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

February 6, 2012

In response refer to:
F/SWR/2011/05965

James B. Richards
Deputy Director Environmental Planning and Engineering
Office of Natural Sciences and Permits
California Department of Transportation
111 Grand Avenue
Oakland, California 94623-0660

Dear Mr. Richards:

Thank you for your letter of August 11, 2011, requesting formal consultation with NOAA's National Marine Fisheries Service (NMFS) pursuant to section 7 of the Endangered Species Act (ESA) of 1973, as amended (16 U.S.C. 1531 *et seq.*), for the San Francisco-Oakland Bay Bridge East Span Seismic Project, located in the San Francisco Bay, San Francisco, California.

The enclosed supplemental biological opinion is based on our review of the remaining activities for the project, and describes NMFS' analysis of potential effects to the following listed species (Evolutionary Significant Units [ESU] or Distinct Population Segment [DPS]), and designated critical habitat, in accordance with section 7 of the ESA: Sacramento River winter-run Chinook salmon ESU (*Oncorhynchus tshawytscha*), Central Valley spring-run Chinook salmon ESU (*O. tshawytscha*), Central Valley steelhead DPS (*O. mykiss*), Central California Coast steelhead DPS (*O. mykiss*), and North American green sturgeon southern DPS (*Acipenser medirostris*).

In the enclosed supplemental biological opinion, NMFS concludes the proposed action is not likely to jeopardize the continued existence of listed salmonids or southern DPS green sturgeon, and is not likely to result in the destruction or adverse modification of salmonid or green sturgeon critical habitat. NMFS anticipates that take of listed salmonids and southern DPS green sturgeon as a result of this project will occur. An incidental take statement is included with the enclosed supplemental biological opinion.

NMFS has also evaluated the proposed action for potential adverse effects to Essential Fish Habitat (EFH) pursuant to section 305(b)(2) of the Magnuson Stevens Fishery Conservation and Management Act (MSA). Based on our review (Enclosure 2), NMFS concludes that the proposed action would result in adverse effects to EFH for various life stages of species managed under the Pacific Groundfish Fishery Management Plan (various rockfish, flatfish, roundfish and sharks)

and the Coastal Pelagic Fishery Management Plan (Northern anchovy and Pacific sardine) under the MSA. The proposed action contains measures to avoid, minimize, mitigate, or otherwise offset some potential adverse effects to EFH. With the additional EFH Conservation Recommendations provided by NMFS, adverse effects to EFH are expected to be adequately minimized or compensated.

Please contact Jacqueline Pearson Meyer at (707) 575-6057, or by e-mail Jacqueline.Pearson-Meyer@noaa.gov. if you have any questions regarding this ESA consultation, or Maureen Goff for EFH questions at 707-575-6067; Maureen. Goff@noaa.gov, or if you require additional information.

Sincerely,

for Rodney R. McInnis
Regional Administrator

Enclosures

cc: Chris Yates, NMFS, Long Beach
Jane Hicks, US Army Corps of Engineers, San Francisco
Vicki Frey, CDFG
Max Delaney, BCDC
Copy to file: ARN# 151422SWR99SR190

Enclosure 1

SUPPLEMENTAL BIOLOGICAL OPINION

ACTION AGENCY:	California Department of Transportation
ACTION:	Bridge Demolition and Dredging Activities for the San Francisco-Oakland Bay Bridge East Span Seismic Project.
CONSULTATION CONDUCTED BY:	National Marine Fisheries Service, Southwest Region
TRACKING NUMBER:	2011/05965
DATE ISSUED:	**February 6, 2012**

I. CONSULTATION HISTORY

In 1998, the California Department of Transportation (Caltrans) proposed to construct a new east span of the San Francisco-Oakland Bay Bridge (SFOBB), approximately 2.18 miles (3.5 kilometers) long, to the north of the existing east span, in order to meet lifeline[1] criteria for providing emergency relief access following a maximum credible earthquake (MCE). An MCE is the largest earthquake reasonably capable of occurring based on current geological knowledge. On October 31, 2001, formal section 7 consultation between NOAA's National Marine Fisheries Service (NMFS) and the Federal Highways Administration (FHWA) for the SFOBB East Span Seismic Project was completed with the issuance of a biological opinion (BO). NMFS analyzed the effects of the proposed construction of the SFOBB East Span Seismic Project on Sacramento River winter-run Chinook salmon, Central Valley spring-run Chinook salmon, Central Valley steelhead, Central California Coast steelhead, and Central California Coast coho salmon, and the critical habitat designated for these species, in accordance with section 7 of the Endangered Species Act of 1973 (ESA), as amended (16 U.S.C. 1531 *et seq.*).

