UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL MARINE FISHERIES SERVICE
Southwest Region
501 West Ocean Boulevard, Suite 4200
Long Beach, California 90802-4213

July 3, 2013

In response, refer to:
2012-02390

Susan M. Fry
Area Manager
U.S. Department of the Interior
Bureau of Reclamation, Mid-Pacific Region
Bay-Delta Office
801 I Street, Suite 140
Sacramento, California 95814-2536

Lieutenant Colonel John K. Baker
U.S. Department of the Army
San Francisco District, Corps of Engineers
1455 Market Street
San Francisco, California 94103-1398

Dear Ms. Fry and Colonel Baker:

This document transmits NOAA's National Marine Fisheries Service's (NMFS) biological opinion (Enclosure 1) based on our review of the proposed 30-year Suisun Marsh Habitat Management, Preservation, and Restoration Plan (SMP) in Solano County, California. The Bureau of Reclamation (Reclamation) will be funding, in part, some maintenance activities and infrastructure improvements, through the Suisun Marsh Preservation Agreement Implementation Fund and the Joint-Use Facility Improvements program. The U.S. Army Corps of Engineers (Corps) will be permitting all field activities proposed in the SMP through either Regional General Permit 3 or a letter of permission (Corps File No. 242156N). NMFS has examined the effects of the proposed SMP on the following listed species (Evolutionarily Significant Units [ESU] or Distinct Population Segments [DPS]) present within the action area, in accordance with section 7 of the Endangered Species Act (ESA) of 1973, as amended (16 U.S.C. 1531 *et seq.*):

Sacramento River winter-run Chinook salmon ESU (*Oncorhynchus tshawytscha*)
endangered (70 FR 37160; June 28, 2005)
critical habitat (58 FR 33212; June 16, 1993);
Central Valley spring-run Chinook salmon ESU (*Oncorhynchus tshawytscha*)
threatened (70 FR 37160; June 28, 2005);
Central California Coast steelhead DPS (*Oncorhynchus mykiss*)
threatened (71 FR 834; January 5, 2006);
Central Valley steelhead DPS (*Oncorhynchus mykiss*)
threatened (71 FR 834; January 5, 2006); and

North American green sturgeon southern DPS (*Acipenser medirostris*)
threatened (71 FR 17757; April 7, 2006)
critical habitat (74 FR 52300; October 9, 2009)

Based on the best available information, the biological opinion concludes that the proposed project is not likely to jeopardize the continued existence of these species or adversely modify designated critical habitat. However, NMFS believes the action is likely to result in take of listed species. An incidental take statement is included with the biological opinion.

Although both Reclamation and Corps are action agencies for this consultation, not all of the activities undertaken in the SMP have a nexus to Reclamation. However, all of the field activities undertaken during implementation of the SMP, including operation and maintenance of managed Suisun Marsh wetland structures, maintenance dredging actions, and wetland restoration, will require authorization from the Corps through either Regional General Permit (RGP) 3 or a letter of permission (LOP). The Corps will retain a Federal nexus for activities undertaken through the SMP so that consultation can be reinitiated, if necessary. The incidental take statement includes non-discretionary terms and conditions for the Corps that are expected to further reduce incidental take of listed anadromous salmonids and green sturgeon in Suisun Marsh.

Additionally, NMFS has evaluated the 30-year SMP for potential adverse effects to Essential Fish Habitat (EFH) pursuant to section 305(b)(2) of the Magnuson-Stevens Fisheries Conservation and Management Act (Magnuson-Stevens Act). Section 305(b)(4)(A) of the Magnuson-Stevens Act authorizes NMFS to provide EFH Conservation Recommendations that will minimize adverse effects of an activity on EFH. Based on our review, NMFS concludes that implementation of the SMP, re-issuance of RGP 3, and issuance of an LOP for related maintenance dredging activities will adversely affect the EFH of various life stages of species managed under the Pacific Groundfish Fishery Management Plan (starry flounder *Platichthys stellatus*), the Pacific Coast Salmon Fishery Management Plan (Chinook salmon), and the Coastal Pelagics Fishery Management Plan (northern anchovy *Engraulis mordax*). Therefore, NMFS has provided EFH Conservation Recommendations in Enclosure 2.

Please note that as lead Federal agency, Reclamation is required to provide a detailed written response to NMFS' EFH Conservation Recommendations within 30 days (Magnuson-Stevens Act (305(b)(4)(B) and 50 CFR 600.920 (k)). The response must include a description of measures adopted by Reclamation for avoiding, mitigating, or offsetting the impact of the project on EFH. If the response is inconsistent with the EFH Conservation Recommendations, the response must explain the reasons for not following the recommendations, including a scientific justification for any disagreement with the agency over the anticipated effects of the proposed action and the measures needed to avoid, mitigate, or offset such effects.

Our practice is to post biological opinions to the NMFS Southwest Region website (http://swr.nmfs.noaa.gov/) 15 business days following transmittal of the opinion to the action agency. We post opinions to our website to increase transparency and provide interested parties an efficient way of obtaining the documents.

If you have questions concerning this consultation, please contact Daniel Logan at (707) 575-6053 or by electronic mail at dan.logan@noaa.gov.

Sincerely,

For William W. Stelle, Jr.
Acting Regional Administrator

Enclosures (2)
1. Biological Opinion
2. Essential Fish Habitat Conservation Recommendations

cc: Chris Yates, NMFS, Long Beach
Dave Wickens, US Army Corps of Engineers Regulatory, San Francisco
Cay Goude, US Fish and Wildlife Service, Sacramento
Andy Raabe, US Fish and Wildlife Service, Sacramento
Dean Messer, California Department of Water Resources, West Sacramento
Katie Shulte Joung, California Department of Water Resources, West Sacramento
James Starr, California Department of Fish and Wildlife, Stockton
Steve Chappell, Suisun Resource Conservation District, Suisun City
Jolanta Uchman, San Francisco Regional Water Quality Control Board, Oakland
Jessica Davenport, San Francisco Bay Conservation and Development Commission, San Francisco.
Administrative File: 151422SWR2012SR00277

Enclosure 1

BIOLOGICAL OPINION

ACTION AGENCY:	U.S. Bureau of Reclamation, Mid-Pacific Region U.S. Army Corps of Engineers, San Francisco District
ACTION:	Suisun Marsh Long-Term Habitat Management, Preservation, and Restoration Plan
CONSULTATION CONDUCTED BY:	National Marine Fisheries Service, Southwest Region
TRACKING NUMBER:	2012-2390
DATE ISSUED:	**July 3, 2013**

I. CONSULTATION HISTORY

NOAA's National Marine Fisheries Service (NMFS) staff attended a January 7, 2008, meeting of the Suisun Marsh Plan Regulatory Group with representatives from the Corps of Engineers (Corps), Bureau of Reclamation (Reclamation), U.S. Fish and Wildlife Service (USFWS), San Francisco Bay Conservation and Development Commission, State Water Resources Control Board, and Suisun Resource Conservation District (SRCD). The proposed Suisun Marsh Long-Term Plan was presented by the consultant team and there was an initial discussion of environmental issues.

NMFS staff attended a November 4, 2009, meeting of the Suisun Marsh Plan Regulatory Group. The agencies discussed the development of environmental documents for compliance with the National Environmental Policy Act (NEPA) and possible approaches for compliance with Endangered Species Act (ESA). The USFWS indicated a programmatic biological opinion may be appropriate for their listed species due to the need for design review of each future tidal marsh restoration project.

NMFS staff participated in March 16, 2010, meeting of the Suisun Marsh Plan Regulatory Group. SRCD distributed a draft of their proposal for exterior levee maintenance. There was extensive discussion regarding the dredging of sediments from tidal sloughs for the purpose of maintaining exterior levees. NMFS reviewed the written description of the exterior levee maintenance program and requested on March 30, 2010, that the document include additional information regarding the frequency and locations of future dredging sites.

At the April 22, 2010, meeting of the Suisun Marsh Plan Regulatory Group, agency representatives discussed the status of various environmental documents under preparation for the Suisun Marsh Long-Term Plan. For the section 7 consultation with NMFS, the group considered whether the Corps, Reclamation, or USFWS should be the Federal action agency. NMFS was informed that a consultant has been selected for preparation of a biological assessment. Reclamation suggested the fisheries effects section of the administrative draft EIS/EIR be submitted to NMFS for review.

During a brief telephone conference call on December 16, 2010, representatives of the Suisun Marsh Plan Regulatory Group discussed the status of the NEPA documents and plan development.

The Suisun Marsh Plan Regulatory Group met on January 11, 2012, to discuss the preparation of a biological assessment for the Section 7 consultation with NMFS and USFWS. The Corps indicated that they will be issuing a 10-year Letter of Permission (LOP) or a 10-year Individual Permit for the dredging component of the program. Other routine maintenance activities within the marsh will be permitted through a 5-year Regional General Permit (RGP). The NEPA document for the Long-Term Plan is for 30 years. USFWS indicated they would like to issue a 30-year programmatic biological opinion. The agencies requested NMFS also consider the assessment of a 30-year plan in the biological opinion.

On June 7, 2012, Reclamation mailed to NMFS a request for initiation of consultation for the Suisun Marsh Habitat Management, Preservation, and Restoration Plan (SMP), a comprehensive 30-year plan designed to address the various conflicts regarding the of resources within much of Suisun Marsh. Included with the June 7 letter was a biological assessment, an essential fish habitat (EFH) assessment, and various appendixes. Also, Reclamation provided DVDs with electronic copies of the various assessments, and the final environmental impact statement for the project.

On May 15, 2013, representatives with NMFS, Corps and Reclamation discussed the roles of Reclamation and the Corps over the 30-term of the SMP. On May 30, 2013, NMFS provided a draft project description to USFWS, Corps, Reclamation, CDFW, and SRCD for review and comment; on June 11, 2013, NMFS received comments back on the draft project description from those agencies.

This biological opinion is based on information provided to NMFS with Reclamation's request for formal consultation dated June 7, 2012. Additional information has been provided by the Corps and SRCD. NMFS considered other sources of scientific and commercial information including journal articles, technical reports, and information received from Reclamation and the applicant through June 20, 2013.

II. DESCRIPTION OF THE PROPOSED ACTION

A. Action Area Overview

The action area encompasses Suisun Marsh (Figure 1) in Solano County, California. Located downstream of the Sacramento–San Joaquin Delta, Suisun Marsh is a mosaic of freshwater, brackish, estuarine, and upland habitats. Suisun Marsh is the largest contiguous brackish marsh remaining on the Pacific Coast of the United States (Meng and Matern 2001), and it represents approximately 12 percent of California's wetland habitat. It is bounded to the west, north, and east by hills, and to the south by Suisun, Grizzly, and Honker bays. Montezuma Slough, the largest slough in the action area, runs from east to west between the Sacramento-San Joaquin Delta and Suisun Bay. Major bodies of water draining to Montezuma Slough include Little Honker Bay, and Denverton and Nurse sloughs.

The second largest slough in the action area is Suisun Slough, which essentially splits the marsh into eastern and western portions. Tributaries to Suisun Slough include Cordelia and Goodyear Sloughs, and several small dead-end sloughs. The marsh includes approximately 116,000 acres, of which 52,000 acres are privately or publicly owned managed wetlands. Of the remaining 64,000 acres, most are bays, sloughs, and upland grasslands. Approximately 6,300 acres are unmanaged tidal wetlands and 2,025 acres are permanently flooded wetlands. Networks of tidal sloughs, principally tributaries of Suisun and Montezuma Sloughs, crisscross the marsh. A system of levees encloses about 90 percent of the historic marsh, separating managed wetlands from tidal sloughs, and sometimes subdividing wetland parcels to facilitate management objectives. Levees range from 4 to 8 feet above ground, and most of the wetlands are at or below mean tide elevation. Water is diverted from tidal sloughs into managed wetlands at high tides. At low tides, water drains from managed wetlands to tidal sloughs through outlet structures throughout the marsh. These water diversion intakes and drains are described in detail in the SMP biological assessment (Reclamation 2012).

Management of diked wetland parcels is focused on providing habitat and conditions conducive to the production of specific vegetative forage for targeted waterfowl species, and on the operations of waterfowl hunting clubs. Over 150 private landowners manage their individual parcels according to management plans prepared by the Soil Conservation Service and the SRCD. Private landowners coordinate their activities under the direction of SRCD. CDFW manages more than 14,500 acres within the marsh.

B. Proposed Actions

The SMP addresses user conflicts in Suisun Marsh with a multi-stakeholder approach to the restoration of tidal wetlands and the management of managed wetlands. The SMP includes both tidal restoration activities, and managed wetland operations and maintenance activities to be permitted by the Corps under a Regional General Permit or Letter of Permission. Reclamation will provide cost-share funding for operation and maintenance of the water monitoring and management facilities owned and operated by California Department of Water Resources (DWR) in the Suisun Marsh in accordance with the Suisun Marsh Preservation Agreement. Reclamation will also provide cost-share funding for the Preservation Agreement Implementation Fund that will provide funding for various managed wetland enhancement actions. Table 1 describes the various agencies involved with the Suisun Marsh Plan.

The Corps proposes to re-issue RGP 3 at five year intervals for 30 years beginning in 2013. RGP 3 will authorize 29 types of maintenance activities within Suisun Marsh. Most maintenance actions authorized with RGP 3 are associated with the repair and maintenance of existing levees and replacement of water control structures. Table 2 presents a complete list of repair and maintenance activities to be included in RGP 3. In addition to maintenance activities, RGP 3 will authorize installation of brush boxes as alternative bank protection on exterior levees.

With the issuance of a Letter of Permission (LOP), the Corps proposes to authorize dredging for levee maintenance and fish screen maintenance in the Suisun Marsh action area. The LOP will be for a 10-year term and the Corps will re-issue the LOP at 10 year intervals for 30 years beginning in 2013. The Corps will issue RGP 3 and LOP pursuant to their authorities under section 404 of the Clean Water Act.

The proposed actions in Suisun Marsh are presented below as three components: (1) operation and maintenance of managed wetland structures, (2) maintenance dredging actions, and (3) wetland restoration. Although RGP 3 only authorizes maintenance of managed wetland facilities, maintenance at water control facilities (*i.e.*, tidal gates and culverts) allows for subsequent operations. As such, operations are interdependent and interrelated to RGP 3 maintenance activities, and operation of water control facilities are considered in this biological opinion.

Under the SMP, both tidal restoration and managed wetland activities will proceed concurrently. Beginning in year 11 of the 30-year program, managed wetland activities under RGP 3 and the LOP will only be permitted by the Corps if at least one third of the total restoration activities are implemented. Beginning in year 21 of the program, managed wetland activities under RGP 3 and the LOP will only be permitted by the Corps if at least two thirds of the total restoration activities are implemented. Assessment of program implementation and re-issuance of Corps authorizations in 10-year increments will ensure that restoration efforts compensate for impacts and contribute toward tidal marsh habitat restoration throughout the plan implementation.

1. Operation and Maintenance of Managed Suisun Marsh Wetland Structures

Over 150 private landowners throughout Suisun Marsh manage their individual wetland parcels according to management plans prepared by the Soil Conservation Service and the SRCD. These management plans target the creation of seasonal habitat for waterfowl and recreational hunting opportunities. Private landowners coordinate their activities under the direction of SRCD. On parcels owned by the State of California, CDFW manages more than 14,500 acres within the marsh, primarily wetlands for waterfowl.

Wetland management involves diversion and subsequent draining of tidal waters into and out of managed wetlands. Managed wetlands are separated from tidal sloughs and bays by external levees and from adjacent managed wetlands by internal levees. CDFW and private landowners use various structures, such as levees, ditches, water control facilities, grading, pumps, and fish screens to manipulate the timing, duration, and depth of flooding to meet wetland management objectives. Waterfowl habitat and forage studies have concluded that plant communities are controlled by the depth and duration of soil inundations, and by salinity levels in the root zones. A number of factors, including location in the marsh, water control facilities, and water year type, drive the operations schedule for managed wetlands in Suisun Marsh. Most wetland managers in the Suisun Marsh begin flooding their wetlands in late September and October in preparation for the fall migration of waterfowl. Whenever possible, wetland managers use gravity flow to fill and drain their wetlands.

Gravity flow can be used because most of the wetlands are at or below mean tide elevation. Consequently, the wetlands are filled during flood tides when the water can flow through the water control structures into the managed wetlands. Water is drained during ebb tides when water can flow out of the managed wetlands. During initial flood-up, the inlet gates are opened and the drain gates remain closed to allow the managed wetlands to fill to an average depth of eight to twelve inches. Thus, diversions may operate for less than 12 hours a day (during the two high tide cycles) and the volume and velocity of diversions vary greatly based upon the location and diameter of the intake, and the head pressure created by the high tide stage.

