvenile migration and holding; (2) Altered hydrodynamics due to operations of the CVP and SWP export facilities affecting migratory cues of migrating juveniles; (3) Altered riparian and marsh habitats due to levee construction and marshland reclamation efforts; and (4) Increased exposure to non-native predation within the waterways of the Delta.

2.4.1.7.1 Specific Key Stressors in the Delta described in the Recovery Plan

A. Altered hydrographs of the Sacramento and San Joaquin rivers entering the Delta due to upstream operations of reservoirs that does not represent the historic natural unimpaired inflow pattern used by fish for attraction and migratory behavioral cues.
B. Altered hydrodynamics in the central and southern Delta due to the operations of the SWP and CVP export facilities.

C. Loss of natural ecological function in the majority of the Delta landscape due to human activities.
D. Limited quantity and quality of rearing and migratory habitat due to human actions related to levee construction.
E. Loss of extensive marshland habitat in both fresh and saltwater habitats used for rearing and holding of migrating salmonids due to human activities.
F. Unscreened or poorly screened agricultural diversions.
G. Increased predation risks to juvenile salmonids from non-native predators.
H. Restoration and/or creation of floodplain habitat for juvenile salmonids entering or rearing in the Delta.

Recovery actions identified in the Recovery Plan for the Delta that are relevant to this consultation include: landscape level restoration of ecological functions within the Delta waterways, creation of tidal marshland habitat, restoration of floodplain habitat, and restoration of Liberty Island, Cache Slough and the lower Yolo Bypass floodplains, which are the subjects of the restoration actions currently being implemented in the North Delta region in concert with the Recovery Plan.

2.4.2 Status of the Species and Critical Habitat in the Action Area

2.4.2.1 Status of the Species within the Action Area

The action area functions primarily as a migratory corridor for Sacramento River winter-run Chinook salmon, Central Valley spring-run Chinook salmon, California Central Valley steelhead, and the sDPS of North American green sturgeon, but it also provides some use as holding and rearing habitat for each of these species as well. Juvenile salmonids may use the area for rearing for several months during the winter and spring before migrating to the marine environment. Green sturgeon use the area for rearing and migration year-round. Generally, as flows increase in the fall and through the winter, adult salmon, CCV steelhead, and sDPS green sturgeon migrate upstream through the Sacramento and San Joaquin rivers and juveniles migrate downstream in the winter and spring. Adult winter-run typically migrate through the estuary/Delta between November and June with the peak occurring in March (Table 5). Adult CV spring-run migrate through the Delta between January and June (Table 6). Adult CCV steelhead migration typically begins in August, with a peak in September and October, and extends through the winter to as late as May (Table 7). Adult green sturgeon start to migrate upstream to spawning reaches in February and their migrations can extend into July (Table 8), but may also be found holding in waters of the Sacramento River basin and Delta year-round.

2.4.2.1.1 Sacramento River Winter-run Chinook salmon

Adult winter-run are expected to be in the action area from November through June with a peak presence from February to April (Table 5) as they migrate upstream to spawn in the upper Sacramento River. Since the action area is a transition zone between tidal and riverine sections of the Sacramento River, adult salmon sometimes wander through the Delta searching for specific scents that lead them to their natal spawning area. Winter-run adults have been known to stray into the Sacramento Ship Channel (SSC) and around the Delta islands and sloughs as they make their way through the maze of channels leading to the mainstem Sacramento River upstream of the Delta, including the Yolo Bypass when inundated.

For juvenile winter-run, a review of fish monitoring data from 2000–2016 from the Chipps Island trawl and the Sacramento River trawl (Sherwood Harbor) showed very low numbers present from July through October during the in-water work window (USFWS 2013, 2015, 2017; USFWS DFJMP data 2000-2016, University of Washington Columbia Basin Research, 2018)(Figures 7 and 8). Juvenile winter-run occur in the Delta primarily from November through early May with a peak occurrence in March, using length-at-date criteria from trawl data in the Sacramento River near Sherwood Harbor (USFWS 2013, 2015, 2017)(Table 5).

Table 5. Temporal occurrence of winter-run Chinook salmon in the Delta with darker shades indicating months of high presence and lighter shades indicating months of low presence.

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Adult WR[1]	MED	HIGH	HIGH	HIGH	MED	MED	NONE	NONE	NONE	NONE	MED	MED
Juvenile WR[2]	LOW	MED	HIGH	MED	NONE	NONE	NONE	NONE	NONE	LOW	LOW	MED
Salvaged WR[3]	MED	HIGH	HIGH	LOW	LOW	LOW	NONE	NONE	NONE	NONE	NONE	LOW

HIGH MED LOW NONE

[1]Adults enter the Bay November to June (Hallock and Fisher 1985) and are in spawning ground at a peak time of June to July (Vogel and Marine 1991).
[2]Juvenile presence in the Delta was determined using DJFMP data.
[3]Months in which salvage of wild juvenile winter-run at State and Federal pumping plants occurred (NMFS 2016d).

2.4.2.1.2 CV Spring-run Chinook salmon

Adult CV spring-run are expected to be migrating upstream through the action area from January to June with a peak presence from February to April (Table 6). Like adult winter-run Chinook salmon, adult CV spring-run could stray into the SSC or the network of sloughs and waterways surrounding the northern Delta islands in the action area during their upstream migration.

Juvenile CV spring-run are present in the action area as they migrate to the ocean in the spring. Juvenile spring-run are expected to be present in the action area from December through May with a peak presence in April (USFWS 2013, 2015, 2017; USFWS DJFMP data 2000-2016, University of Washington Columbia Basin Research, 2018) (Table 6 and Figures 9 and 10).

Table 6. Temporal occurrence of spring-run Chinook salmon in the Delta with darker shades indicating months of high presence and lighter shades indicating months of low presence.

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Adult SR[1]	MED	HIGH	HIGH	HIGH	MED	MED	NONE	NONE	NONE	NONE	NONE	NONE
Juvenile SR[2]	LOW	LOW	LOW	HIGH	MED	NONE	NONE	NONE	NONE	NONE	NONE	LOW
Salvaged SR[3]	LOW	LOW	MED	HIGH	MED	NONE	NONE	NONE	NONE	NONE	NONE	NONE

HIGH MED LOW NONE

[1]Adults enter the Bay late January to early February (CDFW 1998) and enter the Sacramento River in March (Yoshiyama *et al.* 1998). Adults travel to tributaries as late as July (Lindley *et al.* 2004). Spawning occurs September to October (Moyle 2002).
[2]Juvenile presence in the Delta based on DJFMP data.
[3]Juvenile presence in the Delta based on salvage data (NMFS 2016d).

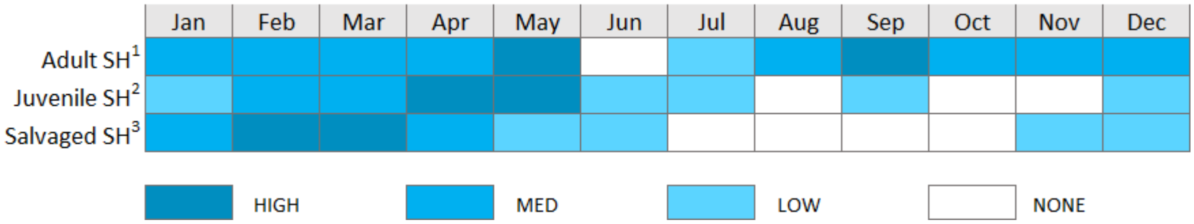
2.4.2.1.3 CCV Steelhead

Wild CCV steelhead juveniles (smolts) can start to appear in the action area as early as October, based on the data from the Sacramento River and Chipps Island trawls (USFWS 2013, 20115, and 2017, University of Washington Columbia Basin Research, 2018; Figures 11 and 12) and CVP/SWP Fish Salvage Facilities (CDFW 2018 ftp salvage website). In the Sacramento River, juvenile CCV steelhead generally migrate to the ocean in spring and early summer at 1 to 3 years of age and 100 to 250 mm FL, with peak migration through the Delta occurring in March and April (Reynolds *et al.* 1993).

Juvenile CCV steelhead presence in CVP/SWP Fish Salvage Facilities increases from November through January (12.4 percent of average annual salvage) and peaks in February (40.4 percent) and March (26.9 percent) before rapidly declining in April (13.3 percent) and May (4.4 percent) (NMFS 2016d). By June, emigration essentially ends (Table 7), with only a small number of fish being salvaged through the summer at the CVP/SWP Fish Salvage Facilities.

Adult steelhead begin to migrate through the action area (lower Sacramento River) starting in July and continue through late fall, with a secondary peak occurring in late spring (presumably adults returning downstream as kelts). The proposed in-water work window is July through the end of October, 2018. The percentile of adult migration passage overlapping with the in-water work window is 2% for July, 12% for August, 44.5% for September, and 25% for October (Hallock et al. 1957, 1961)

Table 7. Temporal occurrence of steelhead in the Delta with darker shades indicating months of high presence and lighter shades indicating months of low presence.



[1]Adult presence was determined using information in (Moyle 2002), (Hallock *et al.* 1961), and (CDFW 2015).
[2]Juvenile presence in the Delta was determined using DJFMP data.
[3]Months in which salvage of wild juvenile steelhead at State and Federal pumping plants occurred; values in cells are salvage data reported by the facilities (NMFS 2016d).

2.4.2.1.4. Southern DPS of North American Green Sturgeon

Adult green sturgeon begin to enter the Sacramento – San Joaquin Delta in late February and early March during the initiation of their upstream spawning run (Moyle *et al.* 1995, Heublein *et al.* 2009). The peak of adult entrance into the Delta appears to occur in late February through early April, with fish arriving upstream of the Glen-Colusa Irrigation District's water diversion on the upper Sacramento River in April and May to access known spawning areas (Moyle 2002). Adults continue to enter the Delta until early summer (June-July) as they move upriver to spawn in the upper Sacramento River basin. It is also possible that some adult green sturgeon will be moving back downstream as early as April and May through the action area, either as early post-spawners or as unsuccessful spawners. The majority of post-spawn adult green sturgeon will move down river to the Delta either in the summer or during the fall. Fish that over-summer in the upper Sacramento will move downstream when the river water cools and rain events increase the river's flow and either hold in the Delta or migrate to the ocean. Data on green sturgeon distribution is extremely limited and out-migration appears to be variable occurring at different times of year. Seven years of recreational fishing catch data for adult green sturgeon (CDFW sturgeon fishing report cards) show that they are present in the Delta during all months of the year (Figure 13).

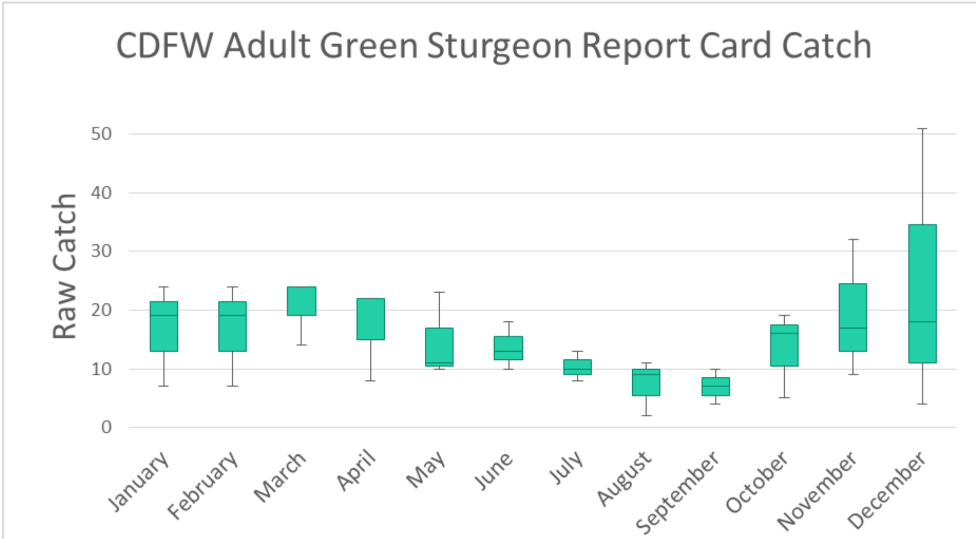


Figure13. CDFW adult raw catch data for green sturgeon in the Delta from 2008-2014. This data indicates presence year round (Gleason et al 2008, DuBois et al. 2009-2015). The monthly median is marked by a horizontal line splitting each box. The upper and lower whiskers show the maximum and minimum values for each month over all years.

Juvenile green sturgeon migrate to the sea when they are 1 to 4 years old (Moyle et al. 1995). According to Radtke (1966), juveniles were collected year round in the Delta during a 1-year study in 1963-1964. The DJFMP rarely collected juvenile green sturgeon at the seine and trawl monitoring sites. From 1981 to 2012, 7,200 juvenile green sturgeon were reported at the State and Federal export facilities (Figure 14), which indicates a higher presence of juvenile green sturgeon during the spring and summer months in the south Delta where export facilities are located.

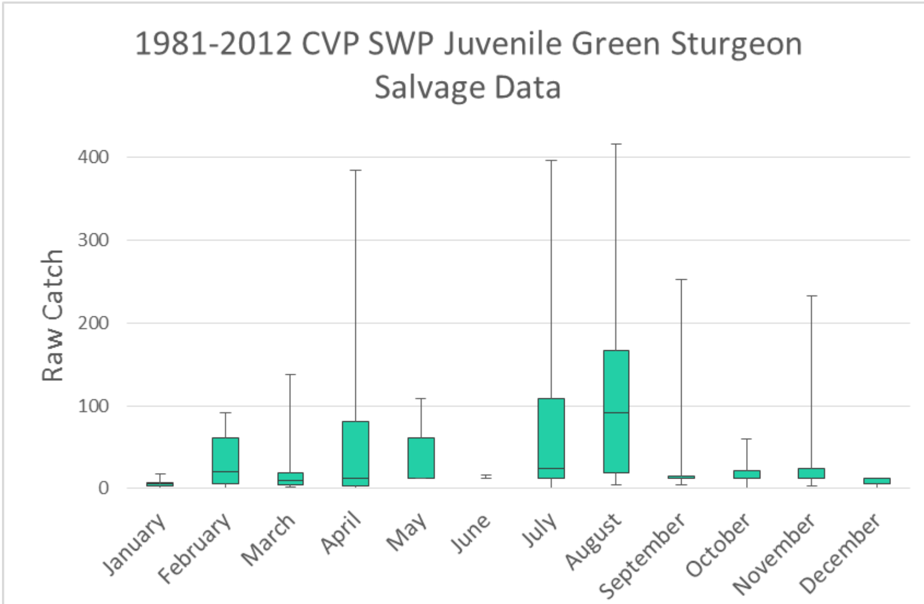


Figure 14. Monthly raw salvage data for juvenile green sturgeon by month at the SWP and CVP export facilities (1981-2012). The monthly median is marked by a horizontal line splitting each box. The upper and lower whiskers show the maximum and minimum values for each month over all years.

Based on the above information, adult and juvenile green sturgeon were determined to be present in the Delta year-round (Table 8).

Table 8. Temporal occurrence of green sturgeon in the Delta with darker shades indicating months of high presence and lighter shades indicating months of low presence.

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
*Adult GS[1]	MED	MED	MED	MED	MED	MED	MED	MED	MED	MED	MED	MED
*Juvenile GS[2]	MED	MED	MED	MED	MED	MED	MED	MED	MED	MED	MED	MED
Salvaged GS[3]	LOW	LOW	LOW	LOW	LOW	NONE	MED	HIGH	LOW	LOW	LOW	LOW

HIGH HIGH   MED MED   LOW LOW   NONE NONE

[1]Adult presence was determined to be year round according to information in (CDFW sturgeon report cards 2008-2014), (Heublein *et al.* 2009), and (Moyle 2002).
[2]Juvenile presence in the Delta was determined to be year round by using information in (USFWS DJFMP data), (Moyle *et al.* 1995) and (Radtke 1966).
[3]Months in which salvage of green sturgeon at State and Federal pumping plants occurred; values in cells are salvage data reported by the facilities (1981-2012 CDFW daily salvage data).
*Not enough catch data to determine percent presence by month for adults or juveniles, except for salvaged green sturgeon.

2.4.2.2 Status of Critical Habitat within the Action Area

The PBFs for steelhead and spring-run Chinook salmon habitat within the action area include freshwater rearing habitat and freshwater migration corridors. Estuarine areas occur farther downstream where mixing occurs and salinity is greater than 0.5 parts per thousand (ppt). The features of the PBFs included in these different sites essential to the conservation of the CCV steelhead DPS and CV spring-run Chinook salmon ESU include the following: sufficient water quantity and floodplain connectivity to form and maintain physical habitat conditions necessary for salmonid development and mobility, sufficient water quality, food and nutrients sources, natural cover and shelter, migration routes free from obstructions, no excessive predation, holding areas for juveniles and adults, and shallow water areas and wetlands. Habitat within the action area is primarily utilized for freshwater rearing and migration by CCV steelhead and CV spring-run Chinook salmon juveniles and smolts and for adult freshwater migration. No spawning of CCV steelhead or CV spring-run Chinook salmon occurs within the action area.

Critical habitat for winter-run Chinook salmon includes the mainstem Sacramento River reach adjacent to the action area, however the action area does not overlap with this section of the Sacramento River and no critical habitat for winter-run is designated within the action area. Nevertheless, it is expected that winter-run will be present in the waterways of the action area and utilize the physical and biological elements found in these waterways as they would within waterways designated as critical habitat.

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

The general condition and function of the aquatic habitat has already been described in the *Rangewide Status of the Species and Critical Habitat* section of this biological opinion. The substantial degradation over time of several of the PBFs has diminished the function and condition of the freshwater rearing and migration habitats in the action area.

Even though the habitat has been substantially altered and its quality diminished through years of human actions, its conservation value remains high for CV spring-run Chinook salmon, CCV steelhead, and the sDPS of North American green sturgeon. All juvenile winter-run and spring-run Chinook salmon, the sDPS of North American green sturgeon, as well as those CCV steelhead smolts originating in the Sacramento River basin must pass into and through the northern Delta to reach the lower Delta and the ocean. A large fraction of these fish will likely pass downstream through the action area having left the Sacramento River channel and entering one of its associated distributaries (Sutter or Steamboat sloughs) or by rearing in the area of the Cache Slough-Lindsey Slough complex. Likewise, adults migrating upstream to spawn are likely to pass through the action area after leaving the main stem of the Sacramento River and entering one of the associated distributaries to reach their upstream spawning areas. Therefore, it is of critical importance to the long-term viability of the Sacramento River winter-run Chinook salmon and CV spring-run Chinook salmon, the sDPS of North American green sturgeon, and CCV steelhead to maintain a functional migratory corridor and freshwater rearing habitat through the action area, whether it has been designated as critical habitat (CV spring-run Chinook salmon, CCV steelhead, and sDPS green sturgeon) or not (winter-run Chinook salmon).

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 DWR's conservation measures taken during the repair.

Our assessment considers the nature, duration, and extent of the action relative to the 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.

Adverse effects can include any impact that reduces the quality or quantity of critical habitat, 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. In addition, adverse effects can include any direct or indirect impact to an individual fish that results in take. "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). The proposed emergency rehabilitation actions include waterside levee repairs and bank stabilization measures that may impact NMFS-listed species and critical habitat through the clearing of surface vegetation on the levee slope, excavation of key trenches on the waterside levee toes, placement of geotextile fabric lining the trenches to the top of the excavation surface, and the placement of rock above and OHWM. The removal of riparian vegetation, IWM, and placement of riprap below the OHWM may contribute to continued fragmentation of existing habitat, and conversion of nearshore aquatic environments to simplified habitats that adversely affect ESA-listed salmonids, green sturgeon, and their designated critical habitat.

Construction activities may increase noise, turbidity, suspended sediment, and sediment deposition that may disrupt feeding or temporarily displace fish from preferred habitat or impair normal behavior. Construction activities will also introduce riprap material into the water column that may injure, harm, or kill listed fish. Some of these effects may occur at a distance from the construction activities because noise and sediment may be propagated away from their point of origin in both an upstream and downstream direction from the construction sites. Substantial increases in suspended sediment could temporarily bury substrates and submerged aquatic vegetation that supports invertebrates for feeding juvenile fish.

The approach used for this analysis was to identify which ESA-listed species would be likely to be present in the action area from July through October during construction activities (Table 9). NMFS conducted a review of nearby CDFW and USFWS monitoring locations, run timing, and fish salvage data to determine the likelihood of ESA-listed fish presence (Tables 5-8). Adult salmonids typically migrate through the Delta within a few days. Juvenile Chinook salmon spend from 3 days to 3 months rearing and migrating through the Delta to the mouth of San Francisco Bay (Brandes and McLain 2001, MacFarlane and Norton 2002).

Table 9. Presence of ESA-listed species in the action area during construction.