Consultation history for the period of September 1998 through October 2001 is documented in the October 2001 BO. The primary concerns with the project considered in the 2001 BO were impacts to listed salmonid species and their designated critical habitat through activities causing

[1] Lifelines in this context are systems and facilities critical to emergency response and recovery after a natural disaster, including hospitals, fire control and policing, food distribution, communication, electric power, liquid fuel, natural gas, transportation (airports, highways, ports, rail, and transit), water and wastewater. In the case of the East Span, a lifeline connection would provide for post-earthquake relief access linking major population centers, emergency relief routes, emergency supply and staging centers, and intermodal links to major distribution centers. The East Span would be serviceable soon after a maximum credible earthquake.

impacts to listed salmonid species and their designated critical habitat through activities causing temporary and permanent impacts associated with sound impacts from pile driving for permanent pile installation, bridge dismantling, and loss or disturbance of aquatic habitat via degradation of eelgrass beds and benthic substrates from dredging activities, placement of temporary and permanent fill, and turbidity and sedimentation. Since the October 31, 2001, BO was issued, consultation has been reinitiated ten times[2] with NMFS to address proposed changes to the project, and to address impacts of the project to recently Federally-listed species.

By letter dated April 30, 2003, NMFS concluded reinitiated consultation with FHWA to address controlled blasting at Yerba Buena Island.

By letter dated January 20, 2004, NMFS concluded reinitiated consultation to address sound monitoring at Pier E3.

By letter dated July 20, 2004, NMFS concluded reinitiated consultation to address the relocation of a 10-inch diameter gas line.

By letter dated August 16, 2004, NMFS concluded reinitiated consultation to address an "on/off" study of the air bubble curtain at Pier E4W.

By letter dated December 3, 2004, NMFS concluded reinitiated consultation to address the use of an impact hammer at Pier T1.

By letter dated April 8, 2005, NMFS concluded reinitiated consultation to address the Eelgrass Pilot Project.

By electronic correspondence dated July 26, 2005, NMFS concluded reinitiated consultation to address the installation of an electric cable between the City of Oakland in Alameda County and Treasure Island in San Francisco County.

NMFS received a letter dated May 7, 2008, from Caltrans requesting reinitiation of consultation pursuant to section 7 of the Endangered Species Act (ESA) regarding the SFOBB East Span Seismic Project in order to address the remaining project activities' impacts on the recently Federally-listed North American southern Distinct Population Segment (DPS) green sturgeon (*Acipenser medirostris*). The southern DPS green sturgeon was listed as threatened on April 7, 2006 (71 FR 17757), and critical habitat was proposed for green sturgeon on September 8, 2008 (73 FR 52084). Supplemental biological and conference opinions were issued on April 10, 2009.

During June and July 2009, two meetings, several telephone conferences, and electronic

[2] This BO represents the tenth reinitiated consultation request for the SFOBB East Span Seismic Project to address the remainder of the proposed project actions, and potential impacts to the Federally-listed salmonids and green sturgeon, and effects associated with demolition activities of the old bridge.

communications occurred regarding a change to the SFOBB project description. On July 7, 2009, Caltrans submitted a request to modify the project description and construction method used during the construction of the Self-Anchored Suspension Span (SAS) of the SFOBB. NMFS received the letter regarding the requested changes on July 14, 2009, and an electronic mail request on August 7, 2009, to reinitiate consultation for the proposed changes. The changes included construction of a temporary access trestle extending from the main tower (T1) of the Self-Anchored Suspension Span. The temporary trestle required an additional 22 piles to be impact driven. NMFS issued supplemental biological and conference opinions for the changes to the project August 21, 2009.