The SRCD provided estimates of the volume of water required during the initial fall flood-up. Most wetland managers in Suisun Marsh flood their wetlands to an average depth of 8 to 12 inches in late September and October in preparation for the fall waterfowl migration. The SRCD estimates the total flooded wetland acreage is about 40,000 acres with average depth of about 1 foot, for a total diversion of 40,000 acre-feet (Reclamation 2012). However, this may be an overestimate of the volume diverted for two reasons. First, many areas within managed wetlands exhibit wetland characteristics, but do not flood, or do not flood to the same depth assumed in the model, and second, some managed wetlands receive treated wastewater for a portion of their water use. In mid-October to late January, water is circulated through wetlands by diverting through adjacent sloughs on flood tides and draining at ebb tides. Following waterfowl season, managed wetlands are drained in February and spring flood-up (leach cycles and irrigations) of the managed wetlands begins. During this period wetlands are rapidly drained and flooded to half the fall water level to remove surface salts from the wetland soils (one to two leach cycles). Water remaining in the wetlands in June and July is drained to allow vegetative growth and routine maintenance activities during the summer work season. All water diversions for wetland operations will follow seasonal and operational restrictions described in Chapter 12 of the SMP Biological Assessment (Reclamation 2012).

After initial flood-up and during waterfowl hunting season (mid-October to late January), water is circulated through wetlands by diverting from adjacent sloughs on flood tides, and draining at ebb tides. Compared to the initial flood-up period, relatively small amounts of water are exchanged between the sloughs and the wetlands during circulation. Water is moved through the managed wetlands to maintain water quality and depth. Although managed wetlands are not typically drained below about eight inches during this period, properties that start to generate poor water quality conditions or that are contributing to high mosquito production may require increased circulation or complete drainage in October. These conditions depend on the weather during the fall season and requirements of the Solano County Mosquito Abatement District.

Managed wetlands are drained in February following waterfowl season, and spring flood-up begins in February and March. Spring management requires drainage of the managed wetland and re-flooding to half of the fall water depth. Drainage capabilities, spring weather, and Delta outflow dictate when most wetlands can complete draining and re-flooding. Subsequent to spring flood-up, wetlands will undergo one to two leach cycles, consisting of rapid draining and flooding to half the fall water level, to remove surface salts from the wetland soils. Once the spring leach cycles are complete, water is only diverted to maintain water level and provide good water quality in the wetlands.

In 1993 and 1994, section 7 consultations between Reclamation, Corps, USFWS, and NMFS, resulted in the establishment of curtailments and restrictions on most unscreened diversions in sloughs known to support juvenile salmonids or delta smelt. These diversion curtailments have been in effect since 1995 and the measures are now incorporated as conditions in the current RGP 3 issued by the Corps. The Corps has proposed to keep these operational restrictions as special conditions in the re-issuance of RGP 3. For the installation of new and replacement of existing water control structures, SRCD strives to consolidate and/or equip intakes with state-of-the-art fish screens when practicable and as funding allows. Intakes that present the highest risk of entrainment to salmonid smolts are given the highest priority, including intakes located on Montezuma, Suisun, and Cordelia Sloughs.

There are 29 maintenance activities authorized in RGP 3 (Table 2). Reclamation and the Corps evaluated the potential maintenance project-related effects and determined that about half of the proposed actions will have no effect on ESA-listed anadromous salmonids, green sturgeon or designated critical habitat (see below). For maintenance activities that may affect ESA-listed anadromous salmonids, green sturgeon, and designated critical habitat, Reclamation and the Corps have proposed best management practices to further reduce potential effects from maintenance activities (Table 3).

Reclamation has determined 16 of the 29 proposed maintenance activities will have no effect on ESA-listed anadromous fish or critical habitat. These activities take place entirely inside the exterior levees of the managed wetlands. These activities are listed below. Further detail is available in the SMP biological assessment (Reclamation 2012).

- Repair existing interior levees.
- Core existing interior levees.
- Grade pond bottoms for water circulation.
- Create pond bottom spreader V-ditches.
- Repair existing interior water control structures.
- Replace pipe for existing interior water control structures or install new interior water control structures.
- Install new blinds and relocate, replace, or remove existing blinds.
- Disc managed wetlands.
- Install drain pumps and platforms.
- Replace riprap on interior levees.
- Remove floating debris from pipes, trash racks, and other structures.
- Install alternative bank protection such as brush boxes, biotechnical wave dissipaters, and vegetation on interior levees.
- Construct cofferdams in managed wetlands.
- Construct new interior ditch; clear existing interior ditches.
- Placement of new riprap on interior levees.

- Constructing new interior levees for improved water control and habitat management in managed wetlands.

Reclamation has determined that 14 of the 29 proposed maintenance activities for managed wetlands are likely to affect or adversely affect ESA-listed anadromous fish or designated critical habitat. Reclamation and the Corps have requested consultation on these activities. Activities and associated best management practices are listed in Table 3. Further detail is available in the SMP biological assessment (Reclamation 2012).

2. Maintenance Dredging Actions

Since 1994, the primary source of material for exterior levee maintenance has come from adjacent managed wetlands or beneficial reuse of suitable imported materials from outside of the managed marsh. However, the anticipated need for levee maintenance over the next 30 years will not be met with these sources. To meet this need for materials to place on levees, landowners and land managers (*i.e.*, CDFW, DWR) may dredge materials adjacent to levee maintenance sites from neighboring tidal sloughs, bays, and dredger cuts using a long-reach excavator or clamshell dredge. To clear sediment accumulations from water control structures, fish screens, and the Suisun Marsh Salinity Control Structure, dredging may occur adjacent to these facilities throughout the marsh.

The Corps and SRCD have proposed to limit dredging for levee maintenance to 2.1 cubic yards per linear foot of channel adjacent to exterior levees on each property or the length of dredger cut. Since dredging from sites exterior to perimeter levees has not occurred since 1994, it is difficult to estimate the total amount of dredging that may occur under RGP 3. The Corps and SRCD propose an annual maximum limit of 100,000 cubic yards of dredging, spread throughout the action area (Table 4). Dredging the maximum annual amount of 100,000 cubic yards will result in impacts to approximately 66 acres within Suisun Marsh. However, based on current needs and feasibility analysis, SRCD anticipates no more than 30,000 cubic yards of dredging per year for a footprint of 19.7 acres.

This dredging will be limited to the period between August and November. To contain runoff from the levee as dredged materials are place on the crown, berms will be constructed on the exterior-side of the levee. Source materials for levee maintenance may also be obtained by dredging from areas interior to perimeter levees (*i.e.*, diked managed wetlands) or from imported materials. Levee maintenance materials obtained by dredging from neighboring sloughs, bays, or dredger cuts will be authorized with a 10-year Letter of Permission from the Corps. Levee maintenance materials obtained by dredging from within diked managed wetlands or imported materials will be authorized by RGP 3.

3. Wetland Restoration

The SMP proposes to restore 5,000 to 7,000 acres of tidal wetlands over the 30-year planning period. Although the exact location, size, timing, and design of each individual tidal restoration action are unknown at this time, the SMP includes guidelines and targets for restoration actions (Tables 5 and 6). The selection of tidal restoration sites will take into consideration several factors, including land available for purchase, physical and biological site characteristics, and contribution to restoration acreage goals. Restoration site selection will include Principal Agencies identified in Table 1. An Adaptive Management Advisory Team has been established for the SMP and this group will work collaboratively with others to select the most biologically appropriate, cost-effective, and SMP-compatible restoration site.

Lands suitable for restoration of tidal wetlands will always be purchased from willing sellers by the project proponent. As restoration opportunities present themselves, factors to be considered are presented in Table 5. Some of the most important physical considerations are location and proximity to existing tidal habitats, site elevation, infrastructure, flood liability of adjacent lands, and costs of required levee improvements and long-term maintenance. Funding sources and projects targeting specific species biological needs also will help focus what sites to pursue. One overarching goal of restoration is to create a diverse mosaic of interconnected habitat types; therefore, the type of restoration that has already occurred will be considered. To ensure that restoration sites are spread geographically throughout the marsh, the SMP has established total restoration target percentages by region (Table 6).

In addition to the above guidelines, future permitting by the Corps is contingent on achieving specific tidal restoration targets. Beginning in year 11 of the 30-year program, managed wetland activities under RGP 3 and the LOP will only be permitted by the Corps if at least 1,650 acres (one third of 5,000 acres) restoration activities are implemented. Beginning in year 21 of the program, activities under RGP 3 and the LOP will only be permitted by the Corps if at least 3,300 acres (two thirds of 5,000 acres) of the total restoration activities are implemented. These restoration actions are intended to compensate for the effects on listed fish, bird and mammal species associated with SMP maintenance activities and to contribute to recovery of listed species.

Once a site has been acquired from a willing seller, the project proponent may take from 1 or more years to undertake necessary land management activities to prepare the site for restoration. All of these preparation actions will be completed behind exterior levees and isolated from tidal sloughs to avoid potential effects to ESA-listed fish and designated critical habitat. Each restoration site will be designed to accomplish specific environmental goals by restoring historical conditions. When construction and other site preparation activities are completed, then the proponent will breach the exterior levee to reconnect the site to tidal exchange. Specific breach locations will be based on maximizing ecological benefit and effects to local hydrology. To protect adjacent properties from an increased risk of flooding, existing exterior levees may be upgraded or new exterior levees constructed prior to breaching a levee. Breaching of levees will occur during the summer when listed anadromous salmonids are not present.

4. Reporting

To track progress of restoration and managed wetland activities, annual reports will be submitted to NMFS and other regulatory agencies. Reports will be prepared by Reclamation, SRCD, DWR, and CDFW. In general, reports will include the following information (for full description of reporting see Chapter 2 of the biological assessment [Reclamation 2012]):

- The location, extent and timing of land acquisition for tidal restoration.
- Status of restoration planning for acquired properties.
- Descriptions of the previous years managed wetland activities, including a description of how actual impacts compare to impacts analyzed in the SMP biological assessment.
- Description of monitoring results.
- A summary of how implemented activities compare to SMP goals in terms of habitat types, managed wetland operations, acreage goals, and species composition.

If any report indicates that restoration or managed wetland targets are not being met nor have the potential not to be met, the SMP agencies along with NMFS and USFWS will convene to determine how to proceed to get plan implementation on track.

In addition to the best management practices described above, a full description of all proposed conservation measures are described in Chapter 12 of the biological assessment (Reclamation 2012). All best management practices and conservation measures described in this biological opinion are parts of the proposed action and are intended to avoid or minimize adverse project-related effects to ESA-listed anadromous fish and designated critical habitat. The NMFS regards these conservation measures as integral components of the proposed action and expects that all proposed avoidance and minimization measures will be completed.

D. Description of the Action Area

The action area is defined as all areas affected directly or indirectly by the Federal action and not merely the immediate area involved (50 CFR 402.02). The action area encompasses 116,000 acres in Suisun Marsh (Figure 1), Solano County, California. It is bounded to the west, north, and east by hills, and to the south by Suisun, Grizzly, and Honker bays. Montezuma Slough, the largest slough in the action area, runs from east to west between the Sacramento-San Joaquin Delta and Suisun Bay. Major bodies of water include Montezuma Slough, Suisun Slough, Little Honker Bay, and Denverton and Nurse sloughs. Tributaries to Suisun Slough include Cordelia and Goodyear Sloughs, and several small dead-end sloughs. The 116,000 acres within Suisun Marsh includes 52,000 acres are privately or publicly owned managed wetlands and 64,000 acres of bays, sloughs, and upland grasslands. The action area includes areas that will be affected by RGP 3 and LOP maintenance activities, as well as, SMP tidal wetland restoration actions.

III. ANALYTICAL FRAMEWORK

A. Jeopardy Analysis

In accordance with policy and regulation, the jeopardy analysis in this biological opinion relies on four components: (1) the Status of the Species, which evaluates the Central California Coast (CCC) steelhead DPS, Central Valley (CV) steelhead DPS, southern DPS of North American green sturgeon, winter-run Chinook salmon ESU, and CV spring-run ESU range-wide conditions, the factors responsible for that condition, and the species' likelihood of both survival and recovery; (2) the Environmental Baseline, which evaluates the condition of these listed species in the action area, the factors responsible for that condition, and the relationship of the action area to the likelihood of both survival and recovery of these listed species; (3) the Effects of the Action, which determines the direct and indirect effects of the proposed Federal action and the effects of any interrelated or interdependent activities on these species in the action area; and (4) Cumulative Effects, which evaluates the effects of future, non-Federal activities in the action area on these species.

The jeopardy determination is made by adding the effects of the proposed Federal action and any Cumulative Effects to the Environmental Baseline and then determining if the resulting changes in species status in the action area are likely to cause an appreciable reduction in the likelihood of both the survival and recovery of these listed species in the wild.

The jeopardy analysis in this biological opinion places an emphasis on the range-wide likelihood of both survival and recovery of these listed species and the role of the action area in the survival and recovery of these listed species. The significance of the effects of the proposed Federal action is considered in this context, taken together with cumulative effects, for purposes of making the jeopardy determination. We use a hierarchical approach that focuses first on whether or not the effects on salmonids and green sturgeon in the action area will impact their respective populations. If the population will be impacted, we assess whether this impact is likely to affect the ability of the population to support the survival and recovery of the DPS or ESU.

B. Adverse Modification Analysis

This biological opinion does not rely on the regulatory definition of "destruction or adverse modification" of critical habitat at 50 C.F.R. 402.02, which was invalidated by *Gifford Pinchot Task Force v. USFWS*, 378 F.3d 1059 (9th Cir. 2004), amended by 387 F.3d 968 (9th Cir. 2004). Instead, we have relied upon the statutory provisions of the ESA to complete the following analysis with respect to critical habitat.

The adverse modification analysis in this biological opinion relies on four components: (1) the Status of Critical Habitat, which evaluates the range-wide and watershed-wide condition of critical habitat for the affected salmonid and green sturgeon DPSs and ESUs in terms of primary constituent elements (PCEs – sites for spawning, rearing, and migration), and/or essential features, and the factors responsible for that condition, and the resulting conservation value of the critical habitat overall; (2) the Environmental Baseline, which evaluates the condition of critical habitat in the action area, the factors responsible for that condition, and the conservation value of critical habitat in the action area; (3) the Effects of the Action, which determines the direct and indirect impacts of the proposed Federal action and the effects of any interrelated or interdependent activities on the critical habitat in the action area and how that will influence the conservation value of affected critical habitat units; and (4) Cumulative Effects, which evaluates the effects of future, non-Federal activities in the action area on the critical habitat and how that will influence the conservation value of affected critical habitat units.

For purposes of the adverse modification determination, we add the effects of the proposed Federal action on green sturgeon and winter-run Chinook salmon critical habitat in the action area, and any Cumulative Effects, to the Environmental Baseline and then determine if the resulting changes to the conservation value of critical habitat in the action area are likely to cause an appreciable reduction in the conservation value of critical habitat range-wide. If the proposed action will negatively affect PCEs and/or essential features of critical habitat in the action area we then assess whether or not this reduction will impact the value of the DPS or ESU critical habitat designation as a whole.

C. Use of Best Available Scientific and Commercial Information

To conduct the assessment, NMFS examined an extensive amount of information from a variety of sources. Detailed background information on the biology and status of the listed species and critical habitat has been published in a number of documents including peer reviewed scientific journals, primary reference materials, and governmental and non-governmental reports. Additional information regarding the effects of the project's actions on the listed species in question, their anticipated response to these actions, and the environmental consequences of the actions as a whole was formulated from the aforementioned resources.

A complete administrative record of this consultation is on file in the NMFS Santa Rosa Area Office (Administrative Record Number 151422SWR2012SR00277).

IV. STATUS OF THE SPECIES AND CRITICAL HABITAT

The following listed species and designated critical habitat occur in the action area and may be affected by the proposed project.

Sacramento River winter-run Chinook salmon ESU (*Oncorhynchus tshawytscha*)
endangered (70 FR 37160; June 28, 2005)
critical habitat (58 FR 33212; June 16, 1993);
Central Valley spring-run Chinook salmon ESU (*Oncorhynchus tshawytscha*)
threatened (70 FR 37160; June 28, 2005);
Central California Coast steelhead DPS (*Oncorhynchus mykiss*)
threatened (71 FR 834; January 5, 2006);
Central Valley steelhead DPS (*Oncorhynchus mykiss*)
threatened (71 FR 834; January 5, 2006); and
North American green sturgeon southern DPS (*Acipenser medirostris*)
threatened (71 FR 17757; April 7, 2006)
critical habitat (74 FR 52300; October 9, 2009).

A. Species Description, Life History, and Status

In this opinion, NMFS assesses four population viability parameters to help us understand the status of CCC steelhead, CV steelhead, CV spring-run Chinook salmon, Sacramento River winter-run Chinook salmon, and southern DPS green sturgeon and their populations' ability to survive and recover. These population viability parameters are: abundance, population growth rate, spatial structure, and diversity (McElhany *et al.* 2000). NMFS has used existing information to determine the general condition of each population and factors responsible for the current status of each DPS or ESU.

We use these population viability parameters as surrogates for numbers, reproduction, and distribution, the criteria found within the regulatory definition of jeopardy (50 CFR 402.02). For example, the first three parameters are used as surrogates for numbers, reproduction, and distribution. We relate the fourth parameter, diversity, to all three regulatory criteria. Numbers, reproduction, and distribution are all affected when genetic or life history variability is lost or constrained. This results in reduced population resilience to environmental variation at local or landscape-level scales.