Month								
	July		August		September		October	
	Life stage							
Species-	**Adults**	**Juveniles**	**Adults**	**Juveniles**	**Adults**	**Juveniles**	**Adults**	**Juveniles**
Winter-run	No	No	No	No	No	No	No	Yes (Very Low[a])
CV spring-run	No	No	No	No	No	Yes (Very Low)[b]	No	Yes (Very Low)[b]
CCV steelhead	Yes (Low)[c]	Yes (Very Low)[d]	Yes (Med)[c]	No	Yes (High)[c]	Yes (Very Low)[d]	Yes (High)[c]	Yes (Very Low)[d]
sDPS green sturgeon	Year-round		Year-round		Year-round		Year-round	

[a] There is a very low potential for juvenile winter-run to enter the Delta in October in response to storms in the upper Sacramento River valley stimulating downstream migration if Sacramento River flows increase above approximately 14,000 cfs at Wilkerson Slough.
[b] There is a very low potential for the presence of yearling spring-run in the action area in September and October if fall storms in the upper Sacramento River tributary watersheds create conditions that stimulate outmigration of yearling fish from those watersheds.
[c] Based on the data from Hallock et al (1961), adult CCV steelhead begin to migrate through the lower Sacramento River region starting in July and August, and peaking in September and October.
[d] Based on the DJFMP Sacramento trawl and Chipps Island trawl data, very low levels of juvenile steelhead have been observed in July, September, and October in the Delta region.

The levee repairs will also contribute to the continued confinement of the riverine system that in turn negatively impacts listed fish species and their designated critical habitat. This analysis also evaluates the long-term impacts of the levee repair on fish species and their critical habitat. Presence of Sacramento River winter-run and CV spring-run Chinook salmon, CCV steelhead, and sDPS green sturgeon in the action area is assumed to occur during their migratory and rearing behaviors that correspond to their presence in the Delta as described in the baseline status section for each listed species.

The purchase of 2.32 acres of mitigation credit from a NMFS approved bank with an applicable service area creates beneficial effects that will restore and protect floodplain, shallow water, and riparian habitat and improve juvenile rearing habitat for all species analyzed in this Opinion. Although the banks technically do not include green sturgeon credits (only salmonid credits), we expect that individual green sturgeon will benefit from the purchase of these credits due to the creation of tidally influenced shallow freshwater habitat with meandering tidal channels, SRA habitat and Tule Marsh SRA habitat that will provide enhanced food production. In addition, the spatially diverse habitats are expected to provide refuge from predators for juvenile fish as well as holding and rearing areas for both juvenile and adult green sturgeon.

2.5.1 Construction Related Effects

NMFS expects that adult CCV steelhead as well as juvenile and adult green sturgeon are likely to be present in the action area during the construction actions, although in low numbers in most of the rehabilitation sites due to their locations in waterways off of the main migratory routes through the northern Delta. Those sites on Elk Slough and Shag Slough (Sites 31, 32, 33, 34, 38, and 39) do not provide direct access through the north Delta for adult steelhead migration, but may provide some holding and rearing habitat for green sturgeon. There is a low probability that juvenile CCV steelhead may be present during the work-window. It is not expected that adult winter-run or spring-run Chinook salmon will be present at any of the sites during the construction window for the Project. There is an extremely low probability for juvenile winter-run to be present in October following large storm events in the upper Sacramento River basin. There is a very low potential for the presence of yearling CV spring-run at any of the rehabilitation sites during the construction window for the Project and none for young-of-the-year (YOY) spring-run Chinook salmon. No spawning habitat for Sacramento River winter-run Chinook salmon, CV spring-run Chinook salmon, CCV steelhead, or green sturgeon is present in the action area, therefore no adverse effects to spawning adults or incubating eggs are expected.

2.5.1.1 Noise Related Effects

Direct effects associated with in-river and waterside construction work will involve the use of heavy construction equipment and activities that will produce pressure waves, and create underwater noise and vibration, thereby temporarily altering in-river conditions. Noise generated by construction activities are expected to take two main forms: sharp, transient spikes in noise caused typically by metal (such as an excavator bucket or bulldozer blade) striking a hard object, or by rocks falling on top of each other when armoring the levee face with stone riprap; and lower frequency or infrasonic noise caused by the movement of construction equipment and their earthmoving excavation activities. Transient noise spikes will be stronger (higher decibels) if they occur on or in the water and transmitted directly to the surrounding water column. Transient noise spikes that occur in the upland areas of the rehabilitation sites will be much lower in magnitude when they reach the water, losing energy as the sound travels through the soil and through the soil/water interface into the active channel. There is a low potential for direct injury or mortality due to the short duration of transient spikes and the nature of their wave rise form. Transient noise is more likely to result in behavioral reactions in exposed fish, such as a startle response. Low frequency or infrasonic noise is also likely to have a low potential for causing direct injury to exposed fish. It is more likely to cause behavioral responses, such as avoidance or movement away from the noise source.

Only those fish that are holding adjacent to or migrating past the levee repair site will be directly exposed or affected by construction related noise. Those fish that are exposed to the effects of construction activities will encounter short-term (*i.e.*, minutes to hours) construction-related noise. Although direct injury or harm is unlikely, behavioral avoidance may cause injury or harm by increasing the susceptibility of some individuals to predation by temporarily disrupting normal sheltering behaviors. These changes may also impair feeding behaviors, which in turn impact their ability to grow and survive. Fish, especially adults, often respond to construction activities by quickly swimming away from the construction sites, resulting in the majority escaping direct physical injury. This is considered a form of harassment that results in the take of exposed fish.

The Project description indicates that all construction activities will occur during the day, and no construction related activities will occur at night, thus giving an 8- to 12-hour reprieve from any construction related noise. Furthermore, construction is scheduled to last no more than two to four weeks at each site, thus reducing the amount of exposure to fish utilizing those locations for rearing, holding, or migration.

2.5.1.2 Contaminant Related Effects

Toxic substances used at construction sites, including gasoline, lubricants, and other petroleum-based products, could enter the waterway as a result of spills or leakage from machinery and injure listed salmonids and green sturgeon exposed to these substances. Petroleum products also tend to form oily films on the water surface that can reduce the exchange of oxygen between the atmosphere and the water, thus reducing dissolved oxygen available to aquatic organisms. The exposure to these substances can kill fish directly in high enough concentrations through acute toxicity or suffocation from lack of oxygen. These chemicals may also kill the prey of listed fish species, reducing their ability to feed and therefore grow and survive. However, due to adherence to BMPs that dictate the use, containment, and cleanup of contaminants, the use of toxic substances at the construction site is not likely to adversely affect listed fish species.

2.5.1.3 Turbidity Related Effects

Excavation of the levee face above the water surface and the submerged toe key for the placement of launch rock will create conditions that can increase the amount of local water turbidity through re-suspension of soils and sediments exposed or dislodged during this process. Likewise, placement of launch rock below the water line and rip rap along the levee face can create large turbidity plumes in adjacent waters. Although increases in turbidity can disrupt feeding and migratory behavior activities of salmonids, NMFS anticipates adherence to the BMPs described above in the *Proposed Action* section will greatly minimize the risk of injury or death caused by increases in turbidity. The Project description indicates that silt curtains will be deployed around each levee repair site and that these curtains will contain any resuspended sediment or soils that are displaced by excavation or the placement of launch rock or rip rap during construction. The silt curtains at each repair site will remain in place until all of the construction actions are completed. Thus, short term turbidity increases associated with construction will be minimized by the deployment of the silt curtain.

However following removal of the silt curtain, it is anticipated that any silt or fine sediments captured behind the curtain may be displaced by river and tidal flows. It is expected that this light material will be picked up by the water flowing over it and re-suspended into the water column creating a localized turbidity plume that moves upstream and downstream of the levee repair site due to tidal action. Initially the magnitude of the turbidity plume could be quite high, depending on how much material was captured behind the silt curtain and the strength of the current flowing over it. If there is little material or flows are weak, little material will be resuspended into the overlying water column and the plume will quickly dissipate over distance and time. If there is an abundance of fine silt or sediment, then the turbidity plume may persist for a longer period and cover a greater distance before dissipating.

Responses of salmonids to elevated levels of suspended sediments often fall into three major categories: physiological effects, behavioral effects, and habitat effects (Bash *et al.* 2001). Salmonids exposed to slight to moderate increases in turbidity exhibited avoidance, loss of station in the stream, reduced feeding rates and reduced use of overhead cover. Reaction distances of rainbow trout to prey were reduced with increases of turbidity of only 15 NTUs over an ambient level of 4 to 6 NTUs in experimental stream channels (Barret *et al.* 1992). Increased turbidity, used as an indicator of increased suspended sediments, also is correlated with a decline in primary productivity, a decline in the abundance of periphyton, and reductions in the abundance and diversity of invertebrate fauna in the affected area (Lloyd 1987, Newcombe and MacDonald 1991). These impacts to the aquatic environment decrease the availability of food resources for salmonids and sturgeon through trophic energy transfers from the lowest trophic levels (*i.e.,* phytoplankton and periphyton) through intermediate levels (*e.g.,* invertebrates) to higher trophic levels (*i.e.*, salmonids and sturgeon).

Based on the timing of construction, it is unlikely that any other salmonid other than adult steelhead, will be present following the removal of the silt curtains. It is expected that any adult steelhead will move away from the turbidity plume and seek waters that are more acceptable to their preferences. Few if any juvenile salmonids are expected to be present during the removal of the silt curtains and the period following thereafter, in which any accumulated fine silt or sediment may be resuspended into the waterway adjacent to the repair site.

It is expected that both juvenile and adult green sturgeon will be present when the silt curtains are removed. Increases in turbidity and sedimentation events are not expected to affect visual feeding success of green sturgeon, as they are not believed to utilize visual cues (Sillman *et al.* 2005). Green sturgeon, which can occupy waters containing variable levels of suspended sediment and thus turbidity, are not expected to be impacted by the increases in the turbidity levels anticipated from the proposed project directly, but suffer secondary effects due to impacts on the habitat (i.e., invertebrate forage base populations).

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

2.5.1.4 Removal of Riparian Vegetation, Submerged Aquatic Vegetation, and Large Woody Materials during Clearing and Grubbing and Armoring of Levee Faces to Prevent Erosion

The Project proposes to remove nearly all existing vegetation along the face of the levee sites identified for repair except for trees or shrubs identified and marked for protection prior to construction. Excavations along the toe of the levee below the waterline and extending out 20 to 30 feet from the waterline of the levee face will remove currently existing shallow water habitat, including any existing SAV present along the levee toe. The cumulative acreage of impacted area is 2.026 acres, which includes 0.930 acres below the OHWM, and 1.096 acres above OHWM. Vegetation clearing will include the removal of any existing submerged instream woody debris (i.e. LWM or IWM) and fallen trees on the levee slope as well as any non-exempted woody vegetation that is currently growing on the levee face of the repair site at each of the various locations described for this Project. Following the construction phase of the Project, repaired levee faces will be reseeded with native plants where possible, with a mix of seeds typically represented by native grasses. Except for the identified trees and shrubs that will be protected during construction, only one of the sites (site 37) has any trees or shrubs that will be planted following the repair of the levee.

The repair of the levees will perpetuate the current habitat conditions in the northern Delta. The construction of levees to protect against flooding has significantly altered the environment of the northern Delta. Levees replaced the naturally occurring shallow water habitat that existed along the banks of rivers and sloughs in the Delta and the spectrum of complex habitats they provided. Shallow water habitats had a broad range of depths and water velocities present due to the presence of shallow water and riparian vegetation, fallen trees and woody materials (*i.e.*, IWM) that existed on their banks, and the ability of the river to migrate across the floodplain to create additional complexity in the geometry of the river's cross section. Native fish species, including listed salmonids and green sturgeon, evolved under these environmental conditions. In addition, naturally flowing rivers were able to construct riverside benches and naturally formed levees during flood events. These benches could be up to 20 feet high and extended for considerable distances inland creating suitable conditions for the establishment and successional development of structurally diverse riparian vegetation communities (The Bay Institute 1998).

Rock rip-rapping, which is designed to protect the levee faces from erosion, will have deleterious effects on the functioning of the riverine process (USFWS 2000). The intent of riprap is to stabilize stream channels and limit natural fluvial processes. The reduction of the erosion and consequent deposition cycle, naturally inherent to all alluvial channels, eliminates a channel's ability to maintain bedforms for salmonid habitat and impairs the ability for a stream to be maintained in a dynamic steady state. This alteration of the aquatic ecosystem has diverse deleterious effects on aquatic communities, ranging from carbon cycling to altering salmonid population structures and fish assemblages (Schmetterling *et al*. 2001). Riprap does not provide the intricate habitat requirements for multiple age classes or species similar to natural banks, or banks that include IWM (Peters *et al*. 1998).

Loss of IWM negatively impacts salmonids through multiple phases of their life history. Schaffter *et al*. (1983) showed that juvenile Chinook salmon densities along riprapped banks are one third that of natural banks with the presence of fallen trees and their root balls in the water. They concluded that traditional riprap methods of protection will likely cause decreases in the salmon numbers in the Sacramento River basin. USFWS (2000) reported that in studies conducted in the Sacramento River near the Butte Basin, the highest number of juvenile Chinook salmon were associated with the nearshore areas with woody material, sloping banks, and moderate velocities. Juvenile Chinook salmon catches (measured as catch per unit effort or "CPU") were consistently lowest at riprapped sites and highest at natural bank sites (areas with overhead cover and instream woody cover) and intermediate in areas where experimental mitigation studies placed artificial IWM bundles and root balls. USFWS (2000) reported that additional studies conducted between Chico Landing and Red Bluff on the Sacramento River confirmed the low value of riprapped banks, the high value of natural banks with varying degrees of instream and overhead woody cover, and the intermediate value of mitigated sites.

In large mainstem streams and rivers such as the Sacramento and San Joaquin rivers, the primary benefit of IWM is to the channel margins. The woody materials act to deflect and break up stream flow, creating small eddies, pools, undercut banks, variability in channel depth, and back water areas conducive to rearing and growth of salmonids (Murphy and Meehan 1991, Bisson *et al*. 1987). Sediment that is trapped by the woody material and stored along the channel margins contributes to the hydraulic and biologic complexity of the stream reach, particularly where organically rich materials are present (Bisson *et al.* 1987). These storage areas create new habitat complexity by trapping inorganic material that creates bars and holes and organic materials that contribute energy and carbon to the local food web of the stream reach (Murphy and Meehan 1991, Bisson *et al.* 1987). These breaks in the river flow also create beneficial holding areas with plentiful food resources and the conditions where salmonids can hold with minimal energy expenditure and feed while rearing. These areas are also beneficial to a wide range of other species native to the system. Such refuges are critically important to the lower river reaches where levee construction and riprapping have disconnected the rivers from the adjoining floodplain where these refuges and rearing habitats formerly existed.

Riprapping affects the stability of IWM along the river channel margin. Stable wood retention is important for creating and maintaining good fish habitat (Bisson *et al.* 1987). Whole trees and their root balls are more important for long-term stability than smaller fragments, as they tend to stay in place for long periods of time. These large pieces of wood may remain in place for decades and in the process trap additional IWM, thus adding to the structure. The longevity of large woody debris however may mask changes in the input of woody materials to the river. Since these large pieces of wood would normally be slow to decay, a decline in the woody material input may be masked. Riprapping of the upper river and Delta waterway banks prevents the normal input of upstream woody materials through erosion. The smooth hydraulic roughness along the riprapped banks prevents pieces of woody materials from becoming anchored and remaining in place. The woody materials are transported downstream, but the riprapping of the lower river and Delta waterway banks further limit these pieces from becoming lodged on the banks and the woody material is lost to the system. There is a continuing reduction of IWM input from upstream and local waterways, so that the presence of large pieces of IWM in the Delta is becoming exceedingly rare. Existing pieces that are removed or break apart from decay are not being replenished from upstream.

Like the studies upriver in the mainstem Sacramento River, salmonids in the Delta are associated with natural banks and IWM cover where there is sandy or muddy substrates and shallow water shorelines (McLain and Castillo 2009). Areas with riprap and a lack of cover tended to be dominated by non-native predators and these riprapped shorelines had lower densities of salmonids present. Other studies have shown this trend for non-natives, in particular piscivorous fish that prey on salmonids, (Nobriga *et al.* 2005, Brown and May 2006, Brown and Michniuk 2007, and Grimaldo *et al.* 2012). It is unclear whether the low density of salmonids in riprapped areas is caused by salmon avoiding these areas volitionally or whether they are very vulnerable to predation from non-native predators with a resulting high predation loss (Schmetterling *et al.* 2001, McLain and Castillo 2009).

2.5.2 Effects to Critical Habitat

The emergency levee repairs are expected to cause a reduction in critical habitat by removing riparian vegetation and installing rock revetment. Revetment was placed along a cumulative 2,196 linear feet for the 9 emergency rehabilitation sites. Approximately 0.930 acres of riprap was placed below the OHWM, creating an area of unproductive, low quality habitat along the interface of the channel bottom and the bank slope. This will last for several years into the future until it regains its current level of ecological function. Above the OHWM, the DWR placed 1.096 acres of riprap. The effects of this project result in continued fragmentation of existing habitat, and conversion of nearshore aquatic areas to simplified habitats that have adverse effects on salmonids and green sturgeon.

2.5.2.1 CCV Steelhead Designated Critical Habitat

The effects to designated critical habitat for CCV steelhead related to the direct effects of construction actions will be short lived during the construction season. However long term modifications to the shallow water and riparian habitats will impact critical habitat until the habitat within the construction areas regain ecological function (i.e., new riparian growth, recolonization of benthic substrates by invertebrates and periphyton, etc.). Within the action area of the Project, the PBFs for designated critical habitat for CCV steelhead are freshwater rearing habitat and freshwater migration corridors.

As described earlier in this document regarding Project effects, the construction actions are anticipated to create elevated levels of noise due to construction equipment moving on the levees and the actual construction activities associated with the levee repairs (i.e., grubbing, excavations, and placement of rock riprap). This is particularly relevant to those portions of the action area along the levees of Steamboat Slough and to a lesser degree Elk Slough. The sections along Steamboat Slough (relevant to Site 37) are an active migratory corridor for adult CCV steelhead moving upstream from the waters of the western Delta and re-entering the mainstem Sacramento River near Paintersville. Elk Slough is accessible to migrating fish, but because of tidal gates at its upstream end, which limit direct access to the Sacramento River channel, fish would likely move into Elk Slough (relevant to Sites 31,32,33, and 34) from its downstream end via its confluence with Sutter Slough and mill about until they dropped back downstream and re-enter Sutter Slough. Following Sutter Slough, these fish can gain access to the mainstem Sacramento River near Courtland by following the riverine flow cues from the mainstem Sacramento River. NMFS does not consider the rehabilitation sites within Shag Slough, Lindsey Slough or Cache Slough as part of the active adult migratory corridor for CCV steelhead during the proposed construction season. None of these three sloughs leads to upstream spawning habitat during the proposed construction season; rather they generally terminate in dead-end channels. However, during periods of flooding when the Yolo Bypass is inundated, upstream migration is possible through the Yolo Bypass and these waterways may provide upstream access to the upper Sacramento River basin for adult CCV steelhead. The period of active migration for CCV steelhead adults in the Sacramento River during summer and fall (Table 7) overlaps with the proposed work window of July 1 through October 31 in the action area, however inundation of the bypass rarely if ever occurs during this period. Likewise, winter rains can create sufficient flows in west side tributaries such as Ulatis Creek and Alamo Creek, which terminate in Cache Slough, that would allow upstream migration of CCV steelhead to potential spawning grounds in these tributaries. During the summer and fall dry season, these tributaries are inaccessible to CCV steelhead.

Noise related to construction equipment and vehicles and the proposed construction activities on the levees will degrade the functioning of the waterways as a freshwater migration corridor during the migration period. NMFS expects that fish will be startled by the construction activity and associated noise, temporarily leaving the nearshore area while the construction is taking place. NMFS assumes that fish will move to an area of the river that is quieter and resume holding or upstream movements during their upstream migration phase. Migration during the daytime may be depressed by the construction activities along the levees, and fish will potentially hold until evening and night before moving through the active construction areas when construction activities cease for the night. Overall, the impacts to critical habitat associated with construction related activities, traffic, and noise are expected to be temporary and result in no permanent damage to the PBFs of the designated critical habitat. When construction in a given reach of the levee repair site is completed, the construction related traffic, activities, and noise ends and no further acute construction related impacts will affect the aquatic system.

As previously described in this document, the perpetuation of the levees, their armored riprapped waterside faces, and the removal of vegetation will diminish the functioning of the action area's waterways for rearing and migration of juvenile CCV steelhead. Levees simplify riverine and estuary habitat complexity and reduce the integrity of the riparian and wetland corridors associated with stream borders and sloughs. Levees also isolate the floodplains from the river, destroying the valuable interface between the riparian and the adjacent aquatic communities that depend on an exchange of inorganic and organic materials to function fully. Riprapping the waterside faces of the levees to provide protection against erosion reduces the ability of riparian vegetation to establish itself, changes the hydrodynamics of the river adjacent to the bank in an ecologically unfavorable manner, and reduces and prevents the establishment of IWM along the river's edge.