1. <u>CV Spring-run and Sacramento River Winter-run Chinook Salmon</u>

a. General Life History

Chinook salmon return to freshwater to spawn when they are 3 to 8 years old (Healy 1991). Runs are designated on the basis of adult migration timing; however, distinct runs also differ in the degree of maturation at the time of river entry, thermal regime and flow characteristics of their spawning site, and actual time of spawning (Myers *et al.* 1998). Both winter-run and spring-run Chinook salmon tend to enter freshwater as immature fish, migrate far upriver, and delay spawning for weeks or months. For comparison, fall-run Chinook salmon enter freshwater at an advanced stage of maturity, move rapidly to their spawning areas on the mainstem or lower tributaries of rivers, and spawn within a few days or weeks of freshwater entry (Healey 1991). Adult endangered Sacramento River winter-run Chinook salmon enter San Francisco Bay from November through May (Hallock and Fisher 1985), and delay spawning until spring or early summer. Adult threatened Central Valley spring-run Chinook salmon enter the Sacramento-San Joaquin Delta (Delta) beginning in January and enter natal streams from March to July (Myers *et al.* 1998). Central Valley spring-run Chinook salmon adults hold in freshwater over summer and spawn in the fall. Central Valley spring-run Chinook salmon juveniles typically spend a year or more in freshwater before migrating toward the ocean. Adequate instream flows and cool water temperatures are more critical for the survival of Central Valley spring-run Chinook salmon due to over summering by adults and/or juveniles.

Sacramento River winter-run Chinook salmon spawn primarily from mid-April to mid-August, peaking in May and June, in the Sacramento River reach between Keswick Dam and the Red Bluff Diversion Dam. Central Valley spring-run Chinook salmon typically spawn between September and October depending on water temperatures. Chinook salmon generally spawn in waters with moderate gradient and gravel and cobble substrates. Eggs are deposited within the gravel where incubation, hatching, and subsequent emergence take place. The upper preferred water temperature for spawning adult Chinook salmon is 55 ^{o}F (Chambers 1956) to 57 ^{o}F (Reiser and Bjornn 1979). The length of time required for eggs to develop and hatch is dependent on water temperature, and quite variable.

Sacramento River winter-run Chinook salmon fry begin to emerge from the gravel in late June to early July and continue through October (Fisher 1994). Juvenile winter-run Chinook salmon spend 4 to 7 months in freshwater prior to migrating to the ocean as smolts. Central Valley spring-run Chinook salmon fry emerge from November to March and spend about 3 to 15 months in freshwater prior to migrating towards the ocean (Kjelson *et al.* 1981). Post-emergent fry seek out shallow, nearshore areas with slow current and good cover, and begin feeding on small terrestrial and aquatic insects and crustaceans. Chinook fry and parr may spend time rearing within riverine and/or estuarine habitats including natal tributaries, the Sacramento River, non-natal tributaries to the Sacramento River, and the Delta.

Within estuarine habitat, juvenile rearing Chinook salmon movements are generally dictated by tidal cycles, following the rising tide into shallow water habitats from the deeper main channels, and returning to the main channels when the tide recedes (Levings 1982, Levy and Northcote 1982, Healey 1991). Juvenile Chinook salmon forage in shallow areas with protective cover, such as intertidal and subtidal mudflats, marshes, channels and sloughs (McDonald 1960, Dunford 1975). As juvenile Chinook salmon increase in length, they tend to school in the surface waters of the main and secondary channels and sloughs, following the tides into shallow water habitats to feed (Allen and Hassler 1986). Kjelson *et al.* (1981) reported that juvenile Chinook salmon demonstrated a diel migration pattern, orienting themselves to nearshore cover and structure during the day, but moving into more open, offshore waters at night. The fish also distributed themselves vertically in relation to ambient light. Juvenile Sacramento River winter-run Chinook salmon migrate to the sea after only rearing in freshwater for 4 to 7 months, and occur in the Delta from October through early May (CDFW 1998). Most Central Valley spring-run Chinook salmon smolts are present in the Delta from mid-March through mid-May depending on flow conditions (CDFW 2000).

b. Status of the Sacramento River Winter-Run Chinook Salmon and Critical Habitat

The Sacramento River winter-run Chinook salmon ESU has been completely displaced from its historical spawning habitat by the construction of Shasta and Keswick dams. Approximately, 300 miles of tributary spawning habitat in the upper Sacramento River is now inaccessible to the ESU. Most components of the Sacramento River winter-run Chinook salmon life history (*e.g.*, spawning, incubation, freshwater rearing) have been compromised by the habitat blockage in the upper Sacramento River. The remaining spawning habitat in the upper Sacramento River is artificially maintained by cool water releases from Shasta and Keswick Dams, and the spatial distribution of spawners is largely governed by the water year type and the ability of the Central Valley Project to manage water temperatures in the upper Sacramento River.

Between the time Shasta Dam was built and the Sacramento River winter-run Chinook salmon were listed as endangered, major impacts to the population occurred from warm water releases from Shasta Dam, juvenile and adult passage constraints at the RBDD, water exports in the southern Delta, and entrainment at a large number of unscreened or poorly-screened water diversions. The naturally spawning component of this ESU has exhibited marked improvements in abundance and productivity in the 2000s (CDFW 2008). These increases in abundance are encouraging, relative to the years of critically low abundance of the 1980s and early 1990s; however, returns of several West Coast Chinook salmon and coho salmon stocks were lower than expected in 2007 (NMFS 2008), and stocks remained low through 2009.

A captive broodstock artificial propagation program for Sacramento River winter-run Chinook salmon has operated since the early 1990s as part of recovery actions for this ESU. As many as 150,000 juvenile salmon have been released by this program, but in most cases the number of fish released was in the tens of thousands (Good *et al.* 2005). NMFS reviewed this hatchery program in 2004 and concluded that as much as 10 percent of the natural spawners may be attributable to the program's support of the population (69 FR 33102). The artificial propagation program has contributed to maintaining diversity through careful use of methods that ensure genetic diversity. If improvements in natural production continue, the artificial propagation program may be discontinued (69 FR 33102).

Critical habitat was designated for the Sacramento River winter-run Chinook salmon on June 16, 1993. Physical and biological features that are essential for the conservation of Sacramento winter-run Chinook salmon, based on the best available information, include: (1) access from the Pacific Ocean to appropriate spawning areas in the upper Sacramento River; (2) the availability of clean gravel for spawning substrate; (3) adequate river flows for successful spawning, incubation of eggs, fry development and emergence, and downstream transport of juveniles; (4) water temperatures between 42.5 and 57.5˚F for successful spawning, egg incubation, and fry development; (5) habitat areas and adequate prey that are not contaminated; (6) riparian areas that provides for successful juvenile development and survival; and (7) access downstream so that juveniles can migrate from the spawning grounds to San Francisco Bay and the Pacific Ocean (58 FR 33212).

Designated critical habitat for Sacramento River winter-run Chinook salmon has been degraded from conditions known to support viable salmonid populations. It does not provide the full extent of conservation values necessary for the recovery of the species. In particular, adequate river flows and water temperatures have been impacted by human actions, substantially altering the historical river characteristics in which the Sacramento River winter-run Chinook salmon evolved. Depletion and storage of stream flows behind large dams on the Sacramento River and other tributary streams have drastically altered the natural hydrologic cycles of the Sacramento River and Delta. Alteration of flows results in migration delays, loss of suitable habitat due to dewatering and blockage; stranding of fish from rapid flow fluctuations; entrainment of juveniles into poorly screened or unscreened diversions, and increased water temperatures harmful to salmonids. Other impacts of concern include alteration of stream bank and channel morphology, loss of riparian vegetation, loss of spawning and rearing habitat, fragmentation of habitat, loss of downstream recruitment of spawning gravels, degradation of water quality, and loss of nutrient input.

Several actions have been taken to improve habitat conditions for Sacramento River winter-run Chinook salmon, including: changes in ocean and inland fishing harvest that to increase ocean survival and adult escapement, and implementation of habitat restoration efforts throughout the Central Valley. However, this population remains below established recovery goals and the naturally-spawned component of the ESU is dependent on one extant population in the Sacramento River. Risks to the ESU's genetic diversity, life-history variability, local adaptation, and spatial structure are particularly concerning, as there is only one remaining population (Good *et al.* 2005, 70 FR 37160). The status of Sacramento River winter-run Chinook salmon is little changed since the last status review, and new information available since Good *et al.* (2005) does not appear to suggest a change in extinction risk (Williams *et al.* 2011). On August 15, 2011, NMFS reaffirmed no change to the listing of endangered for the Sacramento River winter-run Chinook salmon ESU (76 FR 50447).

c. Status of the CV Spring-run Chinook Salmon

Historically, the predominant salmon run in the Central Valley was the spring-run Chinook salmon. Extensive construction of dams throughout the Sacramento-San Joaquin basin has reduced the Central Valley spring-run Chinook salmon run to only a small portion of its historical distribution. The Central Valley drainage as a whole is estimated to have supported Central Valley spring-run Chinook salmon runs as large as 600,000 fish between the late 1880s and 1940s (CDFW 1998). The ESU has been reduced to only three naturally-spawning populations that are free of hatchery influence from an estimated 17 historic populations.[1] These three populations (spawning in three tributaries to the Sacramento River - Deer, Mill, and Butte creeks), are in close geographic proximity, increasing the ESU's vulnerability to disease or catastrophic events.

Central Valley spring-run Chinook salmon from the Feather River Hatchery (FRH) were included in the ESU because they are believed by NMFS to be the only population in the ESU that displays early run timing. This early run timing is considered by NMFS to represent an important evolutionary legacy of the spring-run populations that once spawned above Oroville Dam (70 FR 37160). The FRH population is closely related genetically to the natural Feather River population. The FRH's goal is to release five million spring-run Chinook salmon per year. Recent releases have ranged from about one-and-a-half to five million fish, with most releases below five million fish (Good *et al.* 2005).

Several actions have been taken to improve habitat conditions for Central Valley spring-run Chinook salmon, including: habitat restoration efforts in the Central Valley; and changes in freshwater harvest management measures. Although protective measures likely have contributed to recent increases in Central Valley spring-run Chinook salmon abundance, the ESU is still well below levels observed from the 1960s. Threats from hatchery production (*i.e.*, competition for food between naturally-spawned and hatchery fish, run hybridization and genomic homogenization), climatic variation, high temperatures, predation, and water diversions still persist. Because wild Central Valley spring-run Chinook salmon ESU populations are confined to relatively few remaining watersheds and continue to display broad fluctuations in abundance, the Biological Review Team concluded that the ESU is likely to become endangered within the foreseeable future. The most recent status review concludes the status of Central Valley spring-run Chinook salmon ESU has probably deteriorated since the 2005 status review (Williams *et al.* 2011). New information available since Good *et al.* (2005) indicates an increased extinction risk. Based on this information, NMFS has chosen to maintain the threatened listing for this species (76 FR 50447), but recommends reviewing Central Valley spring-run Chinook status again in 2-3 years, (instead of the normal 5 years) if species numbers do not improve (NMFS 2011).

[1] There has also been a small run in Big Chico Creek in recent years (Good *et al.* 2005).

2. <u>CV and CCC Steelhead</u>

a. General Life History

Steelhead are anadromous forms of *O. mykiss*, spending some time in both freshwater and saltwater. Unlike Pacific salmon, steelhead are iteroparous, or capable of spawning more than once before death (Busby *et al.* 1996). Although one-time spawners are the great majority, Shapovalov and Taft (1954) reported that repeat spawners are relatively numerous (17.2 percent) in California streams. Steelhead young usually rear in freshwater for 1 to 3 years before migrating to the ocean as smolts, but rearing periods of up to 7 years have been reported. Migration to the ocean usually occurs in the spring. Steelhead may remain in the ocean for 1 to 5 years (2 to 3 years is most common) before returning to their natal streams to spawn (Busby *et al.* 1996). The distribution of steelhead in the ocean is not well known. Coded wire tag recoveries indicate that most steelhead tend to migrate north and south along the continental shelf (Barnhart 1986). Adult steelhead typically migrate from the ocean to freshwater between December and April, peaking in January and February (Fukushima and Lesh 1998).

Juvenile steelhead migrate as smolts to the ocean from January through May, with peak migration occurring in April and May (Fukushima and Lesh 1998). Barnhart (1986) reported that peak smolt migration occurs in March and April, and steelhead smolts in California typically range in size from 140 to 210 millimeter (mm) (fork length). Steelhead of this size can withstand higher salinities than smaller fish (McCormick 1994), and are more likely to occur for longer periods in tidally influenced estuaries, such as San Francisco Bay. Smolts primarily use estuaries for rearing prior to seawater entry. Smaller steelhead juveniles are likely to avoid salt water and brackish environments, and while they can be acclimated to brackish water, their growth is likely hindered.

Turbidity (*i.e.*, water clarity) also can influence the behavior, distribution and growth of juvenile salmonids (Cordone and Kelley 1961, Sigler *et al.* 1984, Redding *et al.* 1987, Newcombe and McDonald 1991, Newcombe and Jensen 1996). The impacts of turbidity on juvenile salmonids are largely linked to factors such as background turbidity levels and the duration of turbid conditions. Sigler *et al.* (1984) observed avoidance of turbid water by juvenile steelhead and coho when exposed to turbidities as low as 38 NTUs and 22 NTUs, respectively, for a period of 15-17 days. Sigler *et al.* (1984) also observed that fish kept in these turbid conditions had lower growth rates than fish kept in clear water for the same amount of time.

b. Status of CCC Steelhead DPS

Historically, approximately 70 populations[2] of steelhead existed in the CCC steelhead DPS (Spence *et al.* 2008, Spence *et al.* 2012). Many of these populations (about 37) were independent, or potentially independent, meaning they had a high likelihood of surviving for 100 years absent anthropogenic impacts (Bjorkstedt *et al.* 2005). The remaining populations were

[2] Population as defined by Bjorkstedt *et al.* 2005 and McElhaney *et al.* 2000 as, in brief summary, a group of fish of the same species that spawns in a particular locality at a particular season and does not interbreed substantially with fish from any other group. Such fish groups may include more than one stream. These authors use this definition as a starting point from which they define four types of populations (not all of which are mentioned here).

dependent upon immigration from nearby CCC steelhead DPS populations to ensure their viability (McElhaney *et al.* 2000, Bjorkstedt *et al.* 2005).

While historical and present data on abundance are limited, CCC steelhead numbers are substantially reduced from historical levels. A total of 94,000 adult steelhead were estimated to spawn in the rivers of this DPS in the mid-1960s, including 50,000 fish in the Russian River - the largest population within the DPS (Busby *et al.* 1996). Recent estimates for the Russian River are on the order of 4,000 fish (NMFS 1997a). Abundance estimates for smaller coastal streams in the DPS indicate low but stable levels with recent estimates for several streams (Lagunitas, Waddell, Scott, San Vincente, Soquel, and Aptos creeks) of individual run sizes of 500 fish or less (62 FR 43937). Some loss of genetic diversity has been documented and attributed to previous among-basin transfers of stock and local hatchery production in interior populations in the Russian River (Bjorkstedt *et al.* 2005). Similar losses in genetic diversity in the Napa River may have resulted from out-of-basin and out-of-DPS releases of steelhead in the Napa River basin in the 1970s and 80s. These transfers included fish from the South Fork Eel River, San Lorenzo River, Mad River, Russian River, and the Sacramento River. In San Francisco Bay streams, reduced population sizes and fragmentation of habitat has likely also led to loss of genetic diversity in these populations. For more detailed information on trends in CCC steelhead abundance, see: Busby *et al.* 1996, NMFS 1997a, Good *et al.* 2005, Spence *et al.* 2008.

CCC steelhead have experienced serious declines in abundance and long-term population trends suggest a negative growth rate. This indicates the DPS may not be viable in the long term. DPS populations that historically provided enough steelhead immigrants to support dependent populations may no longer be able to do so, placing dependent populations at increased risk of extirpation. However, because CCC steelhead remain present in most streams throughout the DPS, roughly approximating the known historical range, CCC steelhead likely possess a resilience that is likely to slow their decline relative to other salmonid DPSs or ESUs in worse condition. In 2005, a status review concluded that steelhead in the CCC steelhead DPS remain “likely to become endangered in the foreseeable future” (Good *et al.* 2005). On January 5, 2006, NMFS issued a final determination that the CCC steelhead DPS is a threatened species, as previously listed (71 FR 834).

A more recent viability assessment of CCC steelhead concluded that populations in watersheds that drain to San Francisco Bay are highly unlikely to be viable, and that the limited information available did not indicate that any other CCC steelhead populations could be demonstrated to be viable[3] (Spence *et al.* 2008). Research monitoring data from 2008/09 and 2009/10 of adult CCC steelhead returns shows a decline in adults across the range of the DPS compared to the last ten years (Jeffrey Jahn, personal communication, 2010). The most recent status update found that the status of the CCC steelhead DPS remains “likely to become endangered in the foreseeable future” (Williams *et al.* 2011), as new and additional information available since Good *et al.* (2005), does not appear to suggest a change in extinction risk. On December 7, 2011, NMFS chose to maintain the threatened status of the CCC steelhead (76 FR 76386).