2.5.2.2 CV Spring-run Chinook salmon Designated Critical Habitat

The effects to designated critical habitat for CV spring-run Chinook salmon are very similar to those already described for the CCV steelhead. The main difference is that adult CV spring-run are not expected to be present at any time during the construction season and therefore there are no acute construction related effects to the habitat functioning as a migratory corridor for the adults of this run. It is also unlikely that yearling CV spring-run Chinook salmon will be present during the proposed construction season, except in those unusual situations where early fall storms in the upper Sacramento River basin create high flows in the tributaries that stimulate outmigration to the Delta. This typically occurs after October during the months of November and December.

In contrast, juvenile CV spring-run Chinook salmon (yearlings and young-of-the-year) are expected to use the waterways within the action area as migratory corridors and rearing habitat on a regular basis during their outmigration to the ocean. These are the PBFs of the designated critical habitat for CV spring-run in the action area. The diminished nearshore habitat previously described for juvenile CV steelhead would affect juvenile CV spring-run in a similar fashion; that is, loss of riparian habitat, loss of invertebrate forage base, and loss of ecological function in general due to simplification of the physical habitat.

2.5.2.3 sDPS of North American Green Sturgeon Designated Critical Habitat

The potential impacts to sDPS green sturgeon critical habitat are similar to that just described for the CCV steelhead and CV spring-run Chinook salmon critical habitat. In freshwater riverine systems, NMFS expects that the PBFs affected by the Project will include food resources, water quality, water depth, and migratory corridors. The construction actions will create temporary noise impacts on the waterways of the action area as described for the CCV steelhead above. Presence of juvenile sDPS sturgeon, however, are likely to overlap with all of the construction in-water work window since juveniles are expected to be present year round in the action area. Adults are most likely to be present in the winter and spring, but may also be present year round in low numbers. Potential effects range from delay of migration through the affected reaches due to behavioral avoidance of the construction sounds to loss of invertebrate forage base due to modifications of the near-shore habitat. As described for the CCV steelhead, construction will occur from July 1 to October 31, for one year only (2018). There will be no permanent impacts to designated critical habitat due to the construction generated noises, and no noise related effects when construction is not occurring or when construction has been completed in 2018.

The long term presence of the levees, with riprapped armored levee faces, will impair the functioning of the riparian and aquatic habitats as already discussed in this Opinion. NMFS expects that food resources will be negatively affected due to a lack of riparian and shallow water habitat that would benefit food webs in the action area. Likewise the benefit of diverse channel morphology and variable flows and water depths that a naturally meandering river channel would provide are prohibited from occurring due to the levee construction and armoring. This affects the quality of the migratory corridor, food resources, and variable water depths identified as PBFs for freshwater riverine habitats.

2.5.3 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 for impacts that occur below the OHWM and 2:1 for impacts that occur above the OHWM. This credit purchase is ecologically relevant to the impacts and the species affected because the Liberty Island Conservation Bank includes shallow freshwater habitat, riparian SRA, and Tule Marsh SRA, with habitat values that are already established and meeting performance standards. The bank is located in an area that will benefit the ESUs/DPSs directly affected by the proposed action, as it is located in close proximity to the emergency rehabilitation sites themselves. Although the bank technically does not include green sturgeon credits, we expect that individual green sturgeon will benefit from the purchase of these credits, as the bank provides tidally influenced shallow water areas with soft benthic substrate where juvenile and adult green sturgeon can forage. In addition, the dendritic channels within the inundated area provide a diversity of channel depths and habitats. These areas are directly connected to the waters of Cache Slough where green sturgeon are known to occur.

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 Opinion 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 then credits available, performance security requirements, a remedial action plan, and site inspections by NMFS. A description of these tracking mechanisms can be found in the banking instruments for Liberty Island Native Fisheries Conservation Bank (Wildlands, Inc. 2010).

In addition, the bank has a detailed credit schedule and credit transactions and credit availability are tracked on the Regulatory In-lieu Fee and Bank Information Tracking System (RIBITS). RIBITS was developed by the Corps with support from the USEPA, the USFWS, 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.

2.6.1 Agricultural Practices

Agricultural practices in the Delta may negatively affect riparian and wetland habitats through upland modifications of the watershed that lead to increased siltation or reductions in water flow in stream channels flowing into the Delta. The Delta islands surrounding the action area are primarily agricultural lands with orchards, row crops, and grazing lands for dairy cattle present. The Yolo Bypass floodplain is immediately upstream of the action area, and portions of this floodplain are under cultivation for various crops. Unscreened agricultural diversions throughout the Delta entrain fish including juvenile salmonids and juvenile green sturgeon and are present in the action area within the mainstem Sacramento River, Steamboat Slough, Sutter Slough, Elk Slough, Miners Slough, Shag Slough, Prospect Slough, Lindsey Slough, and Cache Slough. Grazing activities from dairy and cattle operations can degrade or reduce suitable critical habitat for listed salmonids by increasing erosion and sedimentation as well as introducing nitrites, nitrates, ammonia, and other nutrients into the watershed, which then flow into the receiving waters of the Delta. Stormwater and irrigation discharges related to both agricultural and urban activities contain numerous pesticides and herbicides that may negatively affect salmonid reproductive success and survival rates (Dubrovsky *et al.* 1998, 2000; Daughton 2003).

2.6.2 Increased Urbanization

The action area occurs within the Delta and Sacramento regions, which include portions of Sacramento, Solano, and Yolo counties. Population is expected to increase by nearly 3 million people by the year 2020 in the Delta region. Increases in urbanization and housing developments can impact habitat by altering watershed characteristics, and changing both water use and stormwater runoff patterns. For example, the cities of Elk Grove, Laguna, Galt, Davis, Dixon, and West Sacramento are anticipated to experience rapid growth for several decades to come and are located within a 25-mile radius upstream of the action area on the Sacramento River and Yolo Bypass. These waterways are either directly connected to the action area or have runoff from surrounding upland areas via small tributaries that empty into the Yolo bypass, which then flows into and through the action area. The anticipated growth will occur along the I-5, I-80, and US-99 transit corridors. 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 processes 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. There are currently six large boating facilities (large private and public docks and marinas) within the immediate vicinity of the action area. These sites provide recreational boaters access to the Delta. Any increase in recreational boating due to population growth would likely result in increased boat traffic in the action area. 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 resuspending contaminated sediments and degrading areas of submerged vegetation. This in turn would 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 in the Delta is anticipated to result in more contamination from the operation of gasoline and diesel powered engines on watercraft entering the water bodies of the /Delta. Furthermore, increased recreational boating, particularly those that can be trailered from one water body to another, greatly increases the risk of spreading non-native invasive species into the Delta.

2.6.3 Global Climate Change

In section 2.2.5, NMFS discussed the potential effects of global climate change. Anthropogenic activities, most of which are not regulated or poorly regulated, will lead to increased emissions of greenhouse gasses. It is unlikely that NMFS will be involved in any review of these actions through an ESA section 7 consultation.

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 as well as illegal placement of riprap occur within the watersheds of the Sacramento and San Joaquin rivers and their tributaries, as well as the waterways of the Delta. For example, most of the levees have roads on top of the levees which are either maintained by the county, the local reclamation district, the landowner, or by the state. Landowners may utilize roads at the top of the levees to access parts of their agricultural lands and repair the levees to protect property with unauthorized materials (*i.e.*, concrete rubble, asphalt, etc.). 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 the Project.

2.7 Integration and Synthesis

The Integration and Synthesis section is the final step in our assessment of the risk posed to species and critical habitat as a result of implementing the proposed action. In this section, we add the effects of the action (Section 2.4) to the environmental baseline (Section 2.3) and the cumulative effects (Section 2.5), 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) reduce the value of designated or proposed critical habitat for the conservation of the species.

2.7.1 Status of Sacramento River Winter-run Chinook salmon

The most recent 5-year status review (NMFS 2016a) reports that the overall viability of Sacramento River Winter-run Chinook Salmon has declined since the 2010 viability assessment, with the ESU still represented by a vulnerable single spawning population on the mainstem Sacramento River. New information available since the last 5-year review (NMFS 2011a) indicates an increased extinction risk to this ESU. Factors that have influenced this increased extinction risk include extreme drought and poor ocean conditions over the past several years, a sustained rate of decline in abundance over the past decade, a limited spatial distribution of the remaining population, and the large influence of the hatchery produced juveniles on the genetic diversity of the population. Many of the factors originally identified as being responsible for the decline of this ESU are still present, though in some cases they have been reduced by regulatory actions (*e.g*., NMFS CVP/SWP biological opinion in 2009, an ocean harvest biological opinion in 2010, and actions implemented under the CVPIA). Despite efforts to reduce these and other threats (*e.g*., controlling water temperatures with cold water releases, annual spawning gravel augmentation, stabilizing mainstem flows, unimpeded fish passage at RBDD, harvest restrictions, and reduction in Delta export pumping), the ESU has continued to decline in abundance.

The most recent 5-year review (NMFS 2016a) reports that the best available information on the biological status of the ESU and new threats to the ESU indicate that its ESA classification as an endangered species is appropriate and should be maintained. Long-term recovery of this ESU will require improved freshwater habitat conditions, abatement of a wide range of threats, and the establishment of additional spawning areas in Battle Creek and the McCloud River as described in the 2014 Recovery Plan (NMFS 2014).

2.7.2 Status of CV Spring-run Chinook salmon

In the 2016 status review (NMFS 2016b), NMFS found, with a few exceptions, that CV spring-run Chinook salmon populations have generally increased through the 2013 returns (23,696 fish total including hatchery fish) but then sharply declined in 2014 (9,901 total fish including hatchery fish; the last escapement numbers available to the TRT since the last status review in 2010/2011). Based on these escapement numbers, the 2016 status review changed the status of the Mill and Deer creek populations from the high extinction risk category, to moderate, while keeping the Butte Creek 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, adult escapement numbers in 2015 were extremely low. The adult escapement to Central Valley waterways was 1,195 fish. The return to the Feather River Fish Hatchery was 4,440 fish. Returns in 2016 increased slightly but then declined again in 2017. Since the effects of the 2012 to 2015 drought have not been fully realized, NMFS anticipates at least several more years of very low returns, which may result in severe rates of decline (NMFS 2016b).

2.7.3 Status of CCV Steelhead

The 2016 status review (NMFS 2016c) concluded that overall, the status of CCV steelhead appears to have changed little since the 2011 status review when the TRT concluded that the DPS was in danger of extinction. Further, there is still a general lack of data on the status of wild populations. The Central Valley population of steelhead still faces the loss of the majority of the historical spawning and rearing habitat due to dams and other passage impediments, as well as the other factors previously described for their decline. There are some encouraging signs however, as several hatcheries in the Central Valley have experienced increased returns of steelhead over the last few years. There has also been a slight increase in the percentage of wild steelhead in salvage at the south Delta fish facilities, and the percentage of wild fish in those data remains much higher than at Chipps Island. The new video counts at Ward Dam show that Mill Creek likely supports one of the best wild steelhead populations in the Central Valley, though at much reduced levels from the 1950's and 60's. Restoration efforts in Clear Creek continue to benefit CCV steelhead. However, the catch of unmarked (wild) steelhead at Chipps Island is still less than 5 percent of the total smolt catch, which indicates that natural production of steelhead throughout the Central Valley remains at very low levels. Despite the positive trend on Clear Creek and encouraging signs from Mill Creek, all other concerns raised in the previous status review remain.

2.7.4 Status of sDPS North American 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 2015) .

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 2015) .

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

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

Salmon, steelhead and green sturgeon use the action area as an upstream and downstream migration corridor and for rearing. Within the action area, the essential features of freshwater rearing and migration habitats for salmon, steelhead and green sturgeon have been transformed from meandering waterways lined with dense riparian vegetation, to a highly leveed system. Levees have been constructed near the edge of the river and sloughs and most floodplains have been completely separated and isolated from the river. Severe long-term riparian vegetation losses have occurred throughout the Delta, and there are large gaps along leveed shorelines devoid 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 channels, the loss of floodplains, and 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 agricultural transformation of the land within the action area, increased runoff and non-point source contaminants, armoring of levees and shoreline modifications, and increased urbanization affect the species in the action area. These actions typically result in habitat fragmentation, and conversion of complex nearshore aquatic habitat to simplified habitats that incrementally reduces the carrying capacity of the rearing and migratory corridors.

2.7.6 Summary of Project Effects on Sacramento River Winter-run Chinook salmon, CV Spring-run Chinook salmon, CCV Steelhead, and sDPS North American Green Sturgeon

2.7.6.1 Winter-run Chinook Salmon

2.7.6.1.1 Active Construction Related Effects

These effects are related to the immediate acute effects of the construction activities at the rehabilitation sites during the July 1 through October 31 in-water work window. This will apply to all of the impacted fish species for acute construction related actions.

2.7.6.1.1.1 Temporal and Spatial Overlap

Adults - It is not anticipated that there will be any spatial or temporal overlap between construction activities and the presence of adult winter-run Chinook in the action area. The timing of the in-water work window (July 1 through October 31) does not overlap with the anticipated timing of adult winter-run upstream migrations through the Delta (Table 5). Since the likelihood of adult winter-run Chinook salmon presence in the Delta at the time of construction activities is remote, NMFS does not anticipate that there will be any affects to individual adult winter-run, and therefore no effects to the ESU.

Juveniles - There is however a low potential for juvenile winter-run Chinook salmon to be present in the action area during the fall (September and October). Based on the information provided by the Sacramento trawls (Figure 7), a very small proportion of the juvenile winter-run population has been detected in the Delta during these months following large rain events in the upstream Sacramento River Basin watersheds and increased Sacramento River flows in the mainstem. The probability that fish will be present increases with the onset of late fall and winter rains, which typically start occurring in late October and November. These hydrologic events stimulate downstream movement of juvenile winter-run towards the Delta. Typically less than 5% of the annual juvenile winter-run population (as represented by the annual catch in the Sacramento trawl) will be present during these months. This can increase to 5-10% of the annual population if flows are exceptionally high.

Approximately 30 to 40% of these emigrating juveniles are expected to enter the action area through Sutter and Steamboat Sloughs (Perry et al 2010). The majority of downstream emigrating fish (60-70%) are expected to stay in the mainstem of the Sacramento River, and avoid the emergency rehabilitation sites in the action area. For fish to enter the emergency repair construction sites for sites 31, 32, 33, 34, and 37, fish must leave the mainstem Sacramento River at either the Sutter Slough or Steamboat Slough junctions. The likelihood of fish being present at sites 33 and 34 (located in Elk Slough) are low as these sites are several miles upstream of the confluence of Sutter Slough and Elk Slough. Elk Slough is essentially a dead-end slough as culverts and gates control its upstream connection to the Sacramento River. In order for fish to be present at these sites they would have to actively move upstream to these sites through the junction between Elk Slough and Sutter Slough. In contrast, sites 31 and 32 on Elk Slough are much closer to the junction with Sutter Slough, and therefore there is a greater potential for juvenile winter-run to be present. If fish are migrating downstream into the Delta during the in-water construction window, it is likely that some will be present at site 37 on Steamboat Slough, as this site is located on a main migratory corridor for salmon.

The emergency rehabilitation sites located on Shag Slough (sites 38 and 39), Lindsey Slough (site 36) and Cache Slough (site 35) have a low likelihood of fish presence during the in-water construction window due to their distance from waters expected to have winter-run presence in the fall. Typically, fish presence at these sites would be associated with fish moving downstream through the Yolo Bypass when it is flooded. However, the Yolo Bypass generally is not inundated during the fall when the earliest winter-run juveniles may be present in the Delta. Therefore, any juvenile winter-run would have to move upstream from the lower Cache Slough complex where the Sacramento Deepwater Ship Channel, Miners Slough, and Steamboat Slough converge to reach sites 35, 36, 38, and 39.

2.7.6.1.1.2 Effects to Individual Fish

Adults – Since it is not expected that any adult winter-run will be present during the in-water construction window of July 1 to October 31, at any of the emergency rehabilitation sites, there are no effects to individual fish.

Juveniles – There is a low probability of exposure of juvenile winter-run to the effects of the active construction activities during the in-water work window. This is due to temporal and spatial separation of the Project's actions with the migratory timing and presence of juvenile winter-run Chinook salmon in the Delta. If fish are present, they are unlikely to be exposed to conditions that will cause direct mortality or injury. It is expected that most of the responses of exposed fish will be behavioral in nature (harassment). NMFS expects that fish will move away from any noise and activity as well as any turbidity plumes to less disturbed areas of the river channel. This may however cause fish to delay migration, or move away from favored holding or foraging spots along the shoreline into deeper waters or less protected areas away from the riverbank. By moving away from the bank and any overhead cover or IWM to open water habitat, fish become more vulnerable to predation. In addition, fish will be moving away from potential food resources consisting of macroinvertebrates from benthic substrate along the shoreline and terrestrial invertebrates from overhead or riparian vegetation.

NMFS expects some fish passing through the slough channels adjacent to the active construction sites will be consumed by predators due to moving away from the noise and activity related to construction and into areas of the channel where they are vulnerable. This is a secondary effect of the behavioral modifications caused by the construction activities. However, NMFS anticipates that the majority of fish will survive their exposure to the construction activities and pass through the construction site, including those fish that had temporary decreases in foraging success.

The effects of active construction are ameliorated by the Project's construction BMPs which reduce the occurrence and effects of contaminants, turbidity, and stormwater runoff. In addition, construction will only occur during the daylight hours, allowing fish movement through the construction sites during the nocturnal hours without bankside activities or noise to alter their behavior. The duration of active construction will also be relatively short at each site, projected to last approximately two to four weeks, which further reduces the window of exposure to the effects of active construction. If active construction starts earlier in the in-water work window, the likelihood of overlap with the presence of winter-run juveniles is reduced. Conversely, if construction starts late, then the likelihood of overlap with fish presence with active construction increases. Individual fish are expected to move through the active construction sites quickly, on the order of minutes to hours during active construction due to increased noise and activity, or to hold away from the site until passing through at night when activity ceases. It is not anticipated that juvenile winter-run will hold and rear in close proximity to an active construction site, but would seek out less disturbed habitat instead.

2.7.6.1.1.3 Effects to the Winter-run Chinook salmon ESU

Adults **–** NMFS expects that there will be no effects to the winter-run ESU due to the lack of effects to individual fish as previously explained.

Juveniles – The winter-run ESU is comprised of one population currently spawning in the upper Sacramento below Keswick Dam. A sizeable fraction of this population (30-40 percent) will enter Sutter and Steamboat sloughs during their downstream migration through the Delta as previously described. However, during the in-water work window for the Project, the proportion of the population migrating into the Delta is typically less than 5 percent, with a maximum of 5-10 percent, when flows are high enough to stimulate migration in September and October. Therefore, the proportion of the population that enters Sutter and Steamboat sloughs during the in-water work window is approximately 1.5 to 4 percent of the juvenile winter-run population when flows are high enough to stimulate downstream migration. In years when flows are more typical, few if any winter-run juveniles are expected to be present in the Delta during the in-water work window. Since the proportion of fish exposed to the active construction activities is small and an even smaller proportion will experience mortality or diminished health from their exposure, the cumulative potential to diminish the abundance of the ESU is very small.

2.7.6.1.2 Long Term Effects

These effects are related to the habitat changes that will occur after the conclusion of the active construction phase of the Project to repair the damaged levees.

2.7.6.1.2.1 Temporal and Spatial Overlap

Adults – A proportion of the adult winter-run Chinook salmon population will migrate upstream through both Sutter and Steamboat sloughs each year enroute to the mainstem Sacramento River. These fish are most likely to encounter site 37, which is located on Steamboat Slough near its junction with the Sacramento River. Adult winter-run are less likely to encounter locations on Elk Slough due to the presence of the culverts and gates at the upper end of the slough. This structure minimize flows from the Sacramento River from entering Elk Slough. Adult winter-run may also be present in Lindsey, Cache, and Shag sloughs in years when the Yolo Bypass is inundated and flood flows are entering the Delta at the lower end of the bypass. These flows would act as an attractant flow for upstream movements of salmon through the bypass to the upper Sacramento River. It is expected that adult winter-run will move through the reaches with repaired levee sites relatively quickly, taking from hours to a few days to transit these areas.

Juveniles – A large proportion of the juvenile emigrating population (30-40 percent) is expected to migrate through the Sutter and Steamboat sloughs migratory corridor each year (Perry et al. 2010). Site 37 is adjacent to the junction of Steamboat Slough with the mainstem of the Sacramento River and is expected to see the highest number of winter-run juveniles migrating past it. The sites located on Elk Slough (sites 31-34) are expected to see lower numbers of winter-run juveniles compared to site 37, as there is no direct migratory route through Elk Slough from the Sacramento River. Fish in Elk Slough will probably be using this waterway for rearing or holding rather than as an active migratory corridor. The duration of their residency in this waterway is unknown at this time.

In years when the Yolo Bypass floods, a sizeable proportion of the juvenile winter-run population is expected to be entrained into the bypass at the Fremont Weir and the Sacramento Weir. These fish will rear and migrate through the bypass to the lower end of the bypass where the bypass flows discharge into the Cache Slough complex, which includes Shag Slough, Lindsey Slough, and Cache Slough. Exposure to the rehabilitation sites in Shag Slough (sites 38 and 39), Cache Slough (site 35), and Lindsey Slough (site 36) is possible if fish continue to rear in this area after exiting the Yolo Bypass.

Exposures to the disturbed riparian habitat and armored levee shoreline associated with the levee repairs are expected to last for a few hours to a few days for actively migrating juvenile winter-run within the action area. However, exposure to these disturbed sites may be extended for fish that choose to rear in the waterways adjacent to the rehabilitation sites. However, due to the volitional swimming behavior of these juveniles, they can actively avoid the rehabilitation sites if they choose, thus minimizing the length of exposure.

2.7.6.1.2.2 Effects to Individual Fish

Adults – It is not anticipated that adult winter-run Chinook salmon will be substantially affected by the altered shoreline habitat and armored levee faces of the rehabilitation sites. Adults do not actively feed during their upstream spawning migration and thus would not be affected by a loss of riparian habitat and food resources. Loss of shallow water and shoreline habitat complexity could diminish the formation of holding pools and current breaks, but adults could actively seek out areas adjacent to the rehabilitation sites to find these habitat characteristics, or move to other areas of the migration route that support these habitats.

Juveniles – Juvenile winter-run Chinook salmon exposed to the disturbed rehabilitation sites will experience simplified low complexity habitats. A less complex habitat elevates the vulnerability of juveniles to predation by removing areas that can serve as hiding spots and refugia from predators. Juveniles occupying these rehabilitation sites therefore cannot hide or take refuge from predators and thus the length of time they are exposed to predators increases, making the risk of mortality or injury from predatory attacks greater.

Less complex habitats also do not provide the variable hydrodynamics conditions that exist along natural shorelines. Natural shorelines can provide velocity breaks and eddies that juveniles can use to rest and hold, reducing their energy expenditures during emigration. Without velocity breaks, fish are either forced to swim continuously in order to hold position at those locations, or to move downstream with the current to areas with velocity breaks and holding water.

The low habitat complexity of the rehabilitation sites, coupled with the loss of riparian vegetation and shallow water SAV reduces the availability of food for emigrating juvenile winter-run. Riparian vegetation provides an input of energy, organic carbon, and minerals through allochthonous materials falling into the water, which supports the base of the food web in the adjacent waterbody. In addition, terrestrial invertebrates commonly fall into the water from the overhead riparian canopy and shoreline vegetation, providing a source of food to juvenile winter-run Chinook salmon. Shallow water SAV also harbors numerous aquatic macroinvertebrates that provide forage for juvenile winter-run while migrating or rearing. Loss of the SAV because of the shoreline construction and repair of the levee face will reduce the availability of food resources for the juvenile winter-run.

However, while the repair actions will limit and reduce the functionality of the shallow water and riparian habitats associated with those locations, the effects can be reduced by fish moving to sections of the waterways adjacent to the construction sites that contain better habitat with more suitable conditions for fish to feed and rear. Within the waterways of the action area, there is a mosaic of different habitat types. These types of habitats range from the newly disturbed sites associated with the Project that are relatively sterile and ecologically non-functional, to sections of waterways in the action area that have not seen any disturbances for decades and support low to moderate riparian growth, IWM along the banks, and shallow water benches and SAV. Migrating fish can volitionally choose to hold and rear in the reaches of the waterways in the action area that provide the necessary habitat characteristics for growth and survival.

In addition, with the passage of time, the newly disturbed emergency rehabilitation sites are expected to regain some, if not all, of their previous ecological function. Over time, the levee face will become established with the native grasses and plants from the restoration seed mix that was spread on the levee slope at the end of construction. In addition, other plants may become established through seeds or “volunteers” and a riparian vegetation community will become established on the levee face unless it is prevented through levee maintenance actions. Recruitment of IWM along the levee waterline will occur to some degree following storm events when floating woody debris becomes entangled on the shoreline. In addition, the toe of the levee will capture sediment in the riprap over time and form new shallow water habitat in which SAV can take root. This transformation however, may take several years to decades to accomplish.

Most of the take of individual juvenile winter-run will be non-lethal, associated with the loss of foraging and holding areas due to the habitat modifications related to the emergency levee repairs. Most individual fish may see a transient decline in available prey as they move past the rehabilitation sites. Once past the rehabilitation sites, fish will encounter more available forage prey as they move into undisturbed areas. It is not anticipated that these transient declines in available forage prey will result in mortality or morbidity to exposed fish due to the short duration of exposure. Nevertheless, some mortality will occur due to the increased vulnerability to predation at the levee rehabilitation sites as explained above.

2.7.6.1.2.3 Effects to the Winter-run Chinook salmon ESU

Adults - Since few, if any, adult winter-run Chinook salmon would be impacted by the long-term habitat disturbances caused by the Project's levee repairs, there will be little impact to the winter-run ESU as a whole. In typical years, most winter-run adults will stay in the mainstem Sacramento and never go past the rehabilitation sites during their upstream spawning migrations, thus there is no exposure to the Project's actions. In wet years when the Yolo Bypass is inundated, adult winter-run may use this route to migrate to the upper Sacramento, with most avoiding the rehabilitation sites on Lindsey, Cache, and Shag sloughs when entering the southern end of the bypass where flows enter the Delta. Furthermore, the proportion of area impacted by the nine rehabilitation sites is very small compared to the miles of waterways in the action area that are not impacted by the levee repairs. Adult fish can readily access these unaffected areas in the action area during their upstream migrations.

Juveniles – The majority of emigrating juveniles (60-70 percent of the population) are expected to stay in the mainstem Sacramento River and not enter Sutter or Steamboat sloughs. Fish that remain in the mainstem will bypass the rehabilitation sites on Steamboat and Elk sloughs and enter the lower Delta downstream of the Cache Slough complex where the remaining rehabilitation sites are located. These fish will not be exposed to any of the long-term habitat effects described above and thus will not be affected by the Project. Therefore, 60 to 70 percent of the ESU will not be affected each year based on the routing of emigrating juveniles.

Fish that enter Sutter Slough may be exposed to the rehabilitation sites on Elk Slough if they move upstream into Elk Slough. This is considered to be a less likely event than to continue downstream in Sutter Slough towards the Sacramento Deepwater Ship Channel and the Cache Slough complex. All fish that enter Steamboat Slough will have to move past the repair site located just downstream of the junction with the Sacramento River. The combined percentage of fish that take migratory route through Sutter and Steamboat slough is 30 to 40 percent of the population (Perry et al 2010), but it is not anticipated that the percentage of fish that choose the Steamboat Slough route will be this high as some of the fish will go into Sutter Slough. Fish that are exposed to the repair site on Steamboat Slough are unlikely to die as explained above and therefore will not be lost to the winter-run ESU population of juveniles. These fish may experience some non-lethal effects but are expected to move quickly downriver to unaffected locations. A small proportion of the migrating fish will be lost to predation associated with the long-term disturbance of the repair site as described above, but this proportion of the population is considered to be small compared to the surviving proportion of the population and will not affect the ESU as a whole.

Juvenile winter-run that enter the Yolo Bypass during flood conditions will leave the bypass at the downstream end into the Cache Slough complex. It is possible that some fish will move upstream to rear in the dead-end channels of Lindsey, Cache, and Shag Sloughs during these flood conditions, but for the reasons described above, few will experience lethal effects due to the presence of the rehabilitation sites. Therefore, the loss of this small number of fish is considered negligible to the overall population of winter-run juveniles and will not affect the ESU.

2.7.6.2 Central Valley Spring-run Chinook Salmon

2.7.6.2.1 Acute Construction Related Effects

2.7.6.2.1.1 Temporal and Spatial Overlap

Adults - It is not anticipated that there will be any spatial or temporal overlap between construction activities and the presence of adult spring-run Chinook in the action area. The timing of the in-water work window (July 1 through October 31) does not overlap with the anticipated timing of adult spring-run upstream migrations through the Delta (Table 6). Since the likelihood of adult spring-run Chinook salmon presence in the Delta at the time of construction activities is remote, NMFS does not anticipate that there will be any affects to individual adult spring-run, and therefore no effects to the ESU.

Juveniles – There is a very small probability that yearling spring-run may enter the Delta in response to fall rainstorms in the upper Sacramento River watershed. Based on monitoring, it is impossible to determine what percentage of the yearling spring-run population will move out of the upper basin in response to these storms and migrate all the way to the Delta prior to the end of October. Typically, yearling spring-run begin to migrate downstream in November, with most of the migration occurring later in December and January. These fish would have very similar spatial distributions and routing in the northern Delta as described for the distributions of juvenile winter-run in section 2.6.6.1.1.1.

2.7.6.2.1.2 Effects to Individual Fish

Adults – Since it is not expected that any adult spring-run will be present during the in-water construction window of July 1 to October 31, at any of the emergency rehabilitation sites, there are no effects to individual fish.

Juveniles – The effects to individual juvenile spring-run Chinook salmon, as represented by the yearling life history expression, are very similar to that already described for juvenile winter-run Chinook salmon in section 6.2.2.1.1.2. That discussion will serve as the discussion of acute construction effects on juvenile spring-run Chinook salmon.

2.7.6.2.1.3 Effects to the CV Spring-run Chinook salmon ESU

Adults - NMFS expects that there will be no effects to the spring-run ESU due to the lack of effects to individual fish as previously explained.

Juveniles – Only the yearling life history stage will be present in the Delta during the in-water work window. The effects of the acute construction actions on the ESU are very similar to those previously described for the juvenile winter-run population segment in section 2.6.6.1.1.3. Approximately 30-40 percent of the fish in the Sacramento River will enter Sutter and Steamboat sloughs when fish are migrating downstream and potentially exposed to construction related effects. The yearling life history expression of the CV spring-run Chinook salmon ESU represents a fraction of the total juvenile life history phase, based on observed numbers in monitoring efforts throughout the year. The fraction of the yearling spring-run that migrate prior to November is an even smaller fraction than this, and thus the total number of fish exposed to the acute construction actions and experience mortality is a negligible fraction of the juvenile population of the ESU.

2.7.6.2.2 Long Term Effects

2.7.6.2.2.1 Temporal and Spatial Overlap

Adults - A proportion of the adult spring-run Chinook salmon population will migrate upstream through both Sutter and Steamboat sloughs each year enroute to the mainstem Sacramento River. These fish are most likely to encounter site 37, which is located on Steamboat Slough near its junction with the Sacramento River. Adult spring-run are less likely to encounter locations on Elk Slough due to the presence of the culverts and gates at the upper end of the slough. This structure minimize flows from the Sacramento River from entering Elk Slough. Adult spring-run may also be present in Lindsey, Cache, and Shag sloughs in years when the Yolo Bypass is inundated and flood flows are entering the Delta at the lower end of the bypass. These flows would act as an attractant flow for upstream movements of salmon through the bypass to the upper Sacramento River. It is expected that adult spring-run will move through the reaches with repaired levee sites relatively quickly, taking from hours to a few days to transit these areas.

Juveniles – Downstream emigration of juvenile spring-run will be similar to that previously described for juvenile winter-run Chinook salmon in section 2.6.6.1.2.1. Unlike winter-run, juvenile spring-run Chinook salmon have two different life history expressions – a life history expression that emigrates as a young-of-the-year (YOY) fish (the predominant life history expression) and a second expression that emigrates after spending a year or more in the upper natal tributaries before emigrating to the ocean (yearlings). The yearling spring-run life history expression typically emigrates earlier in the water year (November through January) than the YOY life history expression (January through June with a peak in April). Routing of emigrating juveniles will be similar to that already described for the juvenile winter-run.

2.7.6.2.2.2 Effects to Individual Fish

Adults - It is not anticipated that adult spring-run Chinook salmon will be substantially affected by the altered shoreline habitat and armored levee faces of the rehabilitation sites. Adults do not actively feed during their upstream spawning migration and thus would not be affected by a loss of riparian habitat and food resources. Loss of shallow water and shoreline habitat complexity could diminish the formation of holding pools and current breaks, but adults could actively seek out areas adjacent to the rehabilitation sites to find these habitat characteristics, or move to other areas of the migration route that support these habitats.

Juveniles – The effects to individual fish will be similar to that already described for juvenile winter-run Chinook salmon in section 2.6.6.1.2.2. Juvenile spring-run, as previously described, have two life history expressions, YOY and yearling. Based on regional monitoring, yearling spring-run are believed to quickly move through the Delta system and enter the marine environment soon after entering the Delta. In contrast, YOY spring-run may spend a little more time rearing in the Delta as they enter the Delta at a smaller size than yearlings. Therefore, yearlings are expected to have less exposure time to the disturbed emergency rehabilitation sites than YOY and thus fewer effects from the altered habitat.

2.7.6.2.2.3 Effects to the CV Spring-run Chinook salmon ESU

Adults -. Since few if any adult spring-run Chinook salmon would be impacted by the long-term habitat disturbances caused by the Project's levee repairs, there will be little impact to the spring-run ESU as a whole. In typical years, most spring-run adults will stay in the mainstem Sacramento and never go past the rehabilitation sites during their upstream spawning migrations, thus there is no exposure to the Project's actions. In wet years when the Yolo Bypass is inundated, adult spring-run may use this route to migrate to the upper Sacramento, with most avoiding the rehabilitation sites on Lindsey, Cache, and Shag sloughs when entering the southern end of the bypass where flows enter the Delta. Furthermore, the proportion of area impacted by the nine rehabilitation sites is very small compared to the miles of waterways in the action area that are not impacted by the levee repairs. Adult fish can readily access these unaffected areas in the action area during their upstream migrations.

Juveniles – The effects to the juvenile population of CV spring-run will be similar to that already described for juvenile winter-run Chinook salmon in section 2.6.6.1.2.3. Approximately 30 to 40 percent of the population will enter Sutter and Steamboat sloughs where sites 31-34 and site 37 are located. Most fish that encounter a repair site will pass by site 37 on Steamboat Slough, while a smaller number of fish are expected to encounter sites 31-34 on Elk Slough. As presented earlier for juvenile winter-run, the majority of repair site encounters over the long term will result in non-lethal effects to juvenile CV spring-run Chinook. Only a small percentage of those fish encountering a repair site are expected to be predated upon because of the actual site disturbance and loss of habitat. The effects to the entire juvenile population of CV spring-run Chinook salmon is expected to be minor and have no substantial effect on the ESU.

2.7.6.3 California Central Valley Steelhead

2.7.6.3.1 Acute Construction Related Effects

2.7.6.3.1.1 Temporal and Spatial Overlap

Adults – Adult CCV steelhead will be present in the waterways of the action area during the in-water work window of July 1 through October 31. Adult steelhead begin to enter the Delta in July and peak in their abundance in September and October. Approximately 85 percent of the annual spawning population will pass through the Delta between July and the end of October (Hallock et al 1961). Most of the adult population will migrate through the mainstem of the

Sacramento River, but a sizeable percentage is expected to migrate upstream through the channels of Sutter and Steamboat Sloughs. Inundation of the Yolo Bypass by flood waters or discharge from tributaries such as Alamo Creek and Ulatis Creek are unlikely during the in-water construction period. Thus attraction flows into the Yolo Bypass migratory route to the upper Sacramento River or into the west side tributaries to Cache Slough will be unavailable to adult steelhead and their presence in the Cache Slough complex is unlikely until such flows occur.

Juveniles – Based on monitoring data from both the Sacramento trawl and the Chipps Island trawl, juvenile steelhead have the potential to be present in the Delta during the in-water work window, but in very low numbers (Figures 11 and 12). These fish probably represent the "tails" of the migratory temporal distribution as peak migrations occur during the winter (February and March) for each brood year. The spatial distribution of juvenile steelhead and exposure to emergency levee rehabilitation sites is assumed to be similar to juvenile winter-run Chinook salmon, based on potential routes and river flows at junctions described in Perry et al (2010). This distribution is described in section 2.6.6.1.1.1.

2.7.6.3.1.2 Effects to Individual Fish

Adults – Only adult steelhead that are holding adjacent to or migrating past the levee rehabilitation sites will be directly exposed or affected by construction related noise and activities. Those fish that are exposed to the effects of construction activities will encounter short-term (*i.e.*, minutes to hours) construction-related noise depending on how fast they move through the reach of river channel adjacent to the repair site. Although direct injury or harm is unlikely, behavioral avoidance may cause fish to delay their upstream migration or drop back downstream. Fish often respond to construction activities by quickly swimming away from the construction sites, resulting in the majority escaping direct physical injury. This effect is considered a form of harassment that results in the take of exposed fish. Effects are expected to be transitory as the Project description indicates that all construction activities will occur during the day, and no construction related activities will occur at night, thus giving an 8- to 12-hour reprieve from any construction related noise or activity. Furthermore, construction is scheduled to last no more than two to four weeks at each site, thus reducing the amount of exposure to fish utilizing those locations for holding or migration. Effects related to contaminants and turbidity are not expected to impact adults migrating through the action area due to the implementation of construction BMPs designed to limit these factors and the short duration of exposure anticipated for adults as they move through the action area. Finally, the majority of migrating adults are expected to remain in the Sacramento River mainstem and not encounter any of the Project's levee rehabilitation sites, thus having no exposure to any potential effects.

Juveniles - There is a low probability of exposure of juvenile steelhead to the effects of the active construction activities during the in-water work window. This is due to temporal and spatial separation of the Project's actions with the migratory timing and presence of juvenile steelhead in the Delta. If fish are present, they are unlikely to be exposed to conditions that will cause direct mortality or injury. It is expected that most of the responses of exposed fish will be behavioral in nature (harassment). NMFS expects the effects to be similar to those described previously for juvenile winter-run Chinook salmon in section .6.6.1.1.2, with the exception that fewer steelhead juveniles will be present at the end of the work window than in the beginning of the work window. NMFS also expects that the majority of juveniles migrating downstream will remain in the Sacramento River and that any presence in the action area will be a very small percentage of the juvenile population migrating in a given year.

2.7.6.3.1.3 Effects to the CCV Steelhead DPS

Adults – The majority of the currently existing populations of the CCV steelhead DPS originate in the Sacramento River basin (Northwestern California, Northern Sierra Nevada, and the Basalt and Porous Lava diversity groups) and are expected to utilize the action area as a migratory route to reach their spawning areas. Steelhead from the Southern Sierra Nevada diversity group are not expected to be present in the action area, and thus will not be affected by the Project's actions. The majority of adult steelhead migrating upstream are expected to use the mainstem of the Sacramento River as their migratory route, avoiding the locations of the Project's rehabilitation sites. A smaller percentage of the adult population will use the Sutter and Steamboat sloughs migratory route and may be exposed to the Project's construction actions. Thus, only a small percentage of the adult population will be exposed to the effects of the action. Since no lethal take of adult steelhead is expected from exposure to the action's activities and any non-lethal take is expected to be primarily due to harassment of fish by noise and activity, the CCV steelhead DPS will not be negatively impacted by the exposure of the Sacramento River basin steelhead populations to the effects of the action.

Juveniles – As described for the adult steelhead above, the majority of the juvenile steelhead comprising the CCV steelhead DPS originate in the Sacramento River basin and have the potential to migrate through the action area. Assuming that Chinook salmon and steelhead juveniles will have similar route selections at river junctions, then based on the route distribution of acoustically tagged late-fall Chinook salmon (Perry et al 2010) approximately 30-40 percent of the emigrating juvenile steelhead are expected to use Sutter and Steamboat sloughs to reach the western Delta. If less than 5 percent of the juvenile steelhead population is migrating downstream during the in-water work window (Figure 11), then a maximum of approximately 1.5 to 2 percent of the population will select routes that have emergency rehabilitation sites located on them. Most of these fish will have non-lethal exposures to the emergency rehabilitation sites and will continue migrating downstream. A smaller percentage is expected to be predated upon by predators associated with the emergency rehabilitation sites, and can be considered lethal take due to the action. The small numbers of fish migrating during the in-water work window coupled with the small percentage of fish actually lost to the Project's actions will not substantially affect the CCV steelhead DPS viability.

2.7.6.3.2 Long Term Effects

2.7.6.3.2.1 Temporal and Spatial Overlap

Adults – A proportion of the adult CCV Steelhead population will migrate upstream through both Sutter and Steamboat sloughs each year enroute to the mainstem Sacramento River. These fish are most likely to encounter site 37, which is located on Steamboat Slough near its junction with the Sacramento River. Adult steelhead are less likely to encounter locations on Elk Slough due to the presence of the culverts and gates at the upper end of the slough. This structure minimize flows from the Sacramento River from entering Elk Slough. Adult steelhead may also be present in Lindsey, Cache, and Shag sloughs in years when the Yolo Bypass is inundated and flood flows are entering the Delta at the lower end of the bypass. These flows would act as an attractant flow for upstream movements of steelhead through the bypass to the upper Sacramento River. In addition high flows from Alamo and Ulatis creeks, which discharge into the upper end of Cache Slough may attract adult steelhead migrations into Cache Slough. It is expected that adult steelehad will move through the reaches with repaired levee sites relatively quickly, taking from hours to a few days to transit these areas.