[3] Viable populations have a high probability of long-term persistence (> 100 years).

c. Status of the CV Steelhead DPS

Central Valley steelhead historically were well-distributed throughout the Sacramento and San Joaquin rivers (Busby *et al.* 1996). Although it appears Central Valley steelhead remain widely distributed in Sacramento River tributaries, the vast majority of historical spawning areas are currently above impassable dams. At present, all Central Valley steelhead are considered winter-run steelhead (McEwan and Jackson 1996), although there are indications that summer steelhead were present in the Sacramento River system prior to the commencement of large-scale dam construction in the 1940s (IEP Steelhead Project Work Team 1999). McEwan and Jackson (1996) reported that wild steelhead stocks appear to be mostly confined to upper Sacramento River tributaries such as Antelope, Deer, and Mill creeks and the Yuba River. However, naturally spawning populations are also known to occur in Butte Creek, and the upper Sacramento mainstem, Feather, American, Mokelumne, and Stanislaus rivers (CALFED 2000). It is possible that other small populations of naturally spawning steelhead exist in Central Valley streams, but are undetected due to lack of sufficient monitoring and research programs; increases in fisheries monitoring efforts led to the discovery of steelhead populations in streams such as Auburn Ravine and Dry Creek (IEP Steelhead Project Work Team 1999).

Small self-sustaining populations of CV steelhead exist in the Stanislaus, Mokelumne, Calaveras, and other tributaries of the San Joaqiun River (McEwan 2001). On the Stanislaus River, steelhead smolts have been captured in rotary screw traps at Caswell State Park and Oakdale each year since 1995 (Demko *et al.* 2000). Incidental catches and observations of steelhead juveniles also have occurred on the Tuolumne and Merced Rivers during fall-run Chinook salmon monitoring activities, indicating that steelhead are widespread, if not abundant, throughout accessible streams and rivers in the Central Valley (Good *et al.* 2005).

Steelhead counts at the Red Bluff Diversion Dam (RBDD) have declined from an average annual count of 11,187 adults for the ten-year period beginning in 1967, to an average annual count 2,202 adults in the 1990's (McEwan and Jackson 1996). Estimates of the adult steelhead population composition in the Sacramento River have also changed over this time period; through most of the 1950's, Hallock *et al.* (1961) estimated that 88 percent of returning adults were of natural origin, and this estimate declined to 10-30 percent in the 1990's (McEwan and Jackson 1996). Furthermore, the California Fish and Wildlife Plan estimated a total run size of about 40,000 adults for the entire Central Valley, including San Francisco Bay, in the early 1960s (CDFW 1965). In 1991-92, this run was probably less than 10,000 fish based on dam counts, hatchery returns and past spawning surveys (McEwan and Jackson 1996).

The status of Central Valley steelhead appears to have worsened since the 2005 status review (Good *et al.* 2005), when the biological review team concluded that the DPS was in danger of extinction. New information available since Good *et al.* (2005) indicates an increased extinction risk (Williams *et al.* 2011). Steelhead have been extirpated from most of their historical range in this region. Habitat concerns in this DPS focus on the widespread degradation, destruction, and blockage of freshwater habitat within the region, and water allocation problems. Widespread hatchery production of introduced steelhead within this DPS also raises concerns about the potential ecological interactions between introduced and native stocks. Because the Central Valley steelhead population has been fragmented into smaller isolated tributaries without any large source population, and the remaining habitat continues to be degraded by water diversions, the population remains at an elevated risk for future population declines. Based on this information, NMFS chose to maintain the threatened listing for this species (76 FR 50447), but recommends reviewing Central Valley steelhead status again in 2-3 years, (instead of the normal 5 years) if species numbers do not improve (NMFS 2011).

3. Green Sturgeon

a. General Life History

Green sturgeon is an anadromous, long-lived, and bottom-oriented fish species in the family Acipenseridae. Sturgeon have skeletons composed mostly of cartilage and sturgeon lack scales, instead of possessing five rows of characteristic bony plates on their body called "scutes." On the underside of their flattened snouts are sensory barbels and a siphon-shaped, protrusible, toothless mouth. Large adults may exceed 2 meters in length and 100 kilograms in weight (Moyle 2012). Based on genetic analyses and spawning site fidelity, NMFS determined that North American green sturgeon are comprised of at least two distinct population segments (DPS): a northern DPS consisting of populations originating from coastal watersheds northward of and including the Eel River ("northern DPS green sturgeon"), with spawning confirmed in the Klamath and Rogue river systems; and a southern DPS consisting of populations originating from coastal watersheds south of the Eel River ("southern DPS green sturgeon"), with spawning confirmed in the Sacramento River system (Adams *et al.* 2002).

Green sturgeon are the most marine-oriented species of sturgeon (Moyle 2002). Along the West Coast of North America, they range in nearshore waters from Mexico to the Bering Sea (Adams *et al.* 2002), with a general tendency to head north after their out-migration from freshwater (Lindley *et al.* 2011). While in the ocean, archival tagging indicates that green sturgeon occur in waters between 0 and 200 meters depth, but spend most of their time in waters between 20–80 meters and temperatures of 9.5–16.0°C (Nelson *et al.* 2010, Huff *et al.* 2011). Subadult and adult green sturgeon move between coastal waters and estuaries (Lindley *et al.* 2008, Lindley *et al.* 2011), but relatively little is known about how green sturgeon use these habitats. Lindley *et al.* (2011) report multiple rivers and estuaries are visited by aggregations of green sturgeon in summer months, and larger estuaries (*e.g.*, San Francisco Bay) appear to be particularly important habitat. During the winter months, green sturgeon generally reside in the coastal ocean. Areas north of Vancouver Island are favored overwintering areas, with Queen Charlotte Sound and Hecate Strait likely destinations based on detections of acoustically-tagged green sturgeon (Lindley *et al.* 2008, Nelson *et al.* 2010).

Based on genetic analysis, Israel *et al.* (2009) reported that almost all green sturgeon collected in the San Francisco Bay system were southern DPS. This finding is corroborated by tagging and tracking studies which found that no green sturgeon tagged in the Klamath or Rogue rivers (*i.e.*, Northern DPS) have yet been detected in San Francisco Bay (Lindley *et al.* 2011). However, green sturgeon inhabiting coastal waters adjacent to San Francisco Bay include northern DPS green sturgeon.

Adult southern DPS green sturgeon spawn in the Sacramento River watershed during the spring and early summer months (Moyle *et al.* 1995). Eggs are laid in turbulent areas on the river bottom and settle into the interstitial spaces between cobble and gravel (Adams *et al.* 2007).

Like salmonids, green sturgeon require cool water temperatures for egg and larval development, with optimal temperatures ranging from 11 to 17˚C (Van Eenennaam *et al.* 2005). Eggs hatch after 6–8 days, and larval feeding begins 10–15 days post-hatch. Metamorphosis of larvae into juveniles typically occurs after a minimum of 45 days (post-hatch) when fish have reached 60–80 mm total length (TL). After hatching larvae migrate downstream and metamorphose into juveniles. Juveniles spend their first few years in the Sacramento-San Joaquin Delta (Delta) and San Francisco estuary before entering the marine environment as subadults. Juvenile green sturgeon salvaged at the State and Federal water export facilities in the southern Delta are generally between 200 mm and 400 mm TL (Adams *et al.* 2002) which suggests southern DPS green sturgeon spend several months to a year rearing in freshwater before entering the Delta and San Francisco estuary. Laboratory studies conducted by Allen and Cech (2007) indicated juveniles approximately 6-month old were tolerant of saltwater, but approximately 1.5-year old green sturgeon appeared more capable of successful osmoregulation in salt water.

Subadult green sturgeon spend several years at sea before reaching reproductive maturity and returning to freshwater to spawn for the first time (Nakamoto *et al.* 1995). Little data are available regarding the size and age-at-maturity for the southern DPS green sturgeon, but it is likely similar to that of the northern DPS. Male and female green sturgeon differ in age-at-maturity. Males can mature as young as 14 years and female green sturgeon mature as early as age 16 (Van Eenennaam *et al.* 2006). Adult green sturgeon are believed to spawn every two to five years. Recent telemetry studies by Heublein *et al.* (2009) indicate adults typically enter San Francisco Bay from the ocean and begin their upstream spawning migration between late February and early May. These adults on their way to spawning areas in the upper Sacramento River typically migrate rapidly through the estuary toward their upstream spawning sites. Preliminary results from tagged adult sturgeon suggest travel time from the Golden Gate to Rio Vista in the Delta is generally 1-2 weeks. Post-spawning, Heublein *et al.* (2009) reported tagged southern DPS green sturgeon displayed two outmigration strategies; outmigration from Sacramento River prior to September 1 and outmigration during the onset of fall/winter stream flow increases. The transit time for post-spawning adults through the San Francisco estuary appears to be very similar to their upstream migration (*i.e.*, 1-2 weeks).

During the summer and fall, an unknown proportion of the population of non-spawning adults and subadults enter the San Francisco estuary from the ocean for periods ranging from a few days to 6 months (Lindley *et al.* 2011). Some fish are detected only near the Golden Gate, while others move as far inland as Rio Vista in the Delta. The remainder of the population appear to enter bays and estuaries farther north from Humboldt Bay, California to Grays Harbor,Washington (Lindley *et al.* 2011).

Green sturgeon feed on benthic invertebrates and fish (Adams *et al.* 2002). Radtke (1966) analysed stomach contents of juvenile green sturgeon captured in the Sacramento-San Joaquin Delta and found the majority of their diet was benthic invertebrates, such as mysid shrimp and amphipods (Corophium spp). Manual tracking of acoustically-tagged green sturgeon in the San Francisco Bay estuary indicates they are generally bottom-oriented, but make occasional forays to surface waters, perhaps to assist their movement (Kelly *et al.* 2007). Dumbauld *et al.* (2008) report green sturgeon utilize soft substrate in estuaries, presumably feeding on benthic invertebrates. Preliminary data from mapping surveys conducted in Willapa Bay, Washington, showed densities of "feeding pits" (*i.e.*, depressions in the substrate believed to be formed when green sturgeon feed) were highest over shallow intertidal mud flats, while harder substrates (*e.g.,* gravel) had no pits (M. Moser, unpublished data). Within the San Francisco estuary, green sturgeon are encountered by recreational anglers and during sampling by CDFW in the shallow waters of San Pablo Bay.

b. Status of Southern DPS Green Sturgeon and Critical Habitat

To date, little population-level data have been collected for green sturgeon. In particular, there are no published abundance estimates for either northern DPS or southern DPS green sturgeon in any of the natal rivers based on survey data. As a result, efforts to estimate green sturgeon population size have had to rely on sub-optimal data with known potential biases. Available abundance information is comes mainly from four sources: 1) incidental captures in the CDFW white sturgeon monitoring program; 2) fish monitoring efforts associated with two diversion facilities on the upper Sacramento River; 3) fish salvage operations at the water export facilities on the Sacramento-San Joaquin Delta; and 4) dual frequency sonar identification in spawning areas of the upper Sacramento River. These data are insufficient in a variety ways (*e.g.*, short time series, non-target species, *etc*.) and do not support more than a qualitative evaluation of changes in green sturgeon abundance.

CDFW's white sturgeon monitoring program incidentally captures southern DPS green sturgeon. Trammel nets are used to capture white sturgeon and CDFW (2002) utilizes a multiple-census or Peterson mark-recapture method to estimate the size of subadult and adult sturgeon population. By comparing ratios of white sturgeon to green sturgeon captures, estimates of southern DPS green sturgeon abundance can be calculated. Estimated abundance of green sturgeon between 1954 and 2001 ranged from 175 fish to more than 8,000 per year and averaged 1,509 fish per year. Unfortunately, there are many biases and errors associated with these data, and CDFW does not consider these estimates reliable. For larval and juvenile green sturgeon in the upper Sacramento River, information is available from salmon monitoring efforts at the Red Bluff Diversion Dam (RBDD) and the Glenn-Colusa Irrigation District (GCID). Incidental capture of larval and juvenile green sturgeon at the RBDD and GCID have ranged between 0 and 2,068 green sturgeon per year (Adams *et al.* 2002). Genetic data collected from these larval green sturgeon suggest that the number of adult green sturgeon spawning in the upper Sacramento River remained roughly constant between 2002 and 2006 in river reaches above Red Bluff (Israel and May 2010). In 2011, rotary screw traps operating in the Upper Sacramento River at RBDD captured 3,700 larval green sturgeon which represents the highest catch on record in 16 years of sampling (Poytress *et al.* 2011).

Juvenile green sturgeon are collected at water export facilities operated by DWR and Reclamation in the Sacramento-San Joaquin Delta. Fish collection records have been maintained by DWR from 1968 to present and by Reclamaiton from 1980 to present. The average number of southern DPS green sturgeon taken per year at the DWR facility prior to 1986 was 732; from 1986 to 2001, the average per year was 47 (70 FR 17386). For Reclamaiton's facility, the average number prior to 1986 was 889; from 1986 to 2001 the average was 32 (70 FR 17386). Direct capture in the salvage operations at these facilities is a small component of the overall effect of water export facilities on southern DPS green sturgeon; entrained juvenile green sturgeon are exposed to potential high levels of predation by non-native predators, disruption in migratory behavior, and poor habitat quality. Delta water exports have increased substantially since the 1970s and it is likely that this has contributed to negative trends in the abundance of migratory fish that utilize the Delta, including the southern DPS green sturgeon.

During the spring and summer spawning period, researchers with University of California Davis have utilized dual-frequency identification sonar to enumerated adult green sturgeon in the upper Sacramento River. These surveys estimated 175 to 250 sturgeon (±50) in the mainstem Sacramento River during the 2010 and 2011 spawning seasons (E. Mora, personal communication, January 2012). However, it is important to note that this estimate may include some white sturgeon, and movements of individuals in and out of the survey area confound these estimates. Given these uncertainties, caution must be taken in using these estimates to infer the spawning run size for the Sacramento River, until further analyses are completed.
The most recent status review update concluded the southern DPS green sturgeon is likely to become endangered in the foreseeable future due to the substantial loss of spawning habitat, the concentration of a single spawning population in one section of the Sacramento River, and multiple other risks to the species such as stream flow management, degraded water quality, and introduced species (NMFS 2005). Based on this information, the southern DPS green sturgeon was listed as threatened on April 7, 2006 (71 FR 17757).

Critical habitat was designated for the southern DPS of green sturgeon on October 9, 2009 (74 FR 52300) and includes coastal marine waters within 60 fathoms depth from Monterey Bay, California to Cape Flattery, Washington, including the Strait of Juan de Fuca to its United States boundary. Designated critical habitat also includes the Sacramento River, lower Feather River, lower Yuba River, Sacramento-San Joaquin Delta, Suisun Bay, San Pablo Bay, and San Francisco Bay in California. PCEs of designated critical habitat in estuarine areas are food resources, water flow, water quality, mitigation corridor, depth, and sediment quality. In freshwater riverine systems, PCEs of green sturgeon critical habitat are food resources, substrate type or size, water flow, water quality, migratory corridor, depth, and sediment quality. In nearshore coastal marine areas, PCEs are migratory corridor, water quality, and food resources. The current condition of critical habitat for the southern DPS of green sturgeon is degraded over its historical conditions. It does not provide the full extent of conservation values necessary for the recovery of the species, particularly in the upstream riverine habitat of the Sacramento River. In the Sacramento River, migration corridor and water flow PCEs have been impacted by human actions, substantially altering the historical river characteristics in which the southern DPS of green sturgeon evolved. In addition, the alterations to the Sacramento-San Joaquin River Delta may have a particularly strong impact on the survival and recruitment of juvenile green sturgeon due to their protracted rearing time in brackish and estuarine waters.

B. Factors Responsible for Steelhead, Chinook Salmon, and Green Sturgeon Stock Declines

NMFS cites many reasons (primarily anthropogenic) for the decline of steelhead (Busby *et al.* 1996), Chinook salmon (Myers *et al.* 1998), and southern DPS of green sturgeon (Adams *et al.* 2002, NMFS 2005). The foremost reason for the decline in these anadromous populations is the degradation and/or destruction of freshwater and estuarine habitat. Additional factors contributing to the decline of these populations include: commercial and recreational harvest, artificial propagation, natural stochastic events, marine mammal predation, reduced marine-derived nutrient transport, and ocean conditions.

1. Habitat Degradation and Destruction

The best scientific information presently available demonstrates a multitude of factors, past and present, have contributed to the decline of west coast salmonids and green sturgeon by reducing and degrading habitat by adversely affecting essential habitat features. Most of this habitat loss and degradation has resulted from anthropogenic watershed disturbances caused by urban development, agriculture, poor water quality, water resource development, dams, gravel mining, forestry (Busby *et al.* 1996, Adams *et al.* 2002, Good *et al.* 2005), and lagoon management (Smith 1990, Bond 2006).