Juveniles - Downstream emigration of juvenile CCV steelhead will be similar to that previously described for juvenile winter-run Chinook salmon in section 2.6.6.1.2.1. Assuming that Chinook salmon and steelhead juveniles will have similar route selections at river junctions, then based on the route distribution of acoustically tagged late-fall Chinook salmon (Perry et al 2010) approximately 30-40 percent of the emigrating juvenile steelhead moving downstream in the Sacramento River are expected to use Sutter and Steamboat sloughs to reach the western Delta. In years when the Yolo Bypass floods, a sizeable proportion of the juvenile steelhead population from the upper Sacramento River basin is expected to be entrained into the bypass at the Fremont Weir and the Sacramento Weir. These fish will rear and migrate through the bypass to the lower end of the bypass where the bypass flows discharge into the Cache Slough complex, which includes Shag Slough, Lindsey Slough, and Cache Slough. Exposure to the rehabilitation sites in Shag Slough (sites 38 and39), Cache Slough (site 35), and Lindsey Slough (site 36) is possible if fish continue to rear in this area after exiting the Yolo Bypass.

Exposures to the disturbed riparian habitat and armored levee shoreline associated with the levee repairs are expected to last for a few hours to a few days for actively migrating juvenile steelhead within the action area. Exposure to these disturbed sites may be extended for fish that choose to rear in the waterways adjacent to the rehabilitation sites. However, due to the volitional swimming behavior of these juveniles, they can actively avoid the rehabilitation sites if they choose, thus minimizing the length of exposure.

2.7.6.3.2.2 Effects to Individual Fish

Adults – Adult steelhead moving upstream towards their spawning locations are not likely to be exposed to any lethal conditions as a result of the habitat disturbances created at the emergency levee rehabilitation sites. It is expected that the diminishment of invertebrate forage base due to habitat disturbance and simplification will have little effect on adult migrants for two main reasons. First, adult steelhead on their upstream spawning migration engage in minimal feeding behavior, and second, if adult steelhead choose to feed, they can volitionally move to better foraging habitats adjacent to the levee rehabilitation sites in the action area. Most of the adult upstream migrants will avoid the levee rehabilitation sites by staying in the mainstem Sacramento, or taking routes with minimal exposure to those sites. Loss to predation is unlikely due to the size of returning adult steelhead.

Adult steelhead may also be present in Lindsey, Cache, and Shag sloughs in years when the Yolo Bypass is inundated and flood flows are entering the Delta at the lower end of the bypass. These flows would act as an attractant flow for upstream movements of steelhead through the bypass to the upper Sacramento River. In addition, high flows from Alamo and Ulatis creeks, which discharge into the upper end of Cache Slough, may attract adult steelhead migrations into Cache Slough. It is not expected that exposure to any of the emergency rehabilitation sites in this part of the action area will result in anything but non-lethal effects. As with other emergency rehabilitation sites, adult fish can easily move to adjacent habitat to forage if necessary, and exposure will be transitory as fish move upstream on their spawning migrations.

Steelhead may also survive their spawning activities and migrate back downstream as kelts. On their return to the ocean, steelhead kelts will actively feed to replace the energy stores lost due to spawning. As described for the upstream migrants, the majority of fish returning to the Delta and ocean via the Sacramento River will stay in the mainstem of the river and not be exposed to the emergency levee rehabilitation sites. Assuming that adults will also move into the channels of Suttter and Steamboat sloughs in the same proportion as juvenile fish, approximately 30-40 percent of the steelhead kelts will leave the mainstem Sacramento River, however not all of these fish will choose a route with an emergency levee repair site on it (i.e. Sutter Slough). For those fish that migrate past a levee repair site (such as site 37 on Steamboat Slough), there will be a temporary decline in the available forage prey base due to the disturbed aquatic and riparian habitat associated with the repair site. However, exposure will be transitory as adult fish can easily move to adjacent habitat that was not disturbed by the Project and forage on the prey base in those areas. Loss due to predation associated with the emergency repair site is unlikely due to the size of steelhead kelts and the predators they are likely to encounter. Only a very large striped bass would be able to predate upon a smaller sized adult steelhead kelt. Kelts may also migrate downstream through the Yolo Bypass when it is inundated and enter the Delta at its lower terminus in the Cache Slough complex. Only non-lethal effects are anticipated for fish using this migratory route, as adults can easily move to adjacent habitat to forage with minimal effort.

Finally, the disturbed sites will eventually return to their pre-construction habitat status with the passage of time. It is expected that sediment will build up in the nearshore areas and support the growth of SAV along the toe of the levee. Likewise, vegetation is expected to recolonize the levee face from seeds planted immediately after the conclusion of construction (native grasses and plants) for remediation, as well as volunteers and natural seed drift coming from surrounding areas. During high river flows, IWM is expected to become lodged on the repaired levee face, and at least temporarily provide cover along the face of the levee.

Juveniles – Juvenile steelhead will typically migrate into the Delta from January to June. Juveniles can either stay in the Sacramento River migration route to the Delta or when the Yolo Bypass is inundated, migrate through this route to the Delta. Fish that remain in the Sacramento River migration can either take the mainstem of the Sacramento River to the Delta or enter the Sutter and Steamboat sloughs route and enter the Delta in the Cache Slough complex. Regardless of the route, exposure to the emergency rehabilitation sites will result in non-lethal effects to the juvenile steelhead. Fish encountering an emergency repair site will have a temporary reduction in feeding opportunities due to the simplified habitat available and the reduction in forage base prey organisms. Juvenile fish can minimize this effect simply by swimming to adjacent habitat that was not disturbed, and continue to feed. There will be some predation associated with these disturbed sites, as habitat is simplified with minimal refugia from predators, and exposure to predators will increase. However, exposure times are anticipated to be short and juvenile steelhead can seek shelter in adjacent habitat that is not disturbed by the Project.

As described above for adult steelhead, the emergency rehabilitation sites are expected to return to their pre-construction habitat status with the passage of time. Any effects associated with the disturbed habitat will eventually diminish to the point that they are indistinguishable from surrounding undisturbed habitat.

2.7.6.3.2.3 Effects to the CCV Steelhead DPS

Adults - The majority of the currently existing populations of the CCV steelhead DPS originate in the Sacramento River basin (Northwestern California, Northern Sierra Nevada, and the Basalt and Porous Lava diversity groups) and are expected to utilize the action area as a migratory route to reach their spawning areas. Steelhead from the Southern Sierra Nevada diversity group are not expected to be present in the action area, and thus will not be affected by the Project's actions. Since the majority of adults will not be exposed to any of the emergency rehabilitation sites, and those that are exposed are most likely to experience only non-lethal effects, there are no effects to the viability of the CCV steelhead DPS.

Juveniles – Juvenile steelhead migrating through the action area will come from the Sacramento River basin and the DPS diversity groups that originate in that basin. It is not expected that any juveniles from the Southern Sierra Nevada diversity group will be present in the action area, and thus will not be affected by the Project's actions. As described in the previous section, the majority of the effects to exposed fish associated with the long-term impacts of the action will be non-lethal. There will be some fish that will be predated upon due to habitat disturbances at the emergency rehabilitation sites and lost to the population, but this number is considered to be small in comparison to the number of fish that pass through the impacted reach. The proportion of the annual juvenile steelhead population that will actually be exposed to any of the emergency rehabilitation sites is low, based on fish distributions into the action area and the likelihood of exposure to any of the emergency rehabilitation sites. Therefore, the actual number of fish lost to the DPS population is very low, and the number of fish that experience non-lethal effects is marginally larger. Thus, there are no effects to the viability of the CCV steelhead DPS related to the Project's actions.

2.7.6.4 sDPS of North American Green Sturgeon

2.7.6.4.1 Acute Construction Related Effects

2.7.6.4.1.1 Temporal and Spatial Overlap

Adults – Adult green sturgeon are expected to be present year-round in the Delta. Peak presence is during the upstream spawning migration from approximately February through June. Post-spawn adults move back downstream following spawning, but spend varying lengths of time resting upriver before returning downstream. Some individuals move back downstream almost immediately following spawning, while other individuals won't move back downstream for several months until late-fall storms stimulate their downstream migration with cooler water temperatures and increased river flows.

It is unknown what the spatial distribution of adult green sturgeon migration routes are, but it is assumed that most would remain in the main channel of the Sacramento River. However, it is likely that some individuals will use the Sutter Slough and Steamboat Slough migratory routes to access the lower Delta. A further complication to spatial distribution of migratory routes is that adult green sturgeon may spend additional time in the Delta before moving back to the marine environment. These fish could move back and forth into different Delta waterways that are different than their initial downstream migratory route, foraging and holding, until they return to the ocean. During this time, they could encounter any one of the emergency levee rehabilitation sites described for the Project during the in-water work window. For example, anglers in the Sacramento Deepwater Ship Channel, as well as the Cache Slough complex, frequently catch sturgeon, both white sturgeon (*A. transmontanus*) and green sturgeon, throughout the year, which places these fish in the same proximity as the emergency levee repair locations on Shag, Lindsey, and Cache sloughs. Thus, all of the proposed emergency levee rehabilitation sites have the potential to have adult sturgeon present during the in-water work window.

Juveniles – Juvenile green sturgeon may rear for up to three years in the Delta before finally emigrating to the marine environments along the continental shelf. It is believed that juveniles make use of all accessible waterways in the Delta to rear during this period, including all of the waters in the action area. Furthermore, for juveniles moving downstream from their natal rearing areas in the upper Sacramento River basin, a proportion is expected to enter either Sutter or Steamboat sloughs during the in-water work window. Therefore, juvenile green sturgeon presence is assumed to occur at all of the proposed emergency levee rehabilitation sites during the in-water work window for construction activities.

2.7.6.4.1.2 Effects to Individual Fish

Adults – For those adults that are in proximity to the emergency levee rehabilitation sites during active construction, NMFS believes that only non-lethal behavioral modifications will occur. NMFS does not anticipate that any lethal effects will occur to adults following exposure to noise or bank-side activities related to the construction activities. Exposed fish are expected to move away from the disturbance and noise to waters that are quieter and have less activity, resuming foraging or holding behavior. Any delays to movements are temporary. Fish can continue their movements during the night when construction activities cease until the next morning.

Additional reductions to the magnitude of Project related effects are due to the short duration of construction activities during the in-water work window. Construction activities are scheduled to last only two to four weeks at each repair site during the 4-month long in-water work window. Following the completion of construction, there will be no more Project related construction noise or bankside activities to disrupt the behavior of adult green sturgeon in the adjacent channels.

NMFS does not expect any demonstrable effects to adult green sturgeon due to turbidity or contaminants related to Project activities. The Project will adhere to construction BMPs that will minimize the effects or potential release of turbidity plumes with silt curtains. Any turbidity released after the removal of the silt curtains is not anticipated to reach a magnitude that would adversely affect green sturgeon, a species that is typically found in the turbid waters of the Delta and San Francisco Bay estuary. The release of contaminants is also unlikely due to the spill prevention and clean up components of the Project's BMPs. These components of the BMPs are designed to prevent spills or leaks before they can occur, and if they do occur, quickly containing them and cleaning them up before they can enter adjacent waterways.

Juveniles – Effects to juveniles are expected to be the same as those described for adult green sturgeon. NMFS does not anticipate any lethal effects from construction activities. Like the effects to adults, juveniles are most likely to have behavioral modifications. Fish are expected to move away from noise and disturbances to quieter areas of the adjacent waterways, and resume their normal behaviors. These effects are considered non-lethal and temporary in duration.

2.7.6.4.1.3 Effects to the sDPS of North American Green Sturgeon

Adults – No effects to the viability of the sDPS of green sturgeon is expected from the exposure to Project's construction activities. Since exposure to the effects will result in only non-lethal responses, which are temporary in nature, there are no lasting effects to the individual fish and hence the DPS as a whole.

Juveniles – There are no effects to the viability of the sDPS of green sturgeon due to exposure to the Project's construction activities. Since only non-lethal behavioral effects are expected, and individuals are anticipated to fully recover from these effects, there is no loss of any individual fish to the overall population. Thus there is no diminishment in abundance or any of the other elements that affect the viability of the DPS.

2.7.6.4.2 Long Term Effects

2.7.6.4.2.1 Temporal and Spatial Overlap

Adults – The temporal and spatial distribution of adult green sturgeon in relationship to the action area is the same as previously described for section 2.6.6.4.1.1. Since adult green sturgeon are present year-round in the action area, there is no discernable difference in the distribution of adults between the acute construction phase and the long-term project effects in the action area.

Juveniles – The temporal and spatial distribution of juvenile green sturgeon in the action area is the same as previously described for section 2.6.6.4.1.1. Since juvenile green sturgeon are present year-round in the action area, there is no discernable difference between the distribution of juveniles in the acute construction phase and the long-term project effects phase.

2.7.6.4.2.2 Effects to Individual Fish

Adults – Adult green sturgeon will be able to move through the reaches of waterways adjacent to the emergency rehabilitation sites without delay or impediment due to noise or shoreside activity on the levee related to Project actions. There will initially be a decline in food resources available in the nearshore areas due to the repairs of the levees and the resulting simplified habitat as previously explained for Chinook salmon and steelhead. Even though it is expected that there will be a diminishment of food resources due to the removal of shallow water benthic habitat and the riparian vegetation above the water line, both of which supply invertebrates to the adjacent waterway, the overall supply of food resources in the adjacent reaches of the channel will not be affected. Individual fish can volitionally move away from the disturbed rehabilitation sites to find undisturbed habitats with food resources. This effect is considered non-lethal to adult green sturgeon.

The riparian and nearshore habitats associated with the emergency rehabilitation sites will initially be highly disturbed and offer little ecological function. However, over several years to decades, these sites will regain their ecological function as they transition to a more mature phase of channel habitat similar to adjacent undisturbed shoreline habitats. It is expected that new riparian growth will become established on the face of the levee, trapped sediments will create shallow water habitat along the toe of the levee, allowing SAV to take root, and that IWM will become snagged on the levee face following high water flows to create more shoreline complexity. Eventually, the effects of the Project on individual fish will no longer be discernable from adjacent levee reaches in the action area.

Juveniles – The same effects as described for adult green sturgeon in the previous section are expected to apply to juvenile green sturgeon. All effects associated with the long term aspects of the Project are expected to be non-lethal to juvenile sturgeon.

2.7.6.4.2.3 Effects to the sDPS of North American Green Sturgeon

Adults – The long-term effects of the Project are not anticipated to change the viability of the sDPS of North American green sturgeon. All effects are considered non-lethal and fish will not likely have any lasting changes to their health or survival due to the Project.

Juveniles – There will be no change to the viability of the sDPS of North American green sturgeon due to the long-term effects of the Project. All effects are considered non-lethal and fish will not likely have any lasting changes to their health or survival due to the Project.

2.7.6.5 Mitigation

As compensatory mitigation for these emergency levee rehabilitation impacts, DWR purchased credits from a NMFS-approved conservation bank (Liberty Island Conservation Bank) at a 3:1 ratio for all habitat impacted below the OHWM and 2:1 for habitat impacted above the OHWM. This purchase totaled 2.317 acres of credit at the Liberty Island Conservation Bank. The bank has a service area that includes all of the sites of the levee repairs and will benefit rearing juvenile Sacramento River winter-run Chinook salmon, CV spring-run Chinook, and juvenile CCV steelhead from the same diversity groups impacted by the Project. The habitat provided in these banks is the same type of habitat impacted by the levee repair (shallow freshwater habitat, SRA habitat, and Tule Marsh SRA habitat). The habitats in this 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, tidally influenced channels, Tule marshes, and cooler stream temperatures. Although the bank technically does not include green sturgeon credits (only salmonid credits), we expect that individual 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. The purchase of credits at this bank benefits green sturgeon from the sDPS.

2.7.7 Summary of Project Effects on CV Spring-run Chinook salmon, CCV steelhead and sDPS Green Sturgeon Critical Habitat

Within the Project's action area, there is designated critical habitat for CV spring-run Chinook salmon, CCV steelhead, and sDPS green sturgeon. The action area does not include designated critical habitat for Sacramento River winter-run Chinook salmon.

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 primarily be affected by removal of shore side vegetation, placement of riprap on the levee face both above and below the waterline, and disturbances of the shallow water habitat adjacent to the toe of the levee. These activities are expected to reduce the quality of this habitat for rearing and migrating juvenile salmonids. As discussed in the previous sections, these habitat effects are considered to be transitory, and will be resolved over the course of several years as the habitat transforms to a more natural state through ordinary ecological processes. In some cases, migration may be temporarily delayed due to noise and bankside activities for yearling CV spring-run and CCV steelhead smolts that may be present during the in-water work window for construction. The PBF of migratory corridors for adults is not expected to be impacted for spring-run Chinook salmon, but will be for steelhead. Although migrating adult Chinook salmon and steelhead are unlikely to use the nearshore habitat that will be most affected by this project, preferring to use the deeper water of the channel thalweg for migratory movements, the sound of construction will carry across the width of the channels at each repair location. These delays to migration will be temporary as fish can move again at night when construction ceases, or simply pass through the disturbances as it happens since the magnitude of sound energy will never reach the level of injury or mortality, but is only a behavioral deterrent to passage. Furthermore, the construction related sound delays will only last approximately two to four weeks at each repair site location, then cease with the end of construction. The project did not install any features that are expected to permanently block or impede juvenile or adult migration.

Green sturgeon PBFs of migratory corridors, substrate type/size, and food resources are expected to be adversely affected by the project. Construction noise and activities may cause a delay in green sturgeon movements for both adult and juvenile fish. However, as described in the effects synthesis above, these delays are transitory as fish can move at night to avoid the noise or simply move to another area of the river to carry out their normal behaviors, including feeding and holding. Furthermore, the delays are of short duration as the construction at each site will last only two to four weeks, and then the construction related sounds will cease with the conclusion of construction activities. Modification of the nearshore environment, including the levee face and toe, will cover the soft benthic substrate where green sturgeon forage for food with riprap, reducing initial food availability. However, the amount of benthic substrate initially lost is small compared to the amount of available habitat in the waterways of the action area, negligibly reducing food resources. Furthermore, the loss is considered temporary, as the newly placed substrate will eventually become colonized with new aquatic organisms, including invertebrates, which may serve as potential forage prey for sturgeon. With the passage of time, the disturbed areas of the emergency levee rehabilitation sites will become indistinguishable from the adjacent undisturbed channel banks that were not part of the Project.

As discussed in Section 2.6.6.5 above, as mitigation for these impacts, DWR purchased credits from a NMFS-approved conservation bank at a 3:1 ratio for all habitat impacted below the OHWM and 2:1 for habitat impacted above the OHWM. 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 shallow freshwater, floodplain and SRA habitat. Although the banks technically do not include green sturgeon credits, we expect that PBF of food resources will benefit from the purchase of these credits, as the banks provide areas with soft benthic substrate where juvenile and adult green sturgeon can forage.

2.8 Conclusion

After reviewing and analyzing the current status of the listed species and critical habitat, the environmental baseline within the action area, the effects of the proposed action, any effects of interrelated and interdependent activities, and cumulative effects, it is NMFS' biological opinion that the proposed action is not likely to jeopardize the continued existence of Sacramento River winter-run Chinook salmon, CV spring-run Chinook salmon, CCV steelhead, and sDPS of the North American green sturgeon. The project will not adversely modify designated critical habitat for CV spring-run Chinook salmon, CCV steelhead, and sDPS of North American green sturgeon. Designated critical habitat for Sacramento River winter-run Chinook salmon does not occur within the action area of this Project. This conclusion does not rely on the purchase of mitigation bank credits to support its non-jeopardy or no adverse modification determination.

2.9 Incidental Take Statement

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

2.9.1 Amount or Extent of Take

NMFS anticipates incidental take of Sacramento River winter-run Chinook salmon, CV spring-run Chinook salmon, CCV steelhead, and the sDPS of North American green sturgeon in the action area through the implementation of the Proposed Action. Because of the proposed timing of the in-water work for the construction phase of the Project, actual numbers of fish adversely affected by the construction actions are expected to be low. Only adult CCV steelhead and juvenile and adult sDPS green sturgeon will be present in the action area in any substantial numbers during the in-water construction period, but may not always be present at the emergency levee rehabilitation sites during actual construction due to the migratory routing and variability in spatial and temporal distribution within the action area. Only small numbers of individual juveniles from the Sacramento River winter-run and CV spring-run ESUs are expected to be present in the action area during this in-water construction period. Greater numbers of individuals from the four listed species are expected to be present in the action area over the long term, and will be present in the action area in greater numbers than during the construction phase. These fish will be exposed to the post-construction emergency levee rehabilitation sites, and take will occur.

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

The most appropriate threshold for incidental take, is an ecological surrogate of habitat disturbance, which includes the loss of SRA cover and riparian habitat through the placement of rock revetment and removal of vegetation, reduction in the growth and survival of individuals from predation, or by causing fish to relocate and rear in other locations and reduce the carrying capacity of the existing habitat. NMFS will describe (1) the causal link between the surrogate and take of the species; (2) why it is not practical to express the amount of anticipated take or to monitor take related impacts in terms of individuals of the listed species; and (3) sets a clear standard for determining when the amount or extent of the taking has been exceeded.