2. Commercial and Recreational Harvest

Until recently, commercial and recreational harvest of southern DPS green sturgeon was allowed under State and Federal law. The majority of these fisheries have been closed (NMFS 2005). Ocean salmon fisheries off California are managed to meet the conservation objectives for certain stocks of salmon listed in the Pacific Coast Salmon Fishery Management Plan, including any stock that is listed as threatened or endangered under the ESA. Early records did not contain quantitative data by species until the early 1950's. In addition, the confounding effects of habitat deterioration, drought, and poor ocean conditions on salmonids make it difficult to assess the degree to which recreational and commercial harvest have contributed to the overall decline of salmonids and green sturgeon in West Coast rivers.

3. Artificial Propagation

Releasing large numbers of hatchery fish can pose a threat to wild salmon and steelhead stocks through genetic impacts, competition for food and other resources, predation of hatchery fish on wild fish, and increased fishing pressure on wild stocks as a result of hatchery production (Waples 1991).

4. Natural Stochastic Events

Natural events such as droughts, landslides, floods, and other catastrophes have adversely affected salmonid and sturgeon populations throughout their evolutionary history. The effects of these events are exacerbated by anthropogenic changes to watersheds such as logging, roads, and water diversions. These anthropogenic changes have limited the ability of salmonid and sturgeon to rebound from natural stochastic events and depressed populations to critically low levels.

5. Marine Mammal Predation

Predation is not known to be a major factor contributing to the decline of West Coast salmon and steelhead populations relative to the effects of fishing, habitat degradation, and hatchery practices. Predation may have substantial impacts in localized areas. Harbor seal (*Phoca* *vitulina*) and California sea lion (*Zalophus californianus*) numbers have increased along the Pacific Coast (NMFS 1997b).

In a peer reviewed study of harbor seal predation in the Alsea River Estuary of Oregon, the combined results of multiple methodologies led researchers to infer that seals consumed 21 percent (range = 3–63 percent) of the estimated prespawning population of coho salmon. The majority of the predation occurred upriver, at night, and was done by a relatively small proportion of the local seal population (Wright *et al.* 2007).

However, at the mouth of the Russian River, Hanson (1993) reported that the foraging behavior of California sea lions and harbor seals with respect to anadromous salmonids was minimal, and predation on salmonids appeared to be coincidental with the salmonid migrations rather than dependent upon them.

6. Reduced Marine-Derived Nutrient Transport

Marine-derived nutrients from adult salmon carcasses have been shown to be vital for the growth of juvenile salmonids and the surrounding terrestrial and riverine ecosystems (Bilby *et al.* 1996, Bilby *et al.* 1998, Gresh *et al.* 2000). Declining salmon and steelhead populations have resulted in decreased marine-derived nutrient transport to many watersheds. Nutrient loss may be contributing to the further decline of ESA-listed salmonid populations (Gresh *et al.* 2000).

7. Ocean Conditions

Recent evidence suggests poor ocean conditions played a significant role in the low number of returning adult fall run Chinook salmon to the Sacramento River in 2007 and 2008 (Lindley *et al.* 2009). Changes in ocean conditions likely affect ocean survival of all west coast salmonid populations (Good *et al.* 2005, Spence *et al.* 2008).

C. Global Climate Change

Global climate change presents an additional potential threat to anadromous salmonids, green sturgeon and designated critical habitat. Modeling of climate change impacts in California suggests that average summer air temperatures are expected to increase (Lindley *et al.* 2007). Heat waves are expected to occur more often, and heat wave temperatures are likely to be higher (Hayhoe *et al.* 2004). Total precipitation in California may decline; critically dry years may increase (Lindley *et al.* 2007, Schneider 2007). The Sierra Nevada snow pack may decrease by as much as 70 to 90 percent by the end of this century under the highest emission scenarios modeled (Luers *et al.* 2006). Wildfires are expected to increase in frequency and magnitude, by as much as 55 percent under the medium emissions scenarios modeled (Luers *et al.* 2006). Vegetative cover may also change, with decreases in evergreen conifer forest and increases in grasslands and mixed evergreen forests. The likely change in amount of rainfall in Northern and Central Coastal streams under various warming scenarios is less certain, although as noted above, total rainfall across the state is expected to decline.

For the California North Coast, some models show large increases (75 to 200 percent) in rainfall amounts while other models show decreases of 15 percent to 30 percent (Hayhoe *et al.* 2004). It has been estimated that snowmelt contribution to runoff in the San Francisco Bay and San Joaquin Delta may decrease by about 20 percent per decade over the next century (Cloern *et al.* 2011). Many of these changes are likely to further degrade CCC steelhead habitat by reducing stream flows during the summer and raising summer water temperatures. Estuaries may also experience changes detrimental to salmonids. Estuarine productivity is likely to change based on changes in sea level, freshwater flows, nutrient cycling, and sediment amounts (Scavia *et al.* 2002, Cloern *et al*. 2011). In marine environments, ecosystems and habitats important to juvenile and adult salmonids are likely to experience changes in temperatures, circulation, water chemistry, and food supplies (Brewer and Barry 2008, Feely 2004, Osgood 2008, Turley 2008). The projections described above are for the mid to late 21st Century. In shorter time frames, climate conditions not caused by the human addition of carbon dioxide to the atmosphere are more likely to predominate (Cox and Stephenson 2007, Smith *et al*. 2007).

V. ENVIRONMENTAL BASELINE

As described above, Suisun Marsh is bounded to the west, north, and east by hills, and to the south by Suisun, Grizzly, and Honker bays. Montezuma Slough, the largest slough in the action area, runs from east to west between the Sacramento-San Joaquin Delta and Suisun Bay. Major bodies of water draining to Montezuma Slough include Little Honker Bay, and Denverton and Nurse sloughs. The second largest slough in the action area is Suisun Slough, which essentially splits the marsh into eastern and western portions. Tributaries to Suisun Slough include Cordelia and Goodyear Sloughs, and several small dead-end sloughs.

The marsh includes approximately 116,000 acres, of which 52,000 acres are privately or publicly owned managed wetlands. Of the remaining 64,000 acres, most are bays, sloughs, and upland grasslands. Approximately 6,300 acres are unmanaged tidal wetlands and 2,025 acres are permanently flooded wetlands. Networks of tidal sloughs, principally tributaries of Suisun and Montezuma Sloughs, crisscross the marsh. These tidal sloughs and unmanaged tidal wetlands provide over 40,000 acres of habitat for listed species.

Land-use activities such as levee construction, water management, and recreation are pervasive and have degraded habitat quantity and quality for ESA-listed salmonids and green sturgeon through alteration of bank and channel morphology; alteration of ambient water temperatures and salinity levels; elimination of rearing habitat; and fragmentation of available habitats.

Levee building beginning in the mid-1880s has excluded Chinook salmon, steelhead, and green sturgeon from 90 percent of the tidal wetlands that existed historically in the action area. Levees range from 4 to 8 feet above ground, and most of the wetlands are at or below mean tide elevation. Water is diverted from tidal sloughs into managed wetlands at high tides. At low tides, water drains from managed wetlands to tidal sloughs through outlet structures throughout the marsh. These water diversion intakes and drains are described in detail in SRCD and CDFW (2005).

When tidal waters are diverted into managed wetlands, their subsequent temperature, salinity, dissolved oxygen levels, and pH may vary from ambient conditions in adjacent tidal sloughs.

The California Department of Water Resources (DWR) has monitored the quality of drain water from selected ownerships in Suisun Marsh since 1965. On average, salinity and temperature levels in drain water were similar to or slightly higher than ambient levels (SRCD and CDFW 2005). Other water quality parameters (pH, dissolved oxygen) in drain water were comparable to ambient levels.

Although there has been much levee construction, subsequent development of the reclaimed land has been limited. In 1974, the California Legislature enacted the Suisun Marsh Preservation Act that protected Suisun Marsh from urban development. The Suisun Marsh Preservation Act required the San Francisco Bay Conservation and Development Commission to develop a plan for the Marsh and provides for various restrictions on development within Marsh boundaries. The Bay Conservation and Development Commission created the Suisun Marsh Protection Plan in 1976. Most of the pre-existing development within the Marsh was either agricultural or recreational. These land uses can continue under the Suisun Marsh Protection Plan. Agricultural practices have contributed to the degradation of salmonid and sturgeon habitat in Suisun Marsh through alterations to tidal flow patterns, discharge of drainage water, damage to riparian areas, reduction in diversity of native vegetation, and water quality degradation. The major recreation pursuit in Suisun Marsh is waterfowl hunting. Waterfowl hunting in Suisun Marsh relies on constructed levees and alterations to tidal flow and drainage patterns to maximize waterfowl production. These changes to the landscape of Suisun Marsh have affected ESA-listed fish by altering natural estuarine processes and conversion of estuarine habitat to managed ponds for waterfowl.

A. Marsh Regions

To assist in the environmental analysis of the 116,000 acre area of Suisun Marsh, the action area was divided into four regions with similar characteristics (Figure 1, Appendix). Regional characteristics include the size of surrounding sloughs, tidal movements, freshwater inflows, and the operations of the region's intake and discharge structures.

1. <u>Region 1</u>

The western and northwestern portions of the marsh in Region 1 flood from, and drain to, small to medium sloughs. These are primarily tributaries to Suisun and Cordelia sloughs. Sloughs in Region 1 are influenced by freshwater inflows from Green Valley, Suisun, and Ledgewood Creeks. Region 1 also has several small sloughs tributary to Suisun and Cordelia sloughs (*e.g.*, Peytonia Slough) where tidal exchange is minimal. These dead-end sloughs periodically have poor water quality from what are called "black water" events, when anaerobic bacterial decomposition of vegetation in managed wetlands results in extremely low dissolved oxygen (DO). When black water is drained from managed wetlands, water quality in receiving slough waters are likely to be degraded. During monthly sampling at nine locations across the action area, researchers from the University of California, Davis, have documented these events since 1999 (Schroeter and Moyle 2004). These events have occurred in May, June, and October. Oxygen levels less than 1 milligram/liter (mg/L) have been recorded in lower Goodyear Slough, Boynton Slough, and Peytonia Slough; these conditions may persist or reoccur in some areas for up to two months. The levels are sufficient to cause fish mortality, as Schroeter and Moyle

(2004) report observations of 32 dead adult Chinook salmon in Suisun Slough in October 2003 and 2 dead adult Chinook salmon in Suisun Slough in October 2004[4]. Adult salmon attempting to migrate upstream may be delayed from passing through the area to freshwater spawning areas or may die while attempting to pass through the area.

Areas of persistent low dissolved oxygen levels, however, have not been recorded in other regions of the action area, and appear to be limited to a few locations in Region 1 where tidal exchange is minimal. Because diurnal tidal cycles typically restore ambient conditions within a tidal cycle, sloughs with larger tidal exchanges do not appear to be affected by these events. SRCD has worked with landowners to reduce the extent and severity of these events, and to improve dissolved oxygen levels in drain water. Management modifications have included elimination of discharges to dead-end sloughs with minimal tidal exchange (Boynton and Peytonia Sloughs); relocation of discharges to a more tidally energetic channel (Suisun Slough); discouraging and mowing broad leaved vegetation prior to flood-up to reduce oxygen demand during decomposition; increasing circulation to improve aerobic conditions; and rapid flooding and draining to encourage aerobic decomposition. These changes in management are included in the project proposal. Anecdotal evidence suggests that these that these management modifications are effective in reducing or eliminating black water events, but data supporting that conclusion are not currently available.

2. Region 2

The central portion of the marsh in Region 2 is characterized by wetlands that flood off small tidal sloughs, and drain primarily to Suisun or Montezuma sloughs, the largest tidal sloughs in the marsh. These receiving sloughs have maximal tidal exchange, and degraded water has not been documented in this Region.

3. Region 3

The central and southern portions of the marsh are within Region 3 and this area forms the largest geographic region of the marsh. The main slough in the Region is Montezuma Slough, which is influenced by large daily tidal movements, Delta outflow, wind, and the Suisun Marsh Salinity Control Structure. CDFW, SRCD, and NMFS prioritized diversion intakes that posed the greatest risks of entrainment to listed species, and intakes along Montezuma Slough were identified as the highest priority for screening to exclude juvenile salmonids migrating through the slough (based on data from the Suisun Marsh Fish Monitoring program). Sixteen screens were installed between 1996 and 1998. Thirteen of these were installed on private property, two were installed on CDFW property at Joice Island, and one was installed at the large Roaring River Distribution System operated by DWR (SRCD and CDFW 2005). The Region now diverts the majority of water through fish screens (18 fish screens), preventing entrainment on over 19,958 acres of managed wetlands. During fall flood up prior to November 1, some additional water may be diverted from Montezuma Slough via secondary, unscreened intakes. Most of the wetlands divert water from Montezuma Slough, and drain to the large tidal water-bodies of Montezuma Slough, or Grizzly, Suisun, or Honker Bays. As in Region 2, these

[4] Based on the timing of exposure to degraded water quality conditions, these fish were likely Fall Run Central Valley Chinook salmon, which are not listed under the ESA.

receiving sloughs have maximal tidal exchange, and degraded water quality has not been documented in Region 3.

NMFS is aware of three actions that improved conditions for ESA-listed salmonids and green sturgeon in Region 3[5]. In the fall of 2005 a fish screen was installed on Montezuma Slough at the diversion point for the Grizzly Island Wildlife Area. In 2005, on Lower Joice Island, about 25 brush boxes were installed; and have performed well. In October of 2006 at Blacklock restoration site, a collaborative effort led to a planned levee breach that restored 70 acres of Suisun Marsh to tidal wetlands.

4. Region 4

The northwestern portion of the marsh in Region 4 is characterized by wetland units that flood and drain primarily into medium to large tidal sloughs (Nurse and Loco Sloughs) and Little Honker Bay. These receiving sloughs have maximal tidal exchange, and degraded water quality has not been documented in Region 4.

B. Suisun Marsh Salinity Control Structure

The Suisun Marsh Salinity Control Structure spans the width of Montezuma Slough and is located about two miles west of the slough's confluence with the Sacramento-San Joaquin Delta. The structure includes radial gates, permanent barriers adjacent to levees on each side of the channel, removable flashboards, and a boat lock. The structure is operated by DWR from September through May to lower the salinity from Collinsville through Montezuma Slough into the eastern and central portion of Suisun Marsh. The structure also retards the movement of higher salinity water from Grizzly Bay into the western marsh. During full gate operation, the flashboards are installed and the radial gates open and close twice each tidal day. During ebb tides, the gates are open to allow the normal flow of lower salinity water from the Sacramento River to enter Montezuma Slough. During flood tides, the gates are closed to retard the upstream movement of higher salinity water from Grizzly Bay.

Adult salmonid passage has been monitored at the structure since 1993. During the operation season (between October and May), the structure has been shown to delay upstream migration of adult salmonids (DWR and CDFW 2005). Recent operational improvements have minimized upstream delays and adult salmonids can successfully pass upstream through the boat lock structure on the facility. Green sturgeon are thought to successfully pass through either the boat lock or through the gates during periods when the gates are open.

The operation and maintenance of the Suisun Marsh Salinity Control Structure by DWR was addressed in a comprehensive ESA section 7 consultation with Reclamation regarding operation of California's Central Valley water projects. During this formal consultation with Reclamation, NMFS analyzed the effects of the Suisun Marsh Salinity Control Structure on listed anadromous salmonids, green sturgeon and designated critical habitat. In the resulting Biological Opinion and Conference Opinion for the Long-Term Operation of the Central Valley Project and State Water Project (CVP/SWP operations) dated June 4, 2009, (NMFS 2009), NMFS concluded that

[5] Electronic mail message from S Chappell to D. Logan on December, 27, 2007.

the structure does not change habitat suitability or availability for rearing or migration of listed salmonids and green sturgeon, but it does impair adult salmonid upstream passage. However, the anticipated delays in adult salmonid migration will not jeopardize listed species. This formal consultation is briefly discussed below in Section V.E. *Previous Section 7 Consultations and Section 10 Permits in the Action Area*. The Suisun Marsh Salinity Control Structure has been addressed in the biological and conference opinion for CVP/SWP operations issued to Reclamation on June 4, 2009, and is not analyzed further in this biological opinion.

C. Status of Listed Species and Critical Habitat in the Action Area

1. <u>CCC Steelhead, CV Steelhead, CV Spring-Run Chinook Salmon, Sacramento River Winter-Run Chinook Salmon, and southern DPS of green sturgeon</u>

Although available data indicates abundance in the action area is low, winter-run Chinook salmon, CV spring-run Chinook salmon, CCC steelhead, CV steelhead, and individuals from the southern DPS of North American green sturgeon, are seasonally present in the tidal sloughs of Suisun Marsh. Juvenile salmonids and green sturgeon use Suisun Marsh both as a migratory pathway and rearing area as they move downstream through the San Francisco Bay-Delta Estuary to the Pacific Ocean. Listed juvenile salmonids enter the action area at smolt stage, and are expected to be actively emigrating. The action area also provides migratory habitat for adult salmonids and green sturgeon.

Montezuma Slough (Figure 1, Appendix) is located between Central Valley salmonid freshwater spawning and rearing habitat and the Pacific Ocean. Although not the primary migration route through Suisun Bay, a proportion of salmonid species migrating to and from the Sacramento River travel through Montezuma Slough. Movement studies have estimated that between 0.81 and 2.74 percent of all migrating juvenile fall-run Chinook salmon utlize Montezuma Slough as a migratory route to the ocean (USFWS 1993, SRCD and CDFW 2005). Based on their close taxonomic relationships, and similarities in their life history patterns and migratory habits, NMFS expects that these estimates are reasonabale surrogates for the proportion of winter-run Chinook salmon, CV spring-run Chinook salmon, and CV steelhead that migrate through Montezuma Slough.

Since 1979, the University of California, Davis has conducted the Suisun Marsh Fish Monitoring (SMFM) program. Samples are taken monthly from nine sloughs, with sampling stations in each Region of the action area. Sampling stations represent both small dead-end sloughs and large sloughs. The SMFM sampling program is conducted with an otter trawl and some beach seining. Although the SMFM program has documented small numbers of salmonids, their methods target slower moving estuarine species, and are not effective at capturing fish with strong swimming abilities such as salmonids. These fish are able to swim away from the otter trawl.

Another long-term fisheries monitoring effort is conducted a short distance upstream of the action area near the confluence of the Sacramento and San Joaquin rivers. Midwater trawl surveys have been conducted by CDFW and the USFWS near Chipps Island from 1993 through 2007. This sampling targeted salmon and steelhead originating from Central Valley streams. Trawl results indicate smolts enter Suisun Bay as early as December and as late as July, but for most years peak abundances fell during the fall-run Chinook salmon emigration season between April and June. Suisun Bay is adjacent to Suisun Marsh and, thus, this sampling provides an indicator of salmonid presence in Suisun Marsh. This sampling method was unlikely to capture adult salmonids because their strong swimming ability allows them to swim away from the trawl.

Results from the SMFM program and other studies indicate the greatest numbers of salmonid smolts occur in Region 3, followed by Region 4. Sampling has shown that small numbers of smolts occur in regions 1 and 2. The results of salmonid collections in Suisun Marsh fisheries investigations are presented by region in the following paragraphs.

In Region 1, the SMFM program samples Goodyear and Suisun sloughs, and two smaller dead-end sloughs; Boynton and Peytonia sloughs. Between 1980 and 2001, only two Chinook smolts were captured in Region 1 by the SMFM program (SRCD and CDFW 2005). The SMFM program captured one steelhead smolt in Peytonia Slough, a dead-end tributary to upper Suisun Slough (SRCD and CDFW 2005). This smolt was likely part of the CCC steelhead DPS.[6] CCC steelhead utilize lower Suisun Slough and Cordelia Slough in Region 1 as migratory route to and from spawning and rearing habitat in two small streams tributary to Cordelia Slough (Green Valley Creek and Suisun Creek). Surveys conducted in Green Valley and Suisun creeks have documented the presence of juvenile CCC steelhead in these watersheds, but do not provide abundance data (Sanford 1999 and 2001, Hanson Environmental, Inc. 2002).

To determine the entrainment rate of fish at a large unscreened diversion, a two-year study occurred at the Morrow Island Distribution Center on Goodyear Slough[7]. Between 2003 and 2005 no listed salmonids or green sturgeon were detected in the fish entrainment studies at Morrow Island, but did capture two non-listed fall-run Chinook salmon[8].

In Region 2, sampling efforts by the SMFM program between 1980 and 2001 captured 29 Chinook salmon smolts, primarily in lower Suisun and Montezuma sloughs (SRCD and CDFW 2005).

In Region 3, the SMFM program has regularly documented Chinook salmon smolts in upper Montezuma Slough, with 573 fish observed between 1980 and 2001 (SRCD and CDFW 2005). In 1999 and 2000, four CV steelhead smolts were captured in Region 3, in Montezuma Slough (SRCD and CDFW 2005).

In Region 4, the large Nurse Slough, and smaller dead-end Denverton Slough are sampled by the SMFM program. One hundred and sixty Chinook salmon smolts have been documented in lower Denverton, Montezuma, and Nurse sloughs between 1982 and 2003 (SRCD and CDFW 2005). Four CV steelhead smolts have been recorded in Denverton Slough (SRCD and CDFW 2005).

[6] The eastern most spawning streams for CCC steelhead are tributaries to Suisun Slough. Steelhead found east of that slough are considered to be CV steelhead.
7 Interagency Ecological Program (IEP) for the San Francisco Estuary newsletter, volume 20, number 1, winter 2007.
[8] Interagency Ecological Program (IEP) for the San Francisco Estuary newsletter, volume 20, number 1, winter 2007.

While the SMFM sampling methods are not designed to capture fast moving salmonids, the scarcity of captures over a relatively long period of sampling suggests that Chinook salmon smolts utilize Regions 1, 2, and 4 infrequently and in low numbers. The available data also suggest that Chinook salmon smolts do migrate through Montezuma Slough in Region 3. Chinook salmon smolts may also utilize tidal sloughs as foraging habitat during emigration, particularly those tributary to their migratory routes (*e.g.*, Nurse or Denverton sloughs in Region 4). Additional data regarding fish presence in Suisun Marsh is available from a variety of sources, including the Interagency Ecological Program, the Bay-Delta and Tributaries database (BDAT), and CDFW trawl survey data (SRCD and CDFW 2005).

Emigrating winter-run Chinook salmon and CV spring-run Chinook salmon are thought to pass through the estuary fairly rapidly (MacFarlane and Norton 2002, Moyle 2002). The smolts of these species are larger in size than fall-run smolts, because they generally reside in freshwater for approximately one year prior to emigration. They are typically ready to smolt upon entering the Sacramento-San Joaquin Delta upstream of the action area; therefore, they are believed to spend little time rearing in the action area. Juvenile fall-run Chinook salmon reside in fresh water for 4 to 6 months prior to smoltification and, thus, are considerably smaller smolts than winter-run Chinook salmon or CV spring-run Chinook salmon. Juvenile fall-run Chinook salmon were found to spend about 40 days migrating through the Delta to the mouth of San Francisco Bay and grew little in length or weight until they reached the Gulf of the Farallones (MacFarlane and Norton 2002). Based on these results, MacFarlane and Norton (2002) concluded that unlike other salmonid populations in the Pacific Northwest, Central Valley Chinook salmon show little estuarine dependence and may benefit from expedited ocean entry.

The SMFM data described above indicate that CV steelhead smolts migrate through Montezuma Slough in Region 3, and may utilize at least some of its larger tributaries as foraging habitat. CCC steelhead which spawn and rear in Suisun and Green Valley creeks must utilize lower Suisun and Cordelia sloughs in Region 1 as migratory habitat. According to a letter from the SRCD (dated March 16, 2004), Suisun Creek typically discharges into Cordelia Slough and then into lower Suisun Slough (SRCD 2004). The downstream flow may also diverge from Cordelia Slough into Chadbourne Slough and thence to Suisun Slough (SRCD 2004), and this route may also be utilized by steelhead migrants. As with Chinook salmon, the limited data available supports the hypothesis that steelhead smolts utilize tidal sloughs in the action area infrequently and in low numbers. Migration primarily occurs from January through May. Steelhead smolts may also utilize tidal sloughs, particularly those tributary to their migratory routes (*e.g.*, Denverton Slough in Region 3), as foraging habitat during the spring.

Juvenile green sturgeon have been captured in Region 1 in Goodyear Slough, and in Region 4 in Denverton Slough. Researchers at the University of California Davis have used telemetry to track five sub-adults and one adult green sturgeon in the San Francisco Estuary (WFCB 2005). Of the fish that were tracked, one was recorded in Region 4, near Honker Bay. Others were recorded downstream of the action area, in the Carquinez Straits, San Pablo Bay, and San Francisco Bay. Too few green sturgeon have been documented in the action area to draw conclusions about their occurrence. Therefore, based on the known life history of the species (as described above in *Species Life History and Population Dynamics*), it is assumed juvenile green sturgeon could be present in all regions of Suisun Marsh throughout the year. Catch data from CDFW trawls between 1980 and 2001 show green sturgeon in Suisun Bay range between 200 and 546 mm in length with an average length of 400 mm (CDFW unpublished data).

2. Sacramento River Winter-Run Chinook Salmon Critical Habitat

The Project's action area is designated critical habitat for Sacramento winter-run Chinook salmon. Features of designated critical habitat for winter-run Chinook salmon in the action area essential for their conservation are habitat areas and adequate prey that are uncontaminated. These physical and biological features of designated critical habitat within the action area are partially degraded and limited. Habitat degradation in the action area is primarily due to altered and diminished freshwater inflow, levee construction, loss and reduced access to tidal marsh habitat, and non-native invasive species.

3. Green Sturgeon Critical Habitat

The action area is located within designated critical habitat for the southern DPS of green sturgeon. PCEs for green sturgeon in estuarine areas are: food resources, water flow, water quality, migratory corridor, water depth, and sediment quality. These PCEs for green sturgeon critical habitat in the area are partially degraded. Habitat degradation in the action area is primarily due to altered and diminished freshwater inflow, levee construction, loss and reduced access to tidal marsh habitat, and non-native invasive species.

.

D. Factors Affecting the Species Environment in the Action Area

Profound alterations to the environment of the greater San Francisco Bay estuary began with the discovery of gold in the middle of the 19th century. Dam construction, water diversion, hydraulic mining, and the diking and filling of tidal marshes soon followed, launching the San Francisco Bay area into an era of rapid urban development and coincident habitat degradation. There are efforts currently underway to restore the habitat in the Bay, if not directly within the action area, at least within surrounding tributaries and the estuary itself. There have also been alterations to the biological community as a result of human activities, including hatchery practices and the introduction of non-native species.

The action area has been highly modified by levee construction and creation of managed wetlands for waterfowl. Levee building beginning in the mid-1880s has excluded salmonids and sturgeon from 90 percent of the tidal wetlands that existed historically. Land-use activities such as levee construction, water management, and recreation are pervasive and have degraded habitat quantity and quality for Chinook salmon, steelhead, and green sturgeon through alteration of bank and channel morphology; alteration of ambient water temperatures and salinity levels; elimination of rearing habitat; and fragmentation of available habitats.

E. Previous Section 7 Consultations and Section 10 Permits in the Action Area

NMFS has completed two previous consultations with the Corps on RGP 3 for maintenance activities within Suisun Marsh. The first consultation in 1994 only addressed winter-run

Chinook salmon, because that was the only listed species in the action area under the jurisdiction of NMFS at that time. Formal consultation was conducted for a multi-year regional general permit. During consultation, it was determined that some juvenile winter-run Chinook salmon will likely be entrained through unscreened water intakes at managed wetland areas. Through agreement with CDFW, SRCD, and the Corps, water diversions at unscreened intakes in certain sloughs were curtailed during the peak outmigration season of juvenile winter-run Chinook salmon smolts (November through May). These water diversion restrictions, along with those imposed for the seasonal protection of Delta smelt, were incorporated by the Corps as special conditions in RGP 3. Consultation between the Corps and NMFS was concluded with NMFS issuance of a biological opinion dated September 21, 1994. In this opinion, NMFS determined that the proposed action was not likely to jeopardize the continued existence of winter-run Chinook salmon or adversely modify critical habitat.

NMFS and the Corps completed a second formal consultation on the re-issuance of RGP 3 for winter-run Chinook salmon, CV spring-run Chinook salmon, CV steelhead, CCC steelhead and green sturgeon in 2008. The measures developed in the 1994 consultation for RGP 3 were incorporated by the Corps as permit special conditions. A biological opinion was issued on January 16, 2008 which concluded the proposed re-issuance of RGP 3 was not likely to jeopardize the continued existence of listed salmonids, green sturgeon, or adversely modify critical habitat.

As discussed above in Section V.B. *Suisun Marsh Salinity Control Structure*, NMFS and Reclamation completed formal consultation in 2009 on the operation and maintenance of the Suisun Marsh Salinity Control Structure. The consultation addressed the effects of DWR's operation and maintenance of this facility on listed salmonids, green sturgeon and designated critical habitat. The June 4, 2009, Biological Opinion and Conference Opinion for CVP/SWP operations concluded that the structure does not change habitat suitability or availability for rearing or migration of listed salmonids and green sturgeon, but it does impair adult salmonid upstream passage. However, the anticipated delays in adult salmonid migration will not jeopardize listed species.

Since 1991, pursuant to section 7 of the ESA, NMFS has conducted 48 interagency consultations within the action area of this project. Of these 48 consultations, 34 were with the Corps, eight were with Reclamation, two were with U.S. Department of Transportation, one was with the U.S. Maritime Administration, one was with the U.S. Coast Guard, one was with the U.S. Navy, and one was with the Federal Highway Administration. These consultations were primarily related to maintenance of existing infrastructure in Suisun Marsh and along the shoreline of Suisun Bay (*i.e.*, shoreline protection; repair of wharves, docks and piers; replacement of storm water outfalls; and maintenance of utilities infrastructure). A small number of consultations have been conducted for sand mining. NMFS determined that most (they were not likely to adversely affect listed salmonids or green sturgeon or their critical habitat. For those projects with adverse effects on listed salmonids and green sturgeon and/or critical habitat, NMFS determined that they were not likely to jeopardize the continued existence of listed salmonids or adversely modify critical habitat. Adverse effects that resulted from these projects are not anticipated to affect the current population status of listed salmonids or green sturgeon.

Research and enhancement projects resulting from NMFS' Section 10(a)(1)(A) research and enhancement permits and section 4(d) limits or exceptions could potentially occur in Suisun Marsh. Salmonid and sturgeon monitoring approved under these programs includes juvenile and adult net surveys and tagging studies. In general, these activities are closely monitored and require measures to minimize take during the research activities. Through early summer 2013, no research or enhancement activities have occurred in Suisun Marsh.

VI. EFFECTS OF THE ACTION

Pursuant to section 7(a)(2) of the ESA (16 U.S.C. §1536), Federal agencies are directed to ensure that their activities are not likely to jeopardize the continued existence of any listed species or result in the destruction or adverse modification of critical habitat. This biological opinion assesses the effects on ESA-listed anadromous salmonids and the southern DPS of green sturgeon associated with the implementation of the SMP, During the next 30-year period, the Corps proposes re-issuance of RGP 3 at five-year intervals and an LOP at 10-year intervals, and Reclamation proposes to continue cost-share funding of the Suisun Marsh Preservation Agreement and the Preservation Agreement Implementation Fund.

Maintenance and operations activities undertaken within Suisun Marsh may affect endangered winter-run Chinook salmon and their designated critical habitat, threatened CV spring-run Chinook salmon, threatened CCC steelhead, threatened CV steelhead, and threatened southern DPS of North American green sturgeon and its designated critical habitat. The proposed action is likely to adversely affect those listed salmonids and green sturgeon and their habitat primarily through entrainment and degraded water quality resulting from managed wetland operations and some construction activities. In the *Description of the Proposed Action* section of this opinion, NMFS provided an overview of the action. In the *Status of the Species* and *Environmental Baseline* sections of this opinion, NMFS provided an overview of the threatened and endangered species and critical habitats that are likely to be adversely affected by the activity under consultation.

Regulations that implement section 7(a)(2) of the ESA require that biological opinions evaluate the direct and indirect effects of Federal actions and interrelated or interdependent actions to determine whether the effects of those actions are expected to reduce numbers or distribution of ESA-listed species, thereby resulting in an appreciable reduction of the likelihood of survival or recovery of those species in the wild.(16 U.S.C. §1536, 50 CFR §402.02).

NMFS generally approaches "jeopardy" analyses in a series of steps. First, NMFS evaluates the available evidence to identify direct and indirect physical, chemical, and biotic effects of the proposed actions on individual members of listed species or aspects of the species' environment (these effects include direct, physical harm or injury to individual members of a species; modifications to something in the species' environment - such as reducing a species' prey base, enhancing populations of predators, altering its spawning substrate, altering its ambient temperature regimes; or adding something novel to a species' environment - such as introducing exotic competitors or a sound). Once NMFS has identified the effects of the action, the available evidence is evaluated to identify a species' probable response, including behavioral reactions, to these effects. These responses then will be assessed to determine if they can reasonably be expected to reduce a species' reproduction, numbers, or distribution (for example, by changing birth, death, immigration, or emigration rates; increasing the age at which individuals reach sexual maturity; decreasing the age at which individuals stop reproducing; among others). The available evidence is then used to determine if these reductions, if there are any, could reasonably be expected to appreciably reduce a species' likelihood of surviving and recovering in the wild.

The regulatory definition of adverse modification has been invalidated by the courts. Until a new definition is adopted, NMFS will evaluate destruction or adverse modification of critical habitat by determining if the action reduces the value of critical habitat for the conservation of the species.

The presence of each species by life history stage during the proposed operations and maintenance activities is shown in Table 7. In addition to presence, the distribution of species within each of the four regions described above provides information on what life stage may be affected by specific managed wetland operations or maintenance activities. Adverse effects associated with operations include exposure to degraded water quality from draining wetlands and entrainment at water diversions. Maintenance activities authorized under RGP 3 may lead to temporary increases in turbidity. Maintenance dredging activities authorized with an LOP may result in some mechanical injury to green sturgeon, temporary increases of turbidity, and disruption of substrate fauna. In this biological opinion, NMFS analyzed the effects of these operations and activities for a 30-year period.