The behavioral modifications or fish responses that result from the habitat disturbance are described below. NMFS anticipates annual take will be limited to the following forms:

1. Take of listed fish at each of the rehabilitation sites in the form of behavioral modifications (harassment) and increased predation vulnerability is expected to occur during the construction phase due to construction-related sound and shoreline activity. Long term behavioral modifications and increased predation vulnerability resulting from loss and degradation of shoreline riparian habitat and shallow water habitat is also expected to occur until the sites become functional again after many years of natural habitat transformations (i.e., regrowth of riparian and shoreline vegetation, and natural riverine processes creating shallow water benches supporting SAV and deposition of LWM on the shoreline). Quantification of the number of fish exposed to noise, shoreline activities, and increases in predation vulnerability are not currently possible with available monitoring data. Observations of individual fish within the river channel are not possible due to water clarity and depth. However, all fish passing through or otherwise present in the action area during construction activities or over the long term during their adult and juvenile rearing and migratory life history stages will be exposed to the disturbed shoreline habitat associated with the rehabilitation sites. Thus, the footprint of each rehabilitation site defines the area in which projected take will occur for this Project due to the effects of construction actions and the long term habitat disturbance associated with each site. Harm to rearing juvenile Sacramento River winter-run Chinook salmon, CV spring-run Chinook salmon, and CCV steelhead, and adult and juvenile sDPS green sturgeon from the repair of a cumulative 1.096 acres of levee bank above the OHWM, and a cumulative area of 0.930 acres below the OHWM. This loss will affect juvenile Sacramento River winter-run Chinook salmon, CV spring-run Chinook, CCV steelhead, and juvenile and adult sDPS green sturgeon through displacement, increased predation, and loss of food, resulting in decreased growth and survival. The following table describes the anticipated area of disturbed habitat representing the ecological surrogate of take at each emergency levee rehabilitation site location.

Table 10. ecological surrogate of take at each emergency levee rehabilitation site location.

Site #	Site Designation	Water Body	County	Length (ft)	Area of Repair (acres)	Area Below OHWM (acres)	Area above OHWM (acres)
31	LMA-119	Elk Slough	Yolo	105	0.179	0.064	0.115
32	LMA-122	Elk Slough	Yolo	145	0.109	0.066	0.043
33	LMA-139	Elk Slough	Yolo	130	0.126	0.067	0.059
34	LMA-140	Elk Slough	Yolo	138	0.137	0.049	0.088
35	LMA-216	Cache Slough	Solano	81	0.110	0.035	0.075
36	LMA-191	Lindsey Slough	Solano	100	0.080	0.030	0.050
37	LMA-147	Steamboat Slough	Sacramento	190	0.284	0.211	0.073
38	LMA-283	Shag Slough	Solano	380	0.329	0.128	0.201
39	LMA-285	Shag Slough	Solano	927	0.672	0.280	0.392
			Total acres		2.026	0.930	1.096

2. Harm to rearing juvenile Sacramento River winter-run Chinook salmon, spring-run CV Chinook salmon, CCV steelhead, and sDPS green sturgeon from construction activities, resulting in increased turbidity in the footprint of the proposed Project at emergency levee rehabilitation repair sites, extending upstream and downstream (due to tidal flow) 400 feet from the ends of the site and 100 feet from the bank. This disturbed habitat will affect the behavior of fish, including displacement which is reasonably certain to result in fish migration delay, leading to increased predation, decreased feeding, and increased competition. NMFS does not expect to see any direct mortality or morbidity of these fish due to exposure to construction related turbidity. Quantification of the number of fish exposed to turbidity is not currently possible with available monitoring data. Observations of individual fish within the river channel are not possible due to water clarity and depth. However, all fish passing through or otherwise present during construction activities at the rehabilitation sites will be exposed to potential construction related turbidity events, particularly when the silt curtains are removed. Thus, the waterside footprint of each rehabilitation site plus the additional area (length and width) of river channel where turbidity effects are expected to be observed defines the area in which projected take will occur for this Project due to the effects of construction related turbidity. The following table describes the anticipated area of disturbed habitat due to turbidity representing the ecological surrogate of take at each emergency levee rehabilitation site location.

Table 11. Ecological surrogate of take at each emergency levee rehabilitation site location.

Site #	Site Designation	Water Body	County	Length (ft)	Area of Impact (ft^2)
31	LMA-119	Elk Slough	Yolo	905	90,500
32	LMA-122	Elk Slough	Yolo	945	94,500
33	LMA-139	Elk Slough	Yolo	930	93,000
34	LMA-140	Elk Slough	Yolo	938	93,800
35	LMA-216	Cache Slough	Solano	881	88,100
36	LMA-191	Lindsey Slough	Solano	900	90,000
37	LMA-147	Steamboat Slough	Sacramento	990	99,000
38	LMA-283	Shag Slough	Solano	1180	118,000
39	LMA-285	Shag Slough	Solano	1727	172,700
			Total Area (square feet)		939,600

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

2.9.2 Effect of the Take

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

2.9.3 Reasonable and Prudent Measures

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

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

2. Measures shall be taken to monitor incidental take of listed fish and the survival of on-site plantings.

2.9.4 Terms and Conditions

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

1. The following terms and conditions implement reasonable and prudent measure 1:

   a. The Corps shall minimize the removal of existing riparian vegetation and IWM to the maximum extent practicable, and where appropriate, removed IWM will be anchored back into place from the location from which it was removed. Ideally, IWM would be placed to ensure coverage of 80 percent of the shoreline at each erosion repair site and this should persist for at least 50 years (or an alternative duration based on the size of the project and the professional expertise of the Corps' or applicant's staff and knowledge or the duration of expected potential impacts). If IWM fails, it shall be replaced to meet the 80 percent shoreline coverage within one year.

   b. Measures should be taken, to the extent practicable, to minimize the placement of rock revetment below the OHWM of freshwater rearing and migratory corridors. Consider using alternative methods to traditional rock slope protection for levee repairs. For instance, bioengineered products and strategic plantings of small trees and brush are consistent with Project goals to resist erosive forces and wave wash along shorelines and are good alternatives to using riprap.

   c. The use of filter fabric or geotextile fabrics should be avoided to the extent practicable, as they can often be used incorrectly and often are unnecessary. Erosion can occur behind the filter fabric causing the bank to fail, or the fabric can create a slip-face and cause the rock slope protection to slip, exposing the fabric. Consider using gravel "blankets," which can accomplish similar goals to geotextile fabrics without adverse effects described.

   d. To reduce the adverse impacts of predation associated with the placement of rock revetment with larger interstitial voids below the water line (OHWM), NMFS recommends mixing smaller rock with the quarry stone to achieve an average rock diameter of no more than 8 inches. This reduces the size of the interstitial voids that could harbor predators.

   e. Emergency levee rehabilitation sites sites should be re-vegetated onsite preferably including small trees and shrubs, as well as native grasses, at a 3:1 ratio immediately following the completion of the proposed project for any area where existing vegetation is removed or disturbed to facilitate the development of riparian habitat and minimize impacts to designated critical habitat. A detailed re-vegetation plan shall be provided to NMFS prior to the initiation of replanting and should include a list of species and designs depicting the proposed location for each species and their density. The plan should also include the success criteria for the re-vegetation effort to meet the Project's conservation goals. Where appropriate, the vegetation plan should also include proposed irrigation and vegetation monitoring schedules which will likely be needed for several years to obtain conservation goals.

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

   a. A vegetation monitoring report shall be provided to NMFS at years 1, 3, and 5 post-construction no later than December 31st of each reporting cycle. This report shall provide information as to the success of the revegetation program and whether the conservation goals are being met at each site. If goals are not being met, then the report should indicate what actions are being implemented to meet those goals. The reports will be submitted to the address below.

   b. The USACE shall submit a report to NMFS of any incidental take that occurs as part of the project. This report shall be submitted not later than December 31st 2018.

   c. All reports for NMFS shall be sent to:

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

2.10 Conservation Recommendations

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

1. The Corps should minimize any potential for take whenever possible, and implement practices that avoid or minimize negative impacts to salmon, steelhead, and sturgeon and their critical habitat.

2. The Corps should support and promote aquatic and riparian habitat restoration within the Delta and other watersheds, especially those with listed aquatic species. Practices that avoid or minimize adverse effects to listed species should be encouraged.

3. The Corps should continue to work cooperatively with State and Federal agencies, private landowners, governments, and local watershed groups to identify opportunities for cooperative analysis and funding to support salmonid habitat restoration projects.

4. The Corps should make set-back levees integral components of their authorized bank protection or ecosystem restoration efforts.

5. The Corps should conduct or fund studies to identify set-back levee opportunities, at locations where the existing levees are in need of repair or not, where set-back levees could be built now. Removal of the existing riprap from the abandoned levee should be investigated in restored sites and anywhere removal does not compromise flood safety.

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

2.11 Reinitiation of Consultation

This concludes formal consultation for the 2017 Storm Damage DWR Emergency Rehabilitation Phase 3 Critical Repair Project.

As 50 CFR 402.16 states, reinitiation of formal consultation is required where discretionary Federal agency involvement or control over the action has been retained or is authorized by law and if: (1) the amount or extent of incidental taking specified in the incidental take statement is exceeded, (2) new information reveals effects of the agency action that may affect listed species or critical habitat in a manner or to an extent not considered in this opinion, (3) the agency action is subsequently modified in a manner that causes an effect to the listed species or critical habitat that was not considered in this opinion, or (4) a new species is listed or critical habitat designated that may be affected by the action.

3. MAGNUSON-STEVENS FISHERY CONSERVATION AND MANAGEMENT ACT ESSENTIAL FISH HABITAT CONSULTATION

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. For the purposes of interpreting the definition of EFH, "waters" includes aquatic areas and their associated physical, chemical, and biological properties that are used by fish, and may include areas historically used by fish where appropriate; "substrate" includes sediment, hard bottom, structures underlying the waters, and associated biological communities; "necessary" means habitat required to support a sustainable fishery and a healthy ecosystem; and, "spawning, breeding, feeding, or growth to maturity" covers all habitat types used by a species throughout its life cycle.

This analysis is based, in part, on the EFH assessment provided by the United States Army Corps of Engineers (Corps) and descriptions of EFH for Pacific coast salmon as described in Amendment 18 to the Pacific Coast Salmon Plan (Pacific Fisheries Management Council [PFMC], 2014) contained in the fishery management plans (FMP) developed by the PFMC and approved by the Secretary of Commerce.

The proposed Project area is within the region identified as EFH for Pacific salmon in Amendment 18 of the Pacific Coast Salmon FMP. The Corps is receiving this consultation under the MSA for potential impacts to the EFH of Pacific salmon as a result of implementing the 2017 Storm Damage Department of Water Resources Emergency Rehabilitation Phase 3 Project (Project) in USGS Hydrologic Unit Code (HUC) 18020109 (Lower Sacramento).

The PFMC has identified and described EFH, Adverse Impacts and Recommended Conservation Measures for salmon in Amendment 18 to the Pacific Coast Salmon FMP (PFMC 2014). Freshwater EFH for Pacific salmon in the California Central Valley includes waters currently or historically accessible to salmon within the Central Valley ecosystem as described in Myers *et al.* (1998). Sacramento River winter-run Chinook salmon (*Oncorhynchus tshawytscha*), Central Valley spring-run Chinook salmon (*O. tshawytscha*), and Central Valley fall-/late fall-run Chinook salmon (*O. tshawytscha*) are species managed under the Salmon Plan that occur in the USGS HUCs described in Amendment 18.

3.1 Essential Fish Habitat Affected by the Project

The geographic extent of freshwater EFH is identified as all water bodies currently or historically occupied by Council-managed salmon as described in Amendment 18 of the Pacific Coast Salmon Plan. In the estuarine and marine areas, salmon EFH extends from the extreme high tide line in nearshore and tidal submerged environments within state territorial waters out to the full extent of the Exclusive Economic Zone (EEZ) (200 nautical miles or 370.4 km) offshore of Washington, Oregon, and California north of Point Conception. The proposed Project occurs in the area identified as "freshwater EFH", as it is above the tidal influence where the salinity is above 0.5 parts per thousand.

The implementing regulations for the EFH provisions of the MSA (50 CFR part 600) recommend that the FMPs include specific types or areas of habitat within EFH as "habitat areas of particular concern" (HAPC) based on one or more of the following considerations: (1) the importance of the ecological function provided by the habitat; (2) the extent to which the habitat is sensitive to human-induced environmental degradation; (3) whether, and to what extent, development activities are, or will be, stressing the habitat type; and (4) the rarity of the habitat type. Based on these considerations, the Council designated five HAPCs: (1) complex channels and floodplain habitats; (2) thermal refugia; (3) spawning habitat; (4) estuaries; and (5) marine and estuarine SAV. No HAPCs occur in the Project area or will be affected by the Project.

3.2 Adverse Effects on Essential Fish Habitat

The proposed Project is considered to have multiple non-fishing activities that affect EFH for Pacific salmon as described in Amendment 18 to the Pacific Coast Salmon FMP. The following actions are considered to have potential adverse effects on the freshwater EFH in the action area of the Project:

1) *Bank Stabilization and Protection* – The proposed Project has components that will entail bank stabilization and protection activities in the action area which includes freshwater EFH. The alteration of riverine and estuarine habitat from bank and shoreline stabilization, and protection from flooding events can result in varying degrees of change in the physical, chemical, and biological characteristics of existing shoreline and riparian habitat. Human activities removing riparian vegetation, armoring, relocating, straightening and confining stream channels and along tidal and estuarine shorelines influences the extent and magnitude of stream bank erosion and down-cutting in the channel. In addition, these actions have reduced hydrological connectivity and availability of off-channel habitat and floodplain interaction. Armoring of shorelines to prevent erosion and maintain or create shoreline real estate simplifies habitats, reduces the amount of intertidal habitat, and affects nearshore processes and the ecology of a myriad of species (Williams and Thom 2001).

2) *Flood Control Maintenance* - The protection of riverine and estuarine communities from flooding events can result in varying degrees of change in the physical, chemical, and biological characteristics of existing shoreline and riparian habitats. Managing flood flows with flood control structures such as levees can disconnect a river from its floodplain eliminating off-

channel habitat important for salmon. Floodplains serve as a natural buffer to changes in water flow: retaining water during periods of higher flow and releasing it from the water table during reduced flows. These areas are typically well vegetated, lowering water temperatures, regulating nutrient flow and removing toxins. Juvenile salmon use these off channel areas because their reduced flows, greater habitat complexity and shelter from predators may increase growth rates and their chance of survival. Artificial flood control structures have similar effects on aquatic habitat as does the efforts to stabilize banks and remove woody debris. The function of natural stream channels and associated riparian areas and the effects of flood control structures such as levees has been discussed in section 2.4.1.4 of this biological opinion.

3) *Wetland and Floodplain Alterations* – Pacific salmon evolved in the Central Valley with an extensive and complex floodplain adjacent to the river, with many channels and sloughs dissecting the plain and extensive wetlands and marshes fringing the waterways. Most of these floodplains and associated wetlands and marshes have been lost to anthropogenic causes. Floodplains, including side channels, and wetlands throughout the region have been converted through diking, draining, and filling to create agricultural fields, livestock pasture, areas for ports, cities, and industrial lands. The construction of dikes, levees, roads, and other structural development in the floodplain that confine the river have further effects on salmon habitat (PFMC 2014). As described in Amendment 18, a river confined by adjacent development and/or flood control and erosion control structures, can no longer move across the floodplain and support the natural processes that 1) maintain floodplain connectivity and fish access that provide velocity refugia for juvenile salmon during high flows; 2) reduce flow velocities that reduce streambed erosion, channel incision, and spawning redd scour; 3) create side channels and off-channel areas that shelter rearing juvenile salmon; 4) allow fine sediment deposition on the floodplain and sediment sorting in the channel that enhance the substrate suitability for spawning salmon; 5) maintain riparian vegetation patterns that provide shade, large wood, and prey items to the channel; 6) provide the recruitment of large wood and spawning gravels to the channel; 7) create conditions that support hyporheic flow pathways that provide thermal refugia during low water periods; and 8) contribute to the nutrient regime and food web that support rearing and migrating juvenile salmon in the associated mainstem river channels.

3.3 Essential Fish Habitat Conservation Recommendations

The Corps should implement the following conservation measures to offset the adverse effects described in section 3.2 above. In order to avoid or minimize the effects to EFH, NMFS recommends the following conservation measures described in Amendment 18 to the Pacific Coast Salmon FMP:

1) *Bank Stabilization and Protection*

- Minimize the loss of riparian habitats as much as possible.
- Bank erosion control should use vegetation methods or “soft” approaches (such as beach nourishment, vegetative plantings, and placement of IWM) to shoreline modifications whenever feasible. Hard bank protection should be a last resort and the following options should be explored (tree revetments, stream flow deflectors, and vegetative riprap.

- Re-vegetate sites to resemble the natural ecosystem community.
- Replace in-stream fish habitat by providing root wads, deflector logs, boulders, rock weirs and by planting shaded riverine aquatic cover vegetation.
- Use an adaptive management plan with ecological indicators to oversee monitoring and ensure mitigation objectives are met. Take corrective action as needed.
- Implement term and conditions 1(a-e), from the section 7 Opinion for this Project.

2) *Flood Control Maintenance*

Include the conservation measures from the *Bank Stabilization and Protection* section of the Opinion and:

- Retain trees and other shaded vegetation along earthen levees and outside levee toe.
- Ensure adequate inundation time for floodplain habitat that activates and enhances near-shore habitat for juvenile salmon.
- Reconnect wetlands and floodplains to channel/tides.

3) *Wetland and Floodplain Alterations*

- Minimize alteration of floodplains and wetlands in areas of salmon EFH.
- Determine cumulative effects of all past and current floodplain and wetland alterations before planning activities that further alter wetlands and floodplains.
- Promote awareness and use of the USDA's wetland and conservation reserve programs to conserve and restore wetland and floodplain habitat.
- Promote restoration of degraded floodplains and wetlands, including in part reconnecting rivers with their associated floodplains and wetlands and invasive species management.

Fully implementing these EFH conservation recommendations would protect, by avoiding or minimizing the adverse effects described in section 3.2, above, approximately 2,196 linear feet of shoreline comprising a total of 2.026 acres (0.930 acres below the OHWM, and 1.096 acres above the OHWM) of designated EFH for Pacific coast salmon,

3.4 Statutory Response Requirement

As required by section 305(b)(4)(B) of the MSA, the Corps 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 Corps 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 opinion addresses these DQA components, documents compliance with the DQA, and certifies that this opinion 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 opinion are the Corps. Other interested users could include the USFWS, CDFW, and DWR. Individual copies of this opinion were provided to the Corps and DWR. This opinion will be posted on the Public Consultation Tracking System Website. 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 opinion and EFH consultation contain more background on information sources and quality.