NMFS analyzed the operational and maintenance activities in each Region, the listed species likely to be present in each Region, and the relationship between the life history strategy of each species and the risk posed by each activity. Based on this analysis, NMFS determined those species or life history stages most likely to be exposed to adverse effects by Region. Proposed best management practices, proposed improvements to wetland management, and proposed curtailments and restrictions on water diversions were considered.

A. Operation and Maintenance of Managed Suisun Marsh Wetland Areas

1. <u>Water Quality</u> Effects at Managed Wetlands.

As described in the *Environmental Baseline* section, managed wetlands are drained during ebb tides on a seasonal cycle. When the temperature, salinity, pH, and dissolved oxygen levels of drain water is similar to ambient conditions in receiving sloughs it is unlikely to adversely affect listed species or critical habitat, because each species can tolerate small fluctuations in these water quality parameters. Monitoring results show that on average, salinity and temperature levels in drain water are similar to or slightly higher than ambient levels, and other parameters are comparable to ambient levels (SRCD and CDFW 2005). In most Suisun Marsh sloughs, diurnal tide cycles provide adequate circulation to avoid large fluctuations in water quality parameters. Only small, localized changes in water quality are expected in Regions 2, 3, and 4 of Suisun Marsh, because wetlands in these regions drain into medium and large sloughs with good tidal circulation. However, a few small dead-end sloughs in Region 1 have little tidal exchange and low dissolved oxygen conditions may persist during May, June, or October. Improvements to managed wetland operations in Region 1 have been developed in recent years and are expected to decrease the frequency, severity, and duration of these events. However, degraded conditions resulting from drainage in some localized areas of Region 1 may exceed the tolerance of listed species, and adverse effects may occur.

It is not likely that adult or smolt life stages of winter-run Chinook salmon, CV spring-run Chinook salmon, and CV steelhead will enter the affected areas of Region 1, because those areas are beyond the migratory routes of those species. If individuals of those species strayed from typical migration routes, the affected areas with poor water quality present conditions which are well below the preferred range of salmonids (Spence *et al.* 1996). However, migrating adult Chinook salmon typically avoid areas of poor water quality, and we assume that migrating Chinook salmon smolts and migrating adult and smolt CV steelhead will behave similarly when encountering areas of poor water quality. Since the areas within Suisun Marsh affected by poor water quality are remote from the migratory pathways of listed Central Valley listed salmonids, it is unlikely listed Central Valley salmonids will encounter these areas.

CCC steelhead adults and smolts passing to and from Suisun Creek and Green Valley Creek pass through portions of Region 1, via Cordelia and Suisun sloughs. Although low dissolved oxygen events have not been documented on the main migratory routes between Suisun bay and these steelhead streams, poor water quality sites have occurred in small dead-end sloughs tributary to these routes (Schroeter and Moyle 2004). Steelhead that enter these dead-end sloughs could encounter degraded conditions. Those emigrating CCC steelhead exposed to poor water conditions may experience adverse effects including interrupted migration and perhaps mortality (Schroeter and Moyle 2004). Extended exposure to low dissolve oxygen conditions is known to impair salmonid metabolic rate, growth, swimming performance, and overall survival (Barnhart 1986). The peak emigration of steelhead smolts is expected to occur between March and early May and will likely coincide with higher stream flow events. The upstream migration of adult steelhead typically occurs from January through April during high flow events. Water quality in these sloughs is expected to improve during high flow events and afford protection to CCC steelhead from low DO levels associated with the discharge of black water. Therefore, the timing of steelhead migration during high flow events combined with the low probability of fish entering the smaller dead-end sloughs of Suisun Marsh make it unlikely steelhead will experience degraded water quality conditions. Black water events have been recorded in May, June and October, which make it very unlikely to occur during the adult CCC steelhead migration season. Fisheries sampling reported in Crain and Moyle (2011) in slough areas subject to low DO levels did not encounter any steelhead. However, over the 30-year term of the SMP there is a low probability that an unknown, but very small number of CCC steelhead smolts will encounter low dissolved oxygen levels related to a black water discharge event. NMFS estimates that no more than 20 CCC steelhead smolts will be harmed or killed by low dissolved oxygen levels during black water events over the 30-year term of the SMP.

Green sturgeon may be present in Region 1 during these low dissolved oxygen events and past black water discharges have include areas designated as critical habitat for green sturgeon. For adult green sturgeon, localized areas of low dissolved oxygen levels may inhibit upstream migration. However, the small dead-end sloughs in Region 1 where these events have occurred are more than five miles distant from the major migratory routes to spawning grounds in the upper Sacramento River. Therefore, it is not likely that adult green sturgeon will be present in Region 1. Juvenile green sturgeon may experience degraded water quality conditions in Region 1 in May, June, and October. Green sturgeon are tolerant of DO levels ranging from 2 to 5 mg/l (Crain and Moyle 2011). It is unknown how juvenile green sturgeon will respond to low dissolved oxygen conditions; however, fish are known to leave areas when oxygen levels fall below 2 mg/L (Dybas 2005). In addition, the affected areas in Region 1 represent a small proportion of the marsh and the events are generally a small portion of the year. Since juvenile green sturgeon are expected to be distributed throughout the action area, only a very small number of green sturgeon are likely to be affected by black water discharge events. As a result, an unknown, but likely small number of green sturgeon may be unable to avoid poor conditions occurring in Region 1, and may be harmed or killed by low dissolved oxygen levels. Fisheries sampling reported in Crain and Moyle (2011) in slough areas subject to low DO levels did not encounter any green sturgeon. However, over the 30-year term of the SMP, it is reasonable to assume that a very small number of green sturgeon could be present during black water discharge events. NMFS estimates that no more than 5 green sturgeon will be harmed or killed by black water discharge events over the 30-year term of the SMP. Water quality PCEs of designated critical habitat for green sturgeon will be adversely affected by black water discharge events.

2. Fish Entrainment at Managed Pond Water Intakes.

Some water intakes in the marsh, primarily in Region 3, are equipped with fish screens. These screens were designed to exclude delta smelt and juvenile salmonids from entrainment and impingement. Placement of screens were prioritized in Region 3 because diversion sites within that area are located along the major migratory routes used by salmonids within the project area (Montezuma Slough and lower Suisun Slough). NMFS anticipates that no entrainment will occur at these screened diversion locations. However, not all diversions within the project area are screened. Listed adult Chinook salmon and steelhead are not expected to be entrained by unscreened diversions into managed wetlands because the swimming abilities of adult salmonids allow them to easily avoid entrainment in the gravity/tidal diversions utilized in Suisun Marsh. In addition, adult salmonids are migrating upstream and migratory cues such as attraction flows are not present at diversions. Similarly, adult and juvenile green sturgeon are not expected to be entrained by unscreened water diversions in Suisun Marsh. Green sturgeon are bottom oriented feeders and swimmers spending the majority of their time along channel bottoms. The level of intake pipes in the marsh is set so that they will operate at high tides, and this level is typically above the depth at which sturgeon will be expected. To assess fish losses to entrainment during water diversions into Suisun Marsh managed wetlands, CDFW performed fish sampling behind unscreened intakes in the marsh in the late 1990s and captured no adult salmonids or green sturgeon (SRCD and CDFW 2005).

Small numbers of salmonid smolts could be entrained through unscreened diversions into managed wetlands, particularly in September and October when high volume diversions occur. However, during this period, salmonid smolts are not likely to be abundant in the action area; unless early CV emigrants may be present. Sampling has documented small numbers of Chinook salmon smolts entrained during managed pond flood-up operations (DWR 2005, SRCD and CDFW 2005). During three sampling seasons CDFW conducted over 386 total sampling days with a total catch of 109 salmon. It should be noted that 103 of these fish were fall-run sized yoke fry that were washed down in a single high flow event (SRCD and CDFW 2005). Once diverted onto a managed wetland, water may be held for an extended period prior to draining. During residence on wetlands, water quality parameters may vary, creating conditions that may cause stress or mortality of entrained juvenile or smolting salmonids. Entrained salmonids may be exposed to increased predation rates within the managed pond. Thus, it is assumed that few, if any, salmonid smolts will survive in managed wetlands and eventually escape the impounded waters to complete their seaward migration.

To reduce entrainment of salmonids in unscreened diversions, the SRCD has proposed diversion curtailments. Complete and partial diversion gate closures are scheduled to coincide with the peak emigration periods of steelhead and Chinook salmon smolts between November 1 and May 31. At unscreened intakes, gate openings will be limited to 25 percent from November 1 through January 31. Between February 1 and February 21, diversion gates are not restricted, and entrainment of salmonid smolts may occur. Unscreened intakes will be completely closed from February 21 through March 31, and gate openings will range from 20 to 35 percent from April 1 to May 31. Limiting the size of the intakes' opening limits the area of the tidal slough that may be influenced by the "pull" of the diversion that fish must resist to avoid entrainment. The area of influence, where the effects of the diversion may be experienced by fish, corresponds to the size of the diversion pipe. When that pipe is closed to between 20 and 35 percent of its maximum extent, the area of influence is correspondingly smaller. Thus, the restrictions are expected to reduce entrainment because the diversions operated under the restrictions will affect a smaller fraction of the available tidal slough waters. In spite of the strong swimming abilities of salmonid smolts, diversion curtailments and restrictions may not prevent all entrainment. Juvenile steelhead have a longer freshwater rearing period, and emigrate at a larger body size than Chinook salmon. This larger body size imparts greater swimming abilities, and decreases the chance that a CCC steelhead or CV steelhead smolt will be entrained. This is supported by entrainment studies within Suisun Marsh that have encountered few Chinook salmon and no steelhead (SRCD and CDFW 2005). Small numbers of the portion of the smolt populations of winter-run Chinook salmon, CV spring-run Chinook salmon, CCC steelhead, and CV steelhead migrating through the action area may be entrained to unscreened diversion and lost to the population. Since all of the Chinook salmon observed during entrainment monitoring have been non-listed fall-run Chinook (SRCD and CDFW 2005), NMFS estimates that from 50 to 500 listed salmonid juveniles will be entrained and lost at unscreened diversions in Suisun Marsh over the 30-year term of the SMP.

3. Construction and Dredging Associated with RGP 3 Maintenance Activities.

Of the 29 maintenance activities proposed in RGP 3, 16 activities (described previously in *Proposed Actions*) will occur entirely within managed wetlands enclosed by perimeter levees. Reclamation and the Corps have determined these activities have no effect on listed salmonids or green sturgeon present in tidal waters outside the levees (Table 2). Since the federal action agencies have concluded these activities are "no effect" because they are conducted in areas isolated from tidal sloughs with listed fish and outside of designated critical habitat, these 16 maintenance activities are not discussed further in this biological opinion.

For 13 of the 29 maintenance activities proposed for authorization under RGP 3, the activities may affect listed salmonids, green sturgeon, or critical habitat. These activities are primarily repairs to exterior levees, shoreline stabilization, repair or replacement of water control structures, removal of debris, and repairs to existing facilities including fish screens and salinity monitoring stations.

Several best management practices are proposed for the above 13 RGP 3 activities which avoid or reduce potential impacts to tidal slough areas and listed fish. Work will only be conducted during low tide and not occur in-water. Repair or replacement of water control structures will generally be conducted from the levee crown and work is expected to be completed before the tide returns (within 6 to 8 hours). By conducting work in the dry, disturbance of sediments will result in only minimal turbidity. Fish will not be disturbed by construction equipment and activities as the site will be de-watered during low tide. Best management practices are also designed to avoid the introduction of sediments into the waters of the marsh and avoid impacts to existing vegetation. For the stabilization of shoreline and levee sites with the installation of brush boxes, some in-water work is expected, but it will be limited to hand work only. No heavy equipment will be used to install brush boxes. Once completed, brush boxes will capture sediment, provide habitat for emergent vegetation, and increase habitat quality for foraging and rearing salmonid smolts and juvenile green sturgeon. As a result, brush boxes are considered a beneficial alternative to traditional riprap and levee repairs. Based on the inclusion of the proposed best management practices, NMFS concurs with the Corps' determination that the above seven RGP 3 actions and the installation of brush boxes are not likely to adversely affect listed salmonids or green sturgeon.

Maintenance dredging and debris removal at fish screens and other facilities may affect listed salmonids or green sturgeon. However, these activities will be restricted to periods when sensitive salmonid species are not present and during periods of low tide. Dredging will occur around 17 fish screen structures within Suisun Marsh. Dredging around fish screens will be conducted with a long-reach excavator with a 0.5 or 1.0 cubic yard bucket, and is not expected to be necessary at each site annually. Dredge spoils will be placed on the inboard slope of exterior levees. Due to the very small volumes of material to be dredged at existing fish screens, a dredging episode to maintain a fish screen will be limited to a few hours around low tide. Suction dredging will not be used. Turbidity levels during dredging are expected to be minimal, temporary, and limited to the area immediately adjacent to the screen structures. As a result, the levels of turbidity expected are insignificant and discountable and thus not likely to adversely affect listed salmonids or green sturgeon. The excavator bucket size is small (0.5-1.0 cubic yard) and unlikely to capture listed fish during its operation. In combination with scheduling dredging episodes to periods when listed salmonids are not expected to be present, NMFS concurs that maintenance dredging at fish screens is not likely to adversely affect listed salmonids.

Because they are year-round residents in Suisun Marsh, some juvenile green sturgeon may be disturbed by maintenance dredging at fish screens. Suction dredging will not be used, and therefore, entrainment in the equipment will not occur. However, noise generated by the dredging operation will likely cause sturgeon to move out of the area. If green sturgeon react behaviorally to the sound produced by dredging, adequate water depths and carrying capacity in Suisun Marsh sloughs adjacent to maintenance sites will provide sufficient area for fish to temporarily disperse and sound from dredging is not be expected to result in more than an insignificant effect on them. These disturbances will be limited in number and geographic scope and temporary, and the behavioral response of green sturgeon is not expected to result in adverse effects to those sturgeon exposed.

Adverse effects to listed fish and critical habitat may occur during installation of riprap on exterior levees. The placement of riprap can result in the loss of soft-bottom intertidal habitat in areas with mudflats and emergent vegetation adjacent to perimeter levees. This conversion will result in a reduction of foraging and rearing habitat of salmonid smolts and green sturgeon in Suisun Marsh. These changes are likely to be minor in spatial aspect, as most sites will be the placement of rock to replace missing riprap. However, up to 200 linear feet of new riprap may be placed annually on the external sides of levees. Emergent vegetation will be lost in some areas, but may become reestablished in the interstices of the riprap. Emergent vegetation provides a source of allochthonous prey and provides cover and protection from visual predators. To minimize impacts during placement of the riprap, the applicant will conduct the work at low tide when most or all of the work area is exposed, negating the need to place riprap in water. Riprap placed on exterior levees in Suisun Marsh has generally been placed in areas with maximal tidal exchange and erosive forces. If the existing riprap is damaged or lost and not replaced, unprotected soils in the levees will be exposed to those erosive forces. These damaged areas, if not repaired, will likely lead to additional levee scour introducing more fine sediments and will negatively affect constituent elements of salmonid and sturgeon habitat, thereby, adversely affect ESA-listed fish in the area. The amount of lost emergent vegetation due to placement of rock riprap is expected to be small. However, the project will be maintaining the existing degraded condition of shoreline habitat adjacent to levees in Suisun Marsh.

Installation of new exterior drain structures could adversely affect listed species by leading to increased areas with poor water quality due to the discharge of black water. NMFS anticipates that satisfactory best management practices will be used during construction to adequately minimize or eliminate sediment and contaminant input from construction-related activities. However, if a new drain structure is installed in a location with poor tidal circulation, drain water could contribute to poor water quality. As described in *Managed Wetland Operations*, degraded water quality has occurred and may adversely affect CCC steelhead smolts and juvenile green sturgeon. The potential effects of degraded water quality and black water events are discussed above in Section V.A.1. Installation of new exterior drain structures could adversely affect listed species if a structure is installed in a location with poor tidal circulation. However, the SRCD is coordinating closely with landowners to ensure that new drain structures are not placed where black water conditions are likely to occur. Based on SRCD's technical assistance, NMFS anticipates the future operation of new drain structures will not result in discharges that cause low dissolved oxygen levels in the tidal sloughs of the action area.

B. Maintenance Dredging Actions

Under the proposed Corps-issued LOP, landowners within Suisun Marsh may conduct dredging from tidal sloughs adjacent to exterior levees for the purpose of collecting material to place on the levees. This form of levee maintenance has not been conducted in Suisun Marsh since 1994. With the use of a long-reach excavator or clamshell dredge, materials will be collected and placed on the levee crown to repair existing structures. Although ESA-listed anadromous salmonids migrate seasonally through the action area, the LOP will restrict dredging activities to the period of August through November. This schedule avoids the migration periods of all ESA-listed anadromous salmonids. Thus, NMFS anticipates no ESA-listed salmonids will be present in the action area during dredging activities and, therefore, will not be subjected to the temporary effects of degraded water quality.