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

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

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6. APPENDICES

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Figures:
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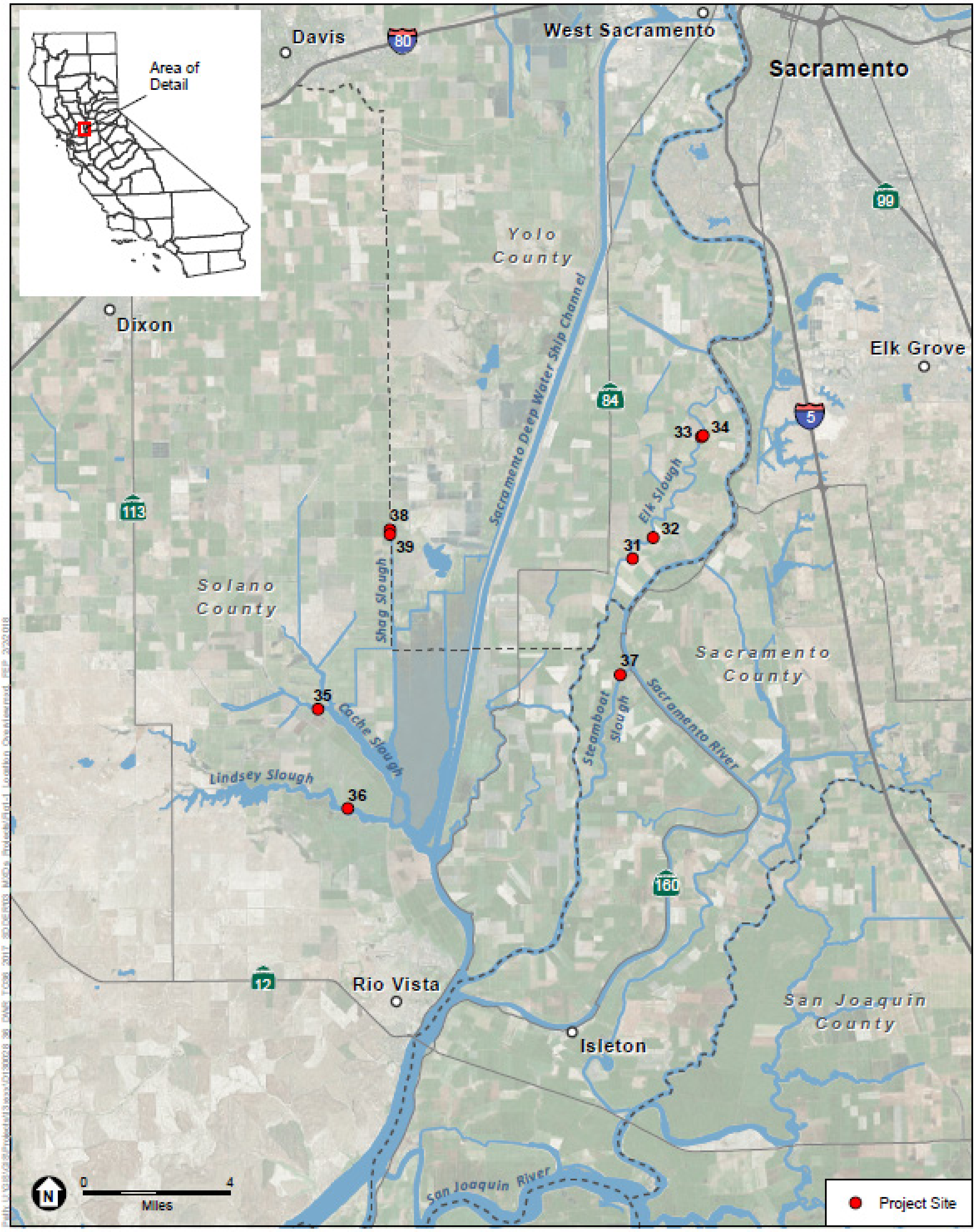
Figure 1: Project Emergency Rehabilitation Site Locations

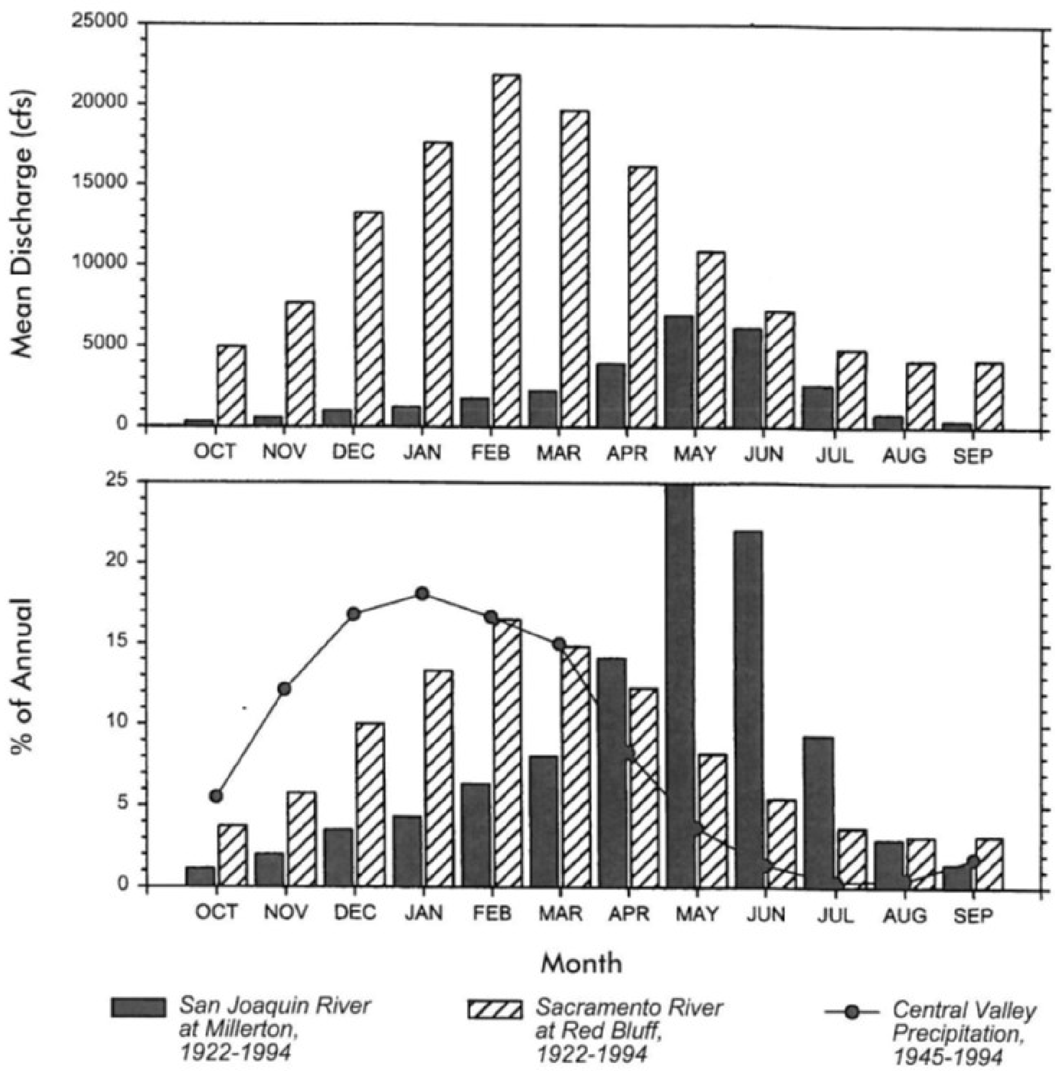


SOURCE: Esri, 2016; ESA, 2018

2017 Storm Damage DWR Emergency Rehabilitation Program - Critical Repair Sites

Figure 2: Average monthly unimpaired (natural) discharge from the upland Sacramento and San Joaquin River watersheds (The Bay Institute 1998).

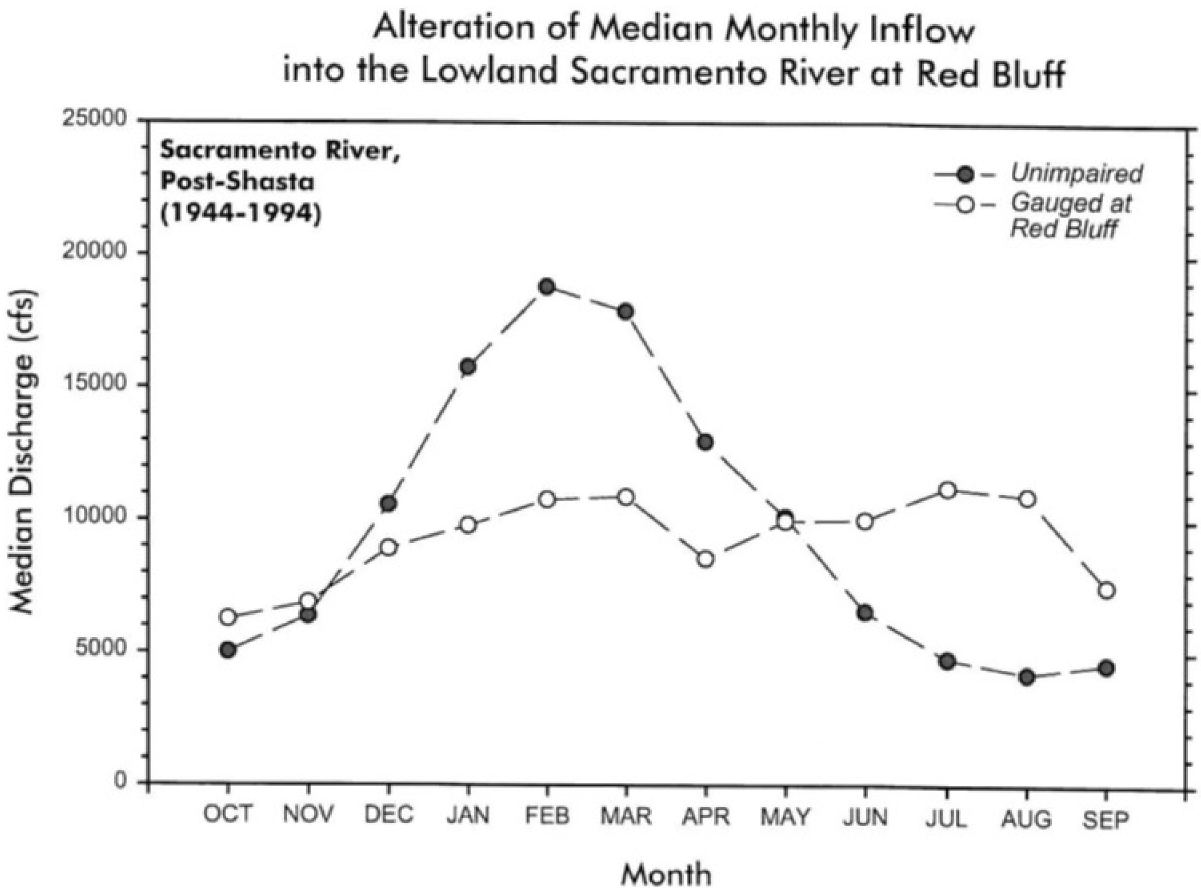
Average Monthly Unimpaired (Natural) Discharge
from the Upland Sacramento and San Joaquin River Watersheds



The annnual Sacramento River runoff at Red Bluff is on average nearly four times greater than the San Joaquin River at Millerton. Temporal differences in the pattern of runoff of the two rivers is due to differences in the amount of precipitation received as rain (dominant on the Sacramento), versus snow (dominant on the San Joaquin) and differences in underlying geology. The lower graph also plots the pattern of Central Valley precipitation to illustrate how precipitation and runoff are out of phase.

Data from California Department of Water Resources.

Figure 3: Alteration of median monthly inflow into the lowland Sacramento River at Red Bluff (The Bay Institute 1998).



Unimpaired Data: median annual discharge, 7,278,000 acre feet.
Gauged Data: median annual discharge, 7,541,236 acre feet.
Median monthly values calculated for each month from period of record.
Median annual values calculated from annual runoff record.

Shasta Dam and associated water project operations have redistributed and dampened median monthly flows on the Sacramento River downstream of Red Bluff. The slightly greater annual median gauged value is due to the diversion of Trinity River flows into the Sacramento River.
Data from California Department of Water Resources and U.S. Geological Survey.

Figure 4: Alteration of median monthly inflow into the lowland Tuolumne and San Joaquin rivers (The Bay Institute 1998).

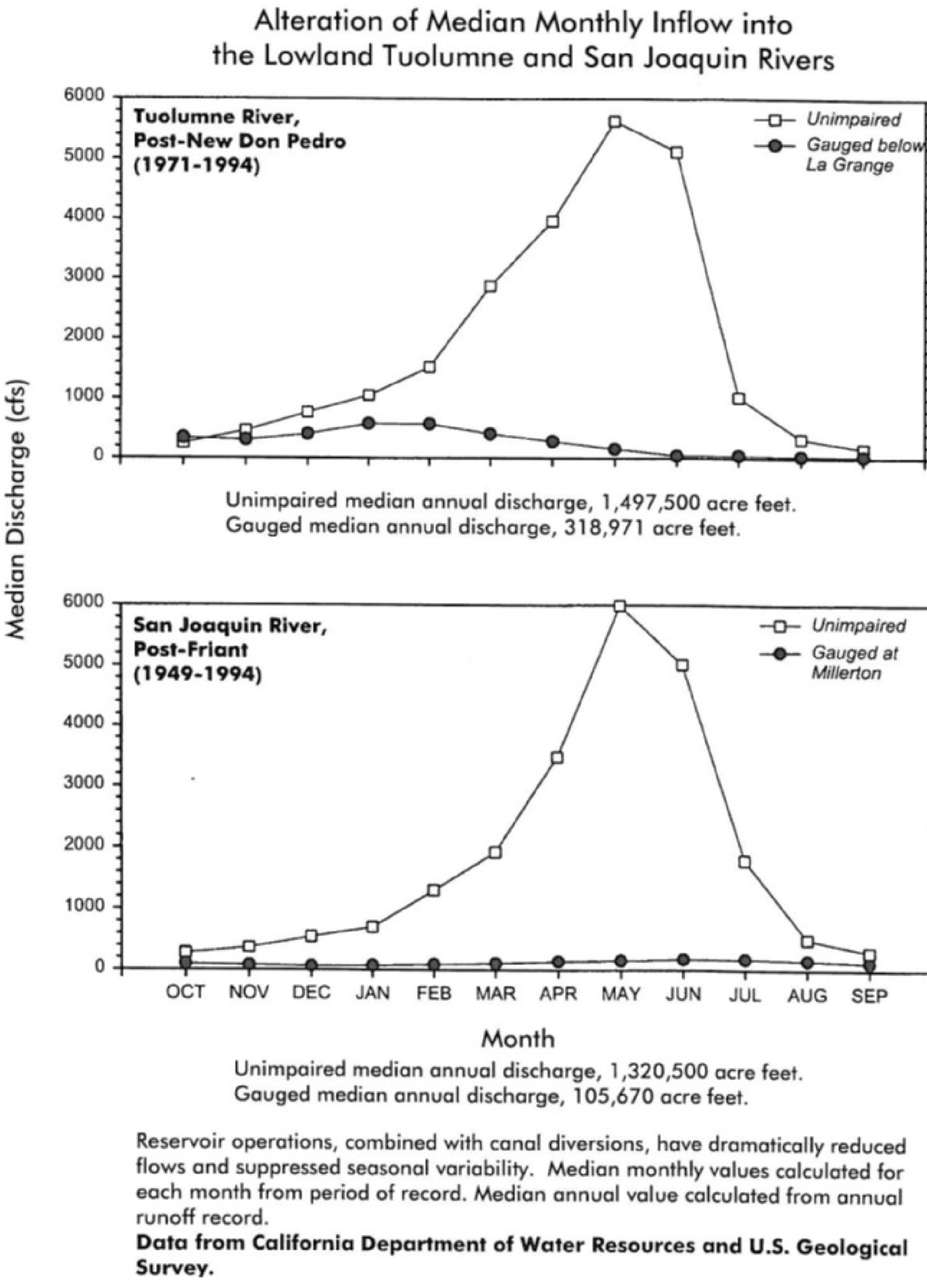


Figure 5: Maximum salinity intrusion for the years 1921 through 1943 (Pre-project conditions in Central Valley –Shasta and Friant Dams non-operational; Sacramento-San Joaquin Delta Atlas, DWR).

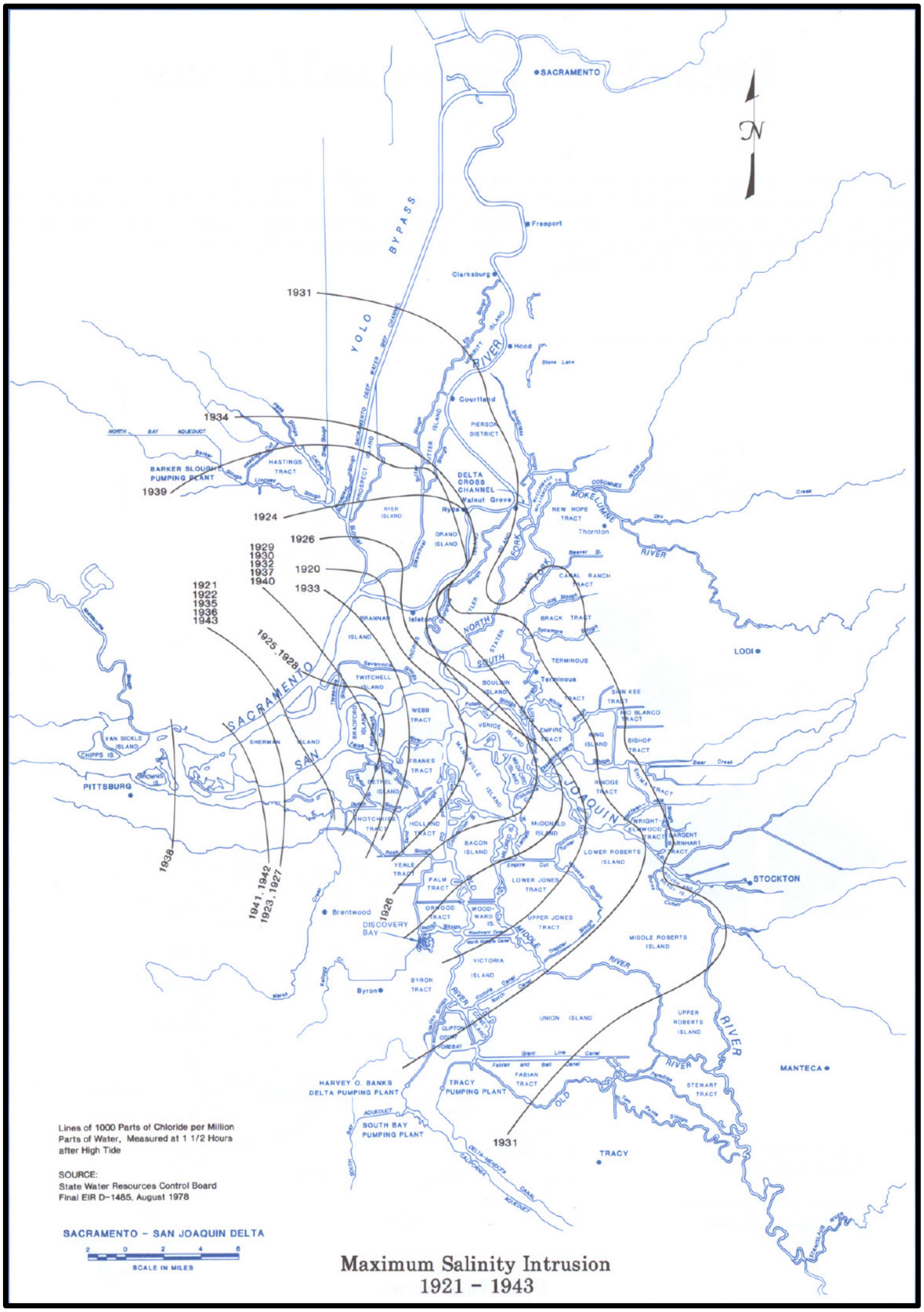


Figure 6: Maximum salinity intrusion for the years 1944 through 1990 (SWP and CVP era; Sacramento-San Joaquin Delta Atlas, DWR).

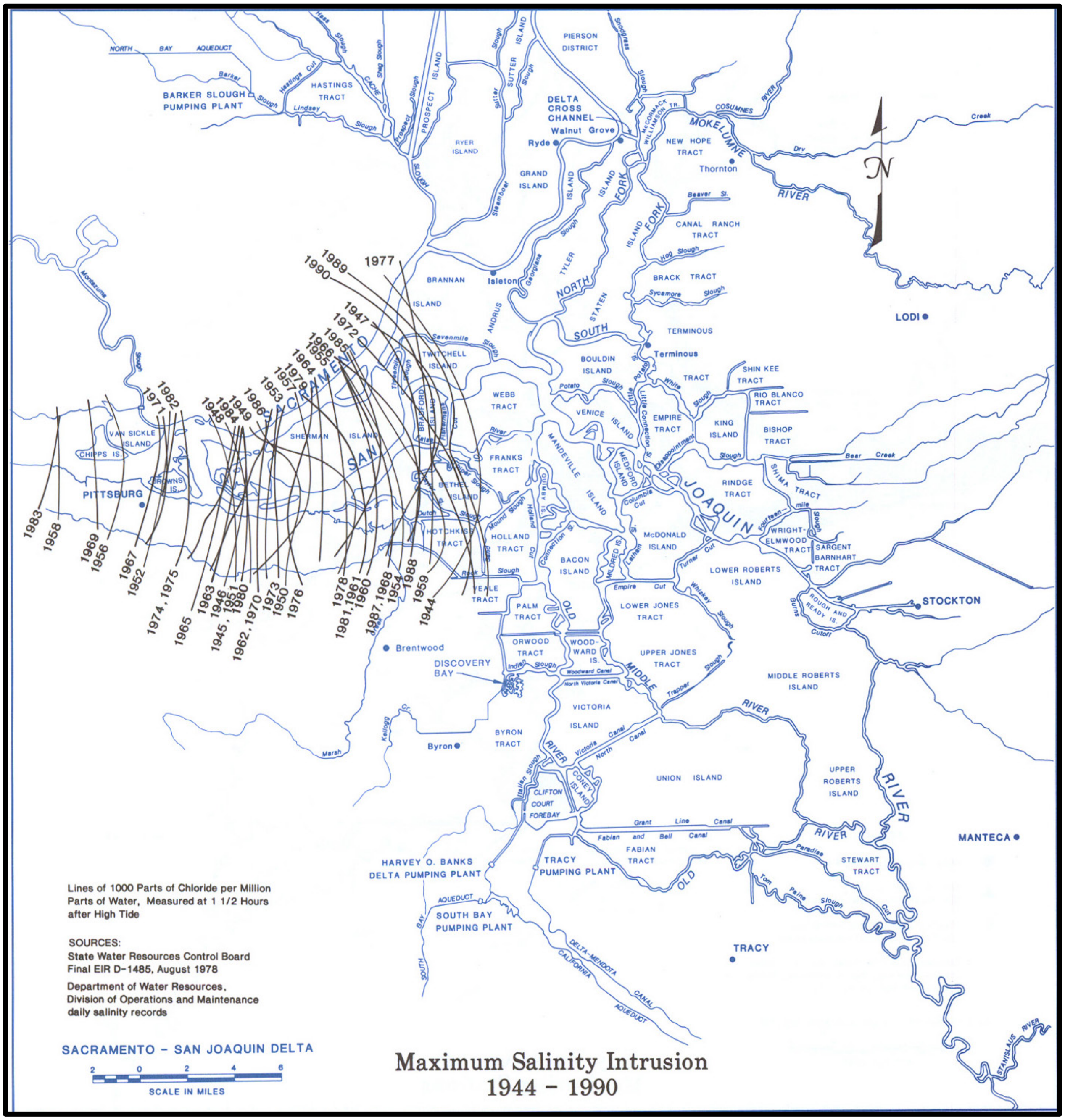


Figure 7: Information from the SAC-PAS website regarding the migration timing of Juvenile winter-run Chinook salmon observed in the Sacramento Trawl (brood years 1993-2017).

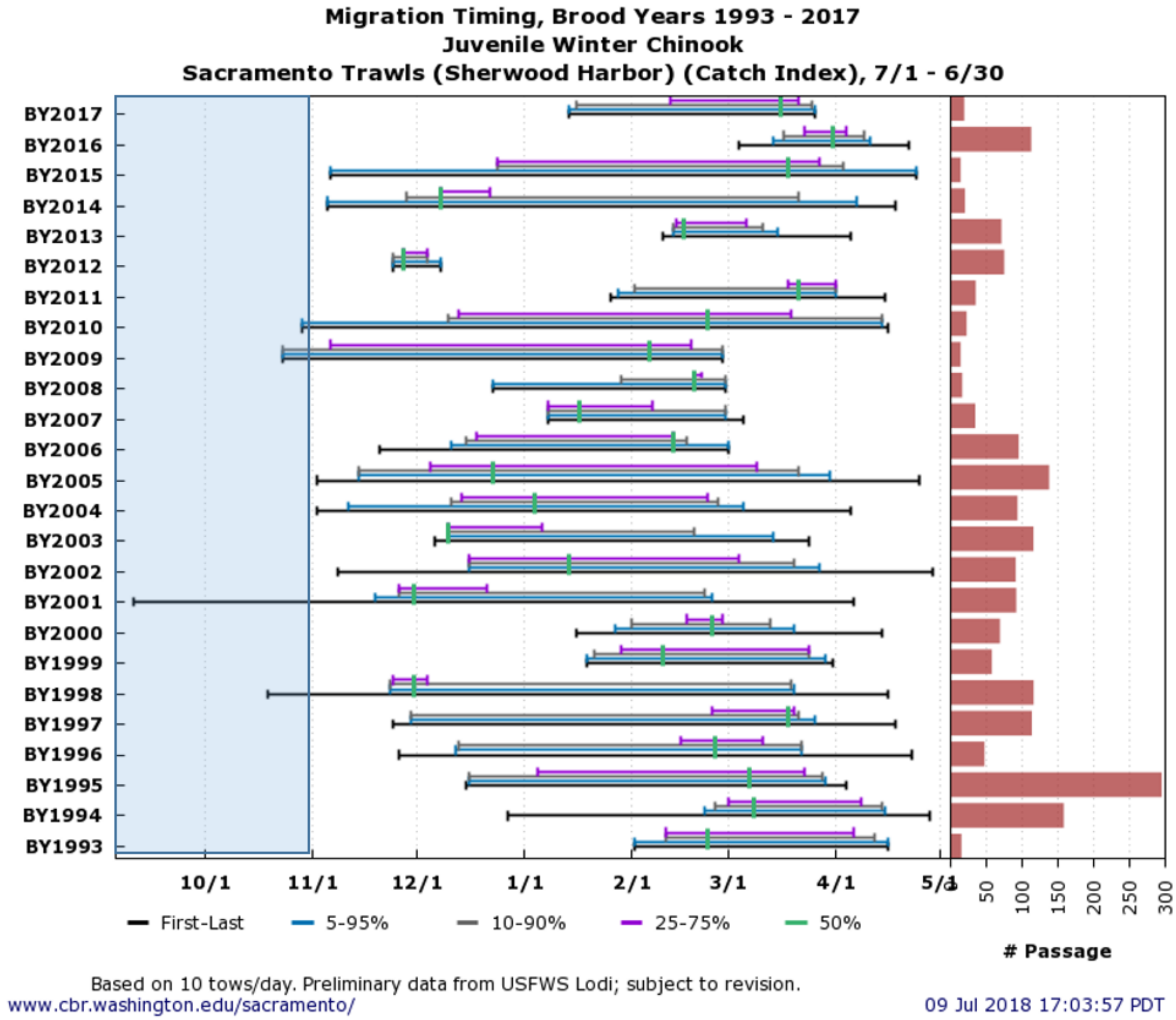


Figure 8: Information from the SAC-PAS website regarding the migration timing of Juvenile winter-run Chinook salmon observed in the Chipps Island Trawl (brood years 1993-2017).

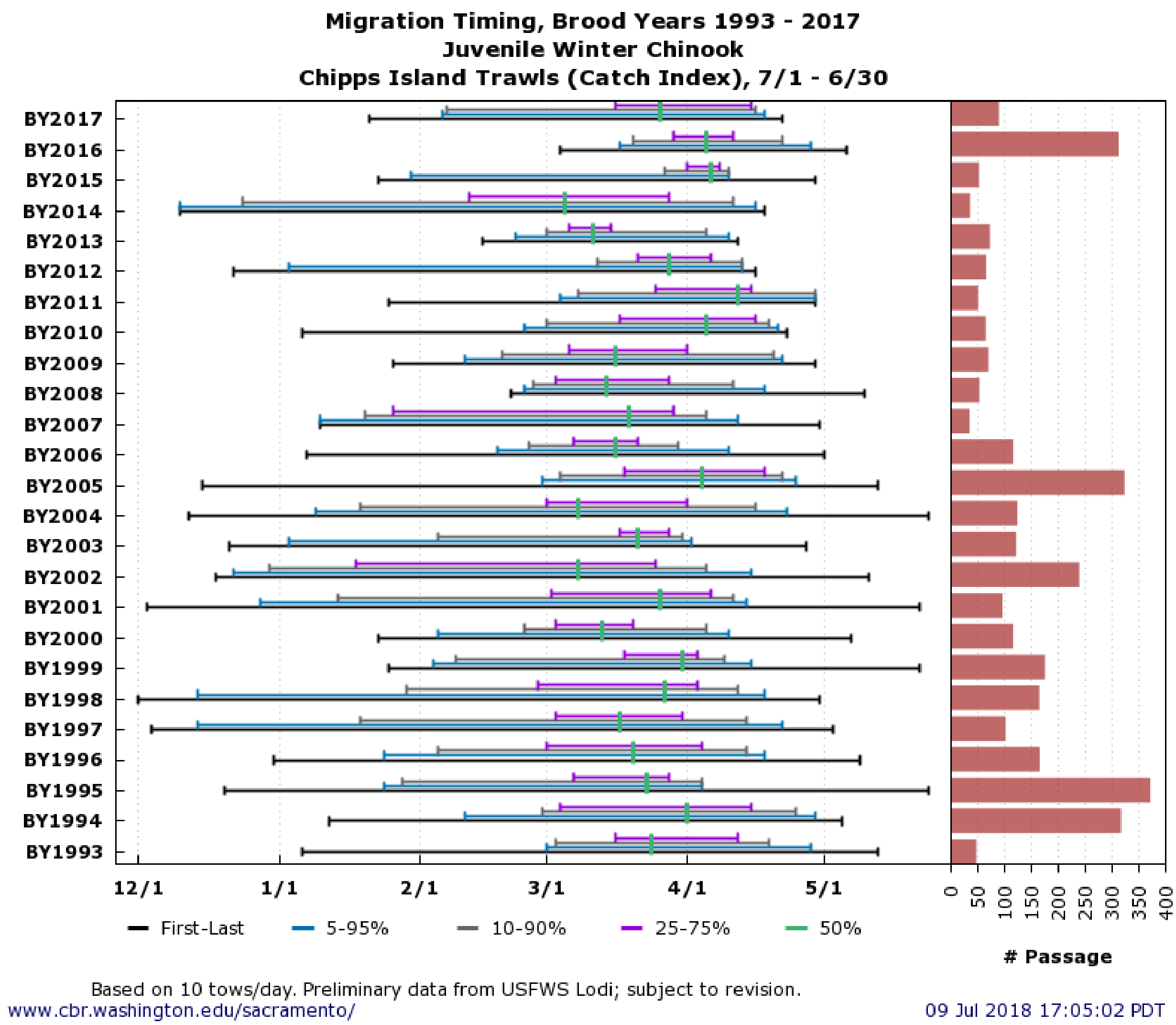


Figure 9: Information from the SAC-PAS website regarding the migration timing of Juvenile spring-run Chinook salmon observed in the Sacramento Trawl (brood years 1993-2016).

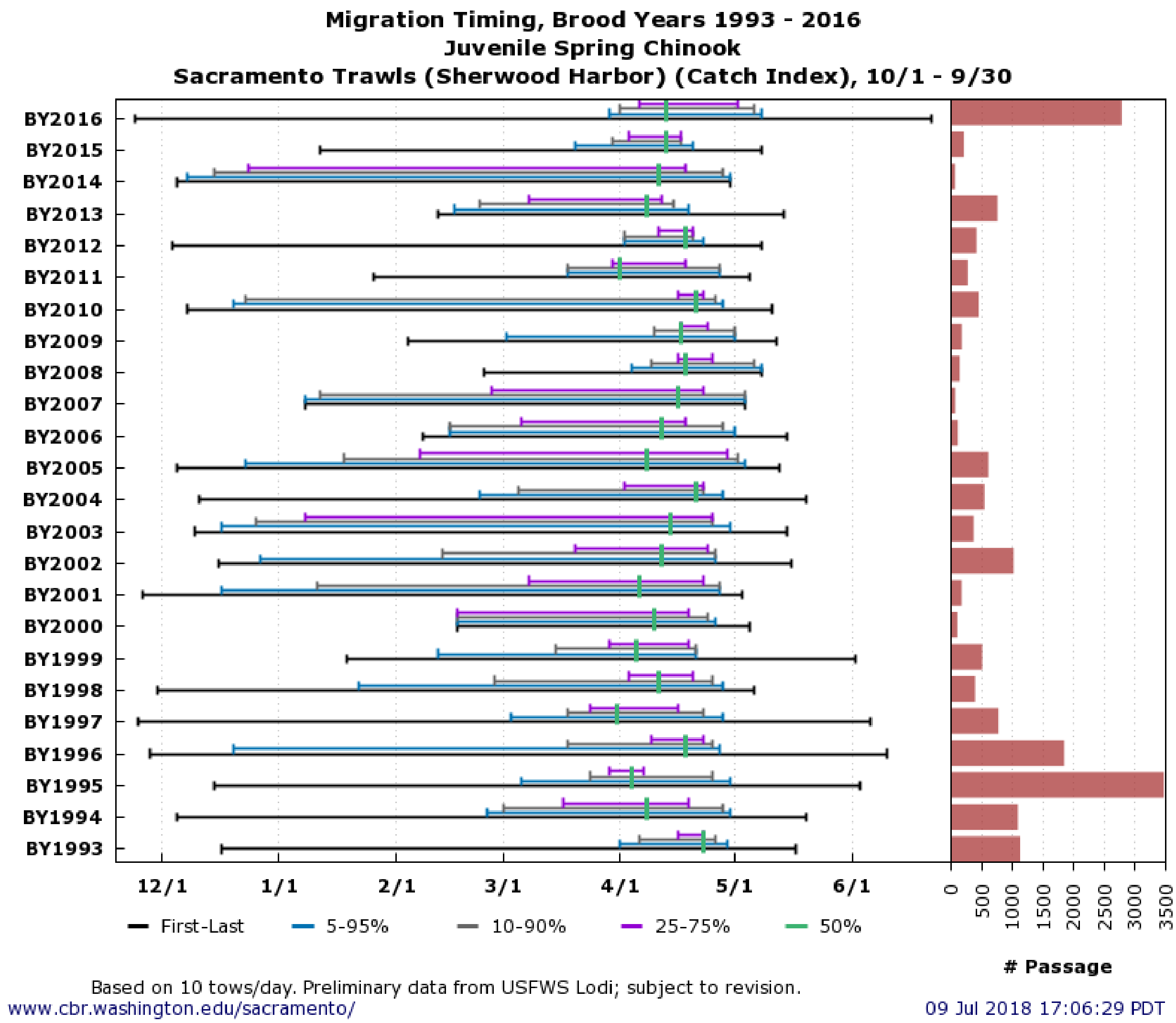


Figure 10: Information from the SAC-PAS website regarding the migration timing of Juvenile spring-run Chinook salmon observed in the Chipps Island Trawl (brood years 1993-2016).

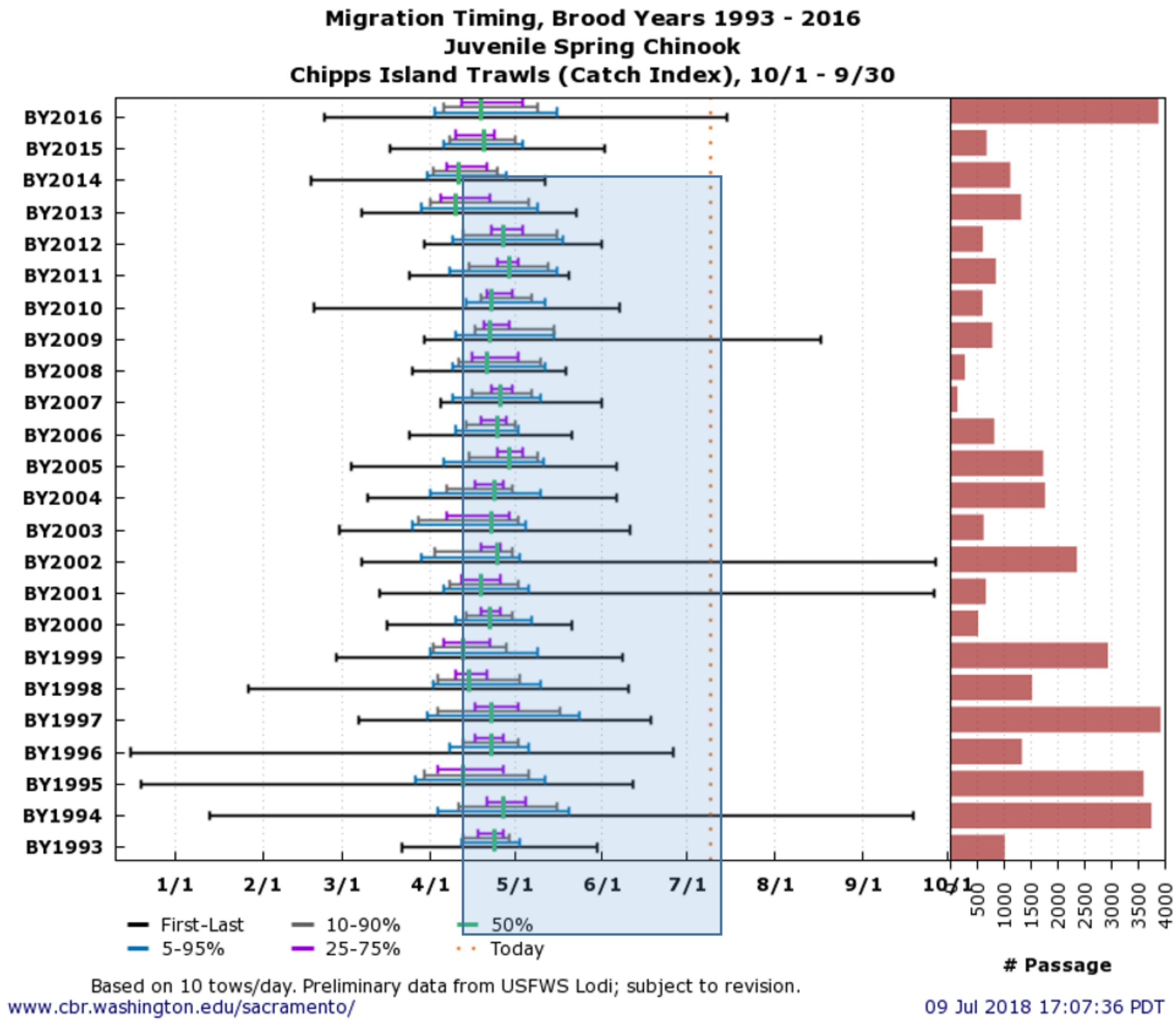


Figure 11. Information from the SAC-PAS website regarding the migration timing of Juvenile wild steelhead observed in the Sacramento Trawl (brood years 1993-2017).

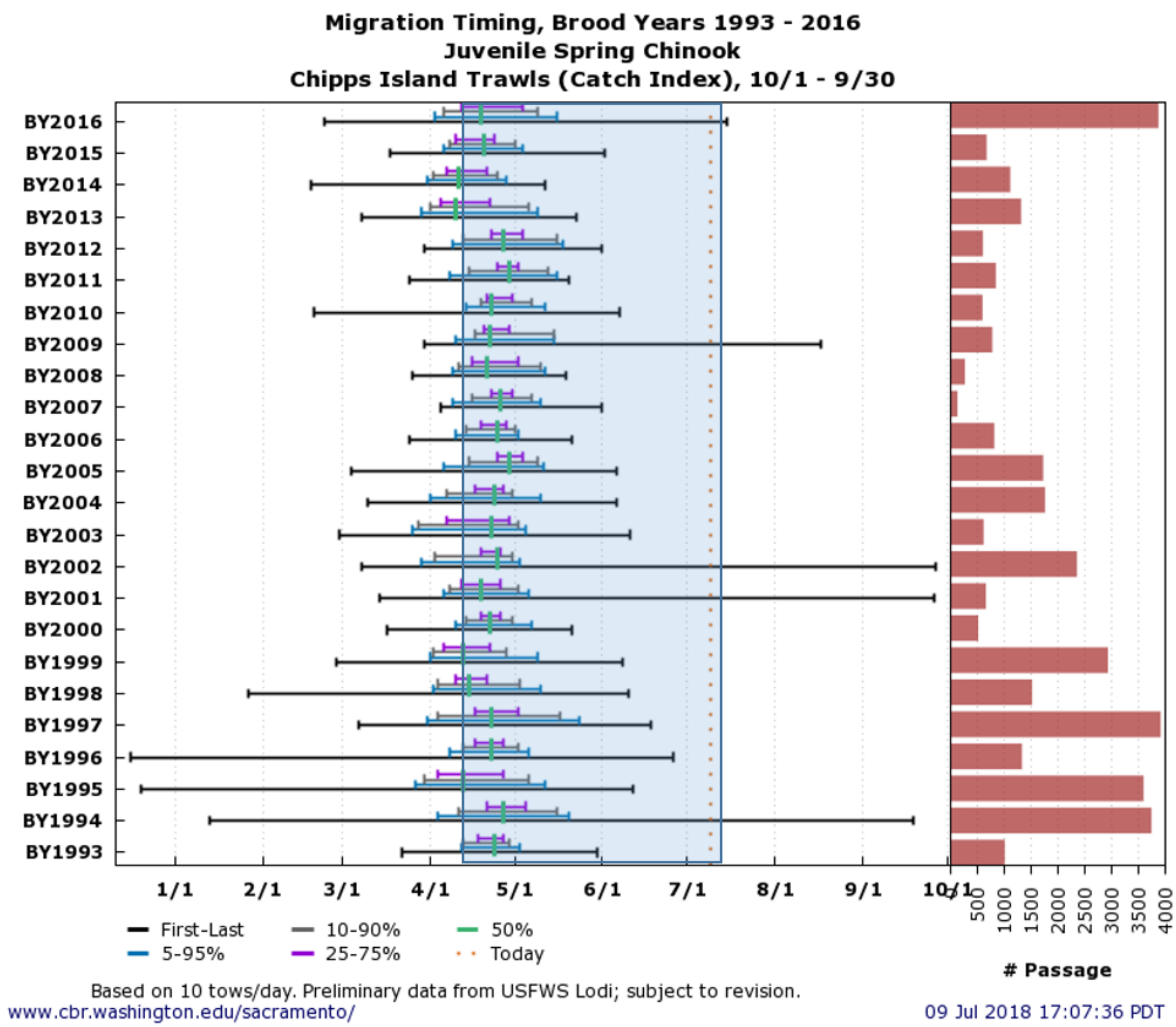


Figure 12: Information from the SAC-PAS website regarding the migration timing of Juvenile wild steelhead observed in the Chipps Island Trawl (brood years 1993-2017).