For threatened green sturgeon, dredging activities associated repair and/or maintenance of levees may have temporary effects on water quality. Dredging is expected to disturb shoreline and bottom sediments which could generate increased levels of turbidity within the adjacent water column. Increased levels of turbidity can affect fish species by disrupting normal feeding behavior, reducing growth rates, increasing stress levels, and reducing respiratory functions. (Benfield and Minello 1996, Nightingale and Simenstad 2001). However, this type of dredging with a long-reach excavator or clamshell dredge typically results in short-term and localized levels of increased turbidity. Plumes of fine sediment from clamshell dredging operations at the Oakland Outer Harbor displayed rapidly decaying concentrations of suspended sediment with time and distance from the source of disturbance (Clarke *et al.* 2005). Minor and localized elevated levels of turbidity associated with dredging activities are expected to quickly disperse with the area's tidal circulation. As a benthic dwelling species, green sturgeon are adapted to living in estuaries with fine sediment bottoms and, thus, are tolerant of high levels of turbidity; specifically, they are tolerant of levels of turbidity that exceed levels expected to result from this project. Therefore, elevated levels of turbidity associated with dredging for levee maintenance are expected to be considerably lower than the thresholds commonly cited as the cause of the above possible behavioral and physical impacts. With regard to this project, impacts to water quality are expected to be insignificant for threatened green sturgeon.

Entrainment or physical injury of green sturgeon by mechanical dredging equipment is not expected to occur, because dredge buckets will be relatively small (less than 12 cubic yards), and green sturgeon are large and powerful swimmers capable of fleeing the area upon commencement of dredging operations. While this in-water activity may startle green sturgeon in the project vicinity, the behavioral response of temporarily leaving the site is not expected rise to a level of adverse effect because it will be of a very short duration and waterways adjacent to the project sites offer ample areas for fish to avoid the area of disturbance. Therefore, the potential for entrainment is discountable and the effects of disturbance during levee maintenance are not expected to rise to levels that will adversely affect green sturgeon.

Upon completion of dredging, edgewater habitat adjacent to the shoreline will be disturbed. Emergent vegetation could be lost and aquatic invertebrates removed with bottom sediments. Existing edgewater habitat in these channels has been altered by the construction of the levee system and past dredging for levee maintenance. Thus, the existing shoreline areas along tidal sloughs are important habitat for fish foraging and cover. Dredging within the wetted portions of the action area has the potential to displace existing shallow water aquatic invertebrates. This may affect green sturgeon and listed anadromous salmonids by temporarily reducing the abundance of intertidal and subtidal prey species. Juvenile green sturgeon likely forage on benthic crustaceans, clams, crabs, annelid worms, and other fishes (Ganssle 1966) in the action area. However, this project's disturbance of the benthic faunal community is not expected to substantially influence the foraging behavior or prey abundance of green sturgeon or salmonids, because of the infrequent and short extent of these dredging activities. Furthermore, some aquatic invertebrates are known to rapidly re-colonize disturbed areas (Collier *et al*. 2000) and the invertebrate community will likely be re-established within one year. If dredging activities result in reduced prey availability, green sturgeon and juvenile salmonids are expected to continue their foraging activities and migration to areas where prey is readily available. However, project impacts to the benthic faunal community are expected due to the potential large amount of material removed annually (up to 100, 000 cubic yards) and the length of shoreline areas affected. Vegetation lost to dredging will reduce habitat complexity, reduce primary production, and eliminate areas of cover for listed fish. The ability for some benthic organisms and vegetation to rapidly re-colonize disturbed sites may reduce the level of impact and impacts will typically be limited to targeted repairs areas spread throughout the 116,000 acre action area.

C. Wetland Restoration

Project construction involves the excavation of sediments, sculpting of local topography, and breaching of levees. Construction activities within the existing perimeter levees will not affect ESA-listed fish or habitat, because the project area will remain isolated from tidal sloughs. With the breaching of the perimeter levees, the initial circulation of tidal waters through the restoration site may affect ESA-listed fish through the discharge of sediment. However, all constructed breaches of perimeter levees will be restricted to the period between August 1 and November 30 to avoid the migration season of listed salmonids. Thus, adult and juvenile salmonids will not be affected by levee breaching at tidal wetland restoration sites. Once completed, the restored marsh is expected to benefit salmonids by increasing the amount of foraging habitat and increasing the amount of brackish habitat for individuals undergoing parr-smolt transformation.

Since juvenile green sturgeon use estuarine waters year-round, they may be in the area during the proposed breaching activities and be exposed to breaching-related effects. Restoration projects will incorporated measures to minimize and control project-related sedimentation for breaching activities, including a stormwater pollution prevention plan, compliance monitoring, and emergency response actions. No resulting discharges from the site will exceed threshold limitations set by the California Regional Water Quality Control Board.

The soils within Suisun Marsh are various silty loams, though some areas are dominated by peat soils. Observations during breaching at the Napa Salt Plant wetland restoration site (a site with the similar soil types), showed that these soils are very cohesive. Soils at the Napa salt Plant wetland restoration site did not exhibit dispersive properties when excavated and subsequently inundated after levee breaching. The construction methods and sediment control measures utilized at the neighboring site proved sufficient to prevent turbidity plumes from entering receiving waters. SMP wetland restoration projects propose to utilize the same techniques to avoid degradation of water quality during breaching events. Therefore, increased turbidity levels associated with construction and breaching events are expected to be localized and short-term in duration. As a benthic dwelling species, green sturgeon are adapted to living in estuaries with fine sediment bottoms and, thus, are tolerant of high levels of turbidity. Green sturgeon in the San Pablo Bay estuary commonly encounter areas of increased turbidity due to storm flow runoff events, wind and wave action, and benthic foraging activities of other aquatic organisms. Therefore, any short-term impact associated with turbidity during implementation of this project is expected to be insignificant for green sturgeon.

Once completed, wetland restoration is expected to benefit designated critical habitat for green sturgeon and winter-run Chinook salmon by increasing the amount of tidal marshland in Suisun Marsh by 5,000 to 7,000 acres. Over time, levee breaches and the restoration of tidal action will create a network of intertidal channels extending out into the marsh plain from constructed pilot channels. NMFS anticipates improvements to water quality and increased foraging opportunities for green sturgeon and salmonids as implementation of the SMP proceeds over the 30-year term. With the project's requirement to meet tidal restoration acreage targets at 10-year intervals, the habitat benefits of the SMP are ensured to accrue.

Overall, the anticipated adverse effects to habitat from the SMP activities are expected to generally be of short duration, infrequent intervals, and to impact small areas at any one time. Proposed maintenance activities will maintain the current altered condition on perimeter levees and the adjacent sloughs. However, restoration of 5,000 to 7,000 acres of tidal wetland habitat is expected to improve the quantity and quality of estuarine habitat in Suisun Marsh for listed fish, including designated critical habitat for winter-run Chinook salmon and green sturgeon.

VII. CUMULATIVE EFFECTS

Cumulative effects are defined in 50 § CFR 402.02 as "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." Future Federal actions, including the ongoing operation of dams, hatcheries, fisheries, water withdrawals, and land management activities will be reviewed through separate section 7 consultation processes and are not considered here. Non Federal actions that require authorization under section 10 of the ESA, and that are not included within the scope of this consultation, will be evaluated in separate section 7 consultations and are not considered here. NMFS is not aware of any future State or private activities that are reasonably certain to occur within the action area, other than those analyzed above resulting from interrelated and interdependent activities and climate change.

Climate change poses a threat to salmonids and green sturgeon within the action area during and after the 30 year proposed action. In the San Francisco Bay region, extreme warm temperatures generally occur in July and August, but as climate change takes hold, the occurrences of these events will likely begin in June and could continue to occur in September (Cayan *et al.* 2012). Interior portions of San Francisco Bay are forecasted to experience a threefold increase in the frequency of hot daytime and nighttime temperatures (heat waves) from the historical period (Cayan *et al.* 2012). Climate simulation models also project that the San Francisco region will maintain its Mediterranean climate regime, but experience a higher degree of variability of annual precipitation during the next 50 years and years that are drier than the historical annual average during the middle and end of the twenty-first century. The greatest reduction in precipitation is forecasted to occur in March and April, with the core winter months remaining relatively unchanged (Cayan *et al.* 2012). The current climate in the San Francisco Bay region is generally warm, and modeled regional average air temperatures show an increase in summer (Lindley *et al.* 2007) and greater heat waves (Hayhoe *et al.* 2004) under climate change scenarios. Cloern *et al.* (2011) projects that the salinity in San Francisco Bay could increase by 0.30-0.45 practical salinity unit (psu) per decade due to the confounding effects of decreasing freshwater inflow and sea level rise (projected by Cloern *et al.* 2011 to rise approximately 4 inches per decade). Sea level rise under this and other scenarios (See, for example, Cayan *et al.* 2012, BCDC 2013) could change result in changes to the remaining un-diked marshes in Suisun Marsh by mid Century. For example depths may increase and saltgrass (*Distichlis spicata*) may decrease (BCDC 2013).

VIII. INTEGRATION AND SYNTHESIS OF EFFECTS

Water operations for managed wetlands in Suisun Marsh during the next 30 years are expected to adversely affect listed salmonids and green sturgeon by degrading water quality from drainage off managed wetlands, and by entrainment during diversions into managed wetlands. CCC steelhead smolts and juvenile green sturgeon that may be present in the small dead-end sloughs of Region 1are the most likely listed fish species under the jurisdiction of NMFS that could be exposed to low dissolved oxygen conditions during black water discharge events. CCC steelhead smolts may be exposed during May and June, and juvenile green sturgeon may be exposed during May, June, and October to black water events. Low dissolved oxygen levels in these marsh areas during black water discharges could result in fish mortality. Although NMFS does not anticipate many CCC steelhead or green sturgeon to be in the areas of poor water conditions, any CCC steelhead or green sturgeon that do encounter areas with degraded water quality conditions from which they cannot escape, will experience adverse effects, that may include death. Mortalities of green sturgeon and CCC steelhead smolts are anticipated to be uncommon and will not occur every year. NMFS estimates that no more than 5 green sturgeon and no more than 20 CCC steelhead smolts will be harmed or killed by black water discharge events over the 30-year term of the SMP. The migratory pathways of winter-run Chinook salmon, CV spring-run Chinook salmon, CV steelhead, and spawning adult green sturgeon occur south of Suisun Marsh Region 1, and they are unlikely to experience the adverse effects of poor water quality associated with black water discharges.

Listed salmonid smolts may be entrained through unscreened diversions into managed wetlands. Once diverted onto a managed wetland, it is assumed that few, if any, fish will escape the impounded waters. Several intakes along major migratory routes are equipped with fish screens and no losses to entrainment are expected at these locations. However, at unscreened diversion sites, salmonid smolts may be entrained, but the numbers are expected to be very small. Central Valley salmonids, both Chinook and steelhead, migrate primarily along Montezuma Slough in Region 3, where screened intakes prevent entrainment. CCC steelhead smolts originating from Suisun and Green Valley creeks do not pass through most of Region 1, or through any part of Regions 2, 3, or 4, and will not be exposed to potential entrainment in most of the action area. In addition, steelhead smolts are larger than Chinook salmon smolts and their better swimming ability will allow them to generally avoid entrainment at gravity operated diversions. When combined with the proposed diversion curtailments from November through May, it is expected that a very small number of juvenile steelhead or Chinook salmon will be entrained at unscreened diversions in Suisun Marsh. Since all of the Chinook salmon observed during entrainment monitoring have been non-listed fall-run Chinook (SRCD and CDFW 2005), NMFS estimates that from 50 to 500 listed salmonid juveniles will be entrained and lost at unscreened diversions in Suisun Marsh over the 30-year term of the SMP.

Thirty different maintenance and operations actions are proposed for authorization under RGP 3 and the LOP. Of the 30 proposed actions, 16 are expected to have no effect on listed species. With the implementation of proposed best management practices, most of the remaining actions are not likely to adversely affect listed species. These actions consist of repair and replacement of water control structures, debris removal, and repairs at existing fish screens, gages, and monitoring stations. These maintenance activities are primarily performed at low tide and, thus, equipment and personnel are not working within tidal waters of Suisun Marsh sloughs. They are generally separated from each other in space and time, over the entire 116,000 acres of the action area, and effects are minimal, localized, and temporary. It is unlikely that combined effects of these maintenance activities will rise to the level of adversely affecting listed and proposed species.

Under RGP 3, replacement of existing riprap on exterior levees and installation of new riprap are expected to adversely listed anadromous salmonids, green sturgeon, and designated critical habitat. Riprap placement can result in the loss of intertidal habitat, including emergent vegetation and benthic organisms living in soft substrate areas. Riprap use will generally occur in areas where riprap was previously placed, which limits the potential loss of existing shoreline habitat. However, landowner maintenance of levees and shoreline areas with riprap will continue to maintain the existing degraded condition of shoreline habitat in the action area and constrain the development of tidal marsh areas along slough margins.

Under the LOP, materials may be dredged from tidal waters for the purpose of maintaining and repairing levees. Dredging may result in increased levels of turbidity in the vicinity of the work site during dredging. Excavators or clamshell dredge operations will be restricted to the period between August and November. This period avoids the migration periods of listed anadromous salmonids in the action area and few green sturgeon are expected to be present at or in close proximity to dredge sites during dredging activities. Anticipated turbidity levels are not expected to result in harm or injury, or behavioral responses that impair migration, foraging, or make green sturgeon more susceptible to predation. However, the removal of sediments during dredging is anticipated to adversely affect shoreline habitat areas by removing vegetation and removing benthic macroinvertebrates. Loss of these prey organisms will reduce foraging opportunities for salmonids and sturgeon, and could contribute to an overall decline in nearshore productivity.

Based on the above, a small number of juvenile, sub-adult, and adult green sturgeon, and adult and smolt CCC steelhead, CV steelhead, CV spring-run Chinook, and Sacramento River winter-run Chinook are expected to be adversely affected by the Project's proposed placement of rock riprap, operation of water control structures, and dredging activities. Therefore, it is unlikely that the small potential loss of individuals as a result of the project will impact future adult returns, due to the large number of individual green sturgeon and salmonids unaffected by the project compared to the small number of green sturgeon and salmonids likely affected by the project.

Due to the life history strategy of green sturgeon which spawn every 3-5 years over an adult lifespan of as much as 40 years (Moyle 2002), the few individuals injured or killed by exposure to black water discharges are likely to be replaced in subsequent generations of green sturgeon. Similarly, due to the relatively large number of juveniles produced by each spawning pair, juvenile salmonids lost to black water events and entrained at managed pond water intakes in future years are expected to produce enough juveniles to replace the small number of individuals injured or killed. It is unlikely that the small potential loss of juveniles by the SMP over the 30-year permit term will impact future adult returns.

Potential impacts to winter-run Chinook salmon and southern DPS green sturgeon critical habitat are not expected to appreciably diminish the capability of the action area to provide PCEs for these species. The existing condition of fish habitat in Suisun Marsh has been influenced by a long history of human disturbance, including diking and draining of marshes for waterfowl and recreational hunting. Currently the action area consists of mostly diked brackish marshes and managed waterfowl ponds that are inaccessible to fish. The existing condition of PCEs in the action area is degraded. In the action area, replacement of existing riprap will continue to maintain the existing degraded condition of shoreline habitat along the tidal sloughs of Suisun Marsh. Installation of new riprap will result in the loss intertidal mudflats and emergent vegetation. Although habitat values in erosive areas are likely to be low, habitat elements that have developed will be lost during replacement. Mudflats are inhabited by a diverse assemblage of benthic infauna and epifauna (organisms living in and on the sediments), and serve as important feeding and rearing areas for listed salmonids and green sturgeon. Vegetation also provides a source of prey from insects that drop from plants, and provides cover and protection from visual predators. Best management practices limit work to low tides, and require the use of the minimum amount of rip rap required.

Over the 30-year term of the SMP, 5,000 to 7,000 acres within the action area will be restored to tidal marsh. This component of the SMP is anticipated to provide significant long-term benefits to winter-run Chinook salmon and green sturgeon critical habitat in the action area. Over time, levee breaches and the restoration of tidal action will create a network of intertidal channels extending out into the marsh plain from constructed pilot channels. The expected levels of disturbance from construction activities on designated critical habitat will be minor, short-term, and localized. NMFS anticipates that these effects will be insignificant to the functioning of designated critical habitat. Tidal marsh restoration and expansion are anticipated to be benefit critical habitat by providing increases in habitat areas, prey base, foraging areas, and cover/shelter areas. Overall, the proposed 5,000 to 7,000 acres of tidal wetland restoration are expected to result in long-term beneficial effects to designated critical habitat, by expanding tidal marsh habitat in Suisun Marsh.

Some of the projected impacts from climate change described in *Status of the Species and Critical Habitat* section of this biological opinion are likely to be realized in the San Francisco Bay Region, including the action area, within the 30-year duration of the SMP. Water temperatures are likely to warm, overall flows may decline (especially in the spring), extreme weather events are likely to increase, and sea levels are likely to continue to rise. NMFS expects that the effects of climate change are unlikely to increase the adverse effects of the proposed action because the timing, duration, or locations of these adverse effects do not match up with