Since the signing of the original October 2001 BO, the green sturgeon southern DPS was Federally listed as threatened (71 FR 17757), and critical habitat for the species was designated (74 FR 52300). Impacts on green sturgeon from construction activities were not considered in the 2001 BO, therefore remaining project activities and associated impacts to green sturgeon were included in the supplemental biological and conference opinions issued April 10, and August 21, 2009.

Several meetings, telephone conference calls, and electronic mail (e-mail) communications were exchanged between July 2011 and November 2011 regarding the existing bridge demolition and dredging activities for the project and assessment of potential impacts to the ESA-listed salmonids and southern DPS green sturgeon associated with remaining activities. NMFS received Caltrans' request for ESA and EFH consultation for the remaining bridge work on August 11, 2011, with additional requested information provided to NMFS on September 28, 2011 and January 8, 2012. The construction of the new bridge is nearly complete. In the October 2001 BO we provided an analysis of the overall effects anticipated from bridge demolition. However, impacts from bridge demolition were not fully analyzed for impacts to salmonids and green sturgeon. The decision to exclude detailed analyses on impacts associated with bridge demolition was based generally upon the lack of information at the time regarding the exact methods to be used for removal of the old bridge components. Given the time since the 2001 BO was issued, multiple changes to project scope, new species listings and critical habitat designations as well as new information becoming available, we can now provide an improved analysis of the anticipated effects from bridge demolition and associated pile driving. These effects will be considered in this opinion for salmonids and green sturgeon. All other remaining components (*e.g.*, construction of the new bridge) for the project remain the same as analyzed in prior consultations and are not expected to vary from what was originally considered. Therefore, impacts on salmonids and green sturgeon from the other remaining components are incorporated here by reference, and updated with additional information if warranted.

II. DESCRIPTION OF THE PROPOSED ACTION

Caltrans is reinitiating consultation on the SFOBB East Span Seismic Project in order to address

the impact of dismantling the existing east span on ESA-listed salmonids, North American southern DPS green sturgeon, and their respective critical habitats. The project is the construction of a new east span of the SFOBB, approximately 2.18 miles (3.5 kilometers) long, to the north of the existing east span located in the San Francisco Bay between Yerba Buena Island (YBI) and Oakland; and removal of the old bridge. The SFOBB is an important transportation component of the Bay Area that provides regional access between the San Francisco Peninsula and the East Bay. The purpose of the project is to provide a seismically upgraded crossing for current and future users between YBI and Oakland. The existing east span is not expected to withstand an MCE on the San Andreas or Hayward fault. The existing east span does not meet lifeline criteria for providing emergency relief access following an MCE and it does not meet all current operations and safety design standards. Construction activities for the new bridge began in 2001, and are expected to continue through 2017. Construction activities for the dismantling the existing east span will include: installation of temporary piles for support of trestles and falsework, removal of bridge decks and marine foundations, and dredging for a barge access channel. These activities are described in detail below.

A. Proposed Actions

The construction of the new bridge was originally divided among nine separate contracts: 1) Yerba Buena Island Transition Structure (YBIT); 2) Self-Anchored Suspension Span (SAS); 3) SAS Marine Foundations E2 and T1 (E2/T1); 4) Skyway Structure; 5) Oakland Approach Structure; 6) Geofill at the Oakland Touchdown; 7) Submarine Cables; 8) Storm-water Treatment System; and 9) Dismantling of the existing east span. The remaining construction activities include dismantling of the existing east span of the bridge. The project description presented below focuses on these remaining bridge removal activities, separated into the major bridge sections.

1. Dismantling of the Existing Bridge

The dismantling of the existing span is anticipated to take place immediately following the opening of the new east span to traffic, currently expected in the fall of 2013. Some preparatory activities related to the dismantling may take place as early as the summer of 2012. Caltrans has refined construction methodology to dismantle the existing east span and these proposed methods will be analyzed in this biological opinion. The existing east span of the old bridge can be divided into major Superstructure and Substructure Sections. The Superstructure consists of the Cantilever Superstructure, the 504’ Truss Span and the 288’ Truss Span, which require temporary in-water supports and trestles for dismantling. The Substructrue consists of in-water Marine Foundations. These structures are outlined below and shown in Figure 1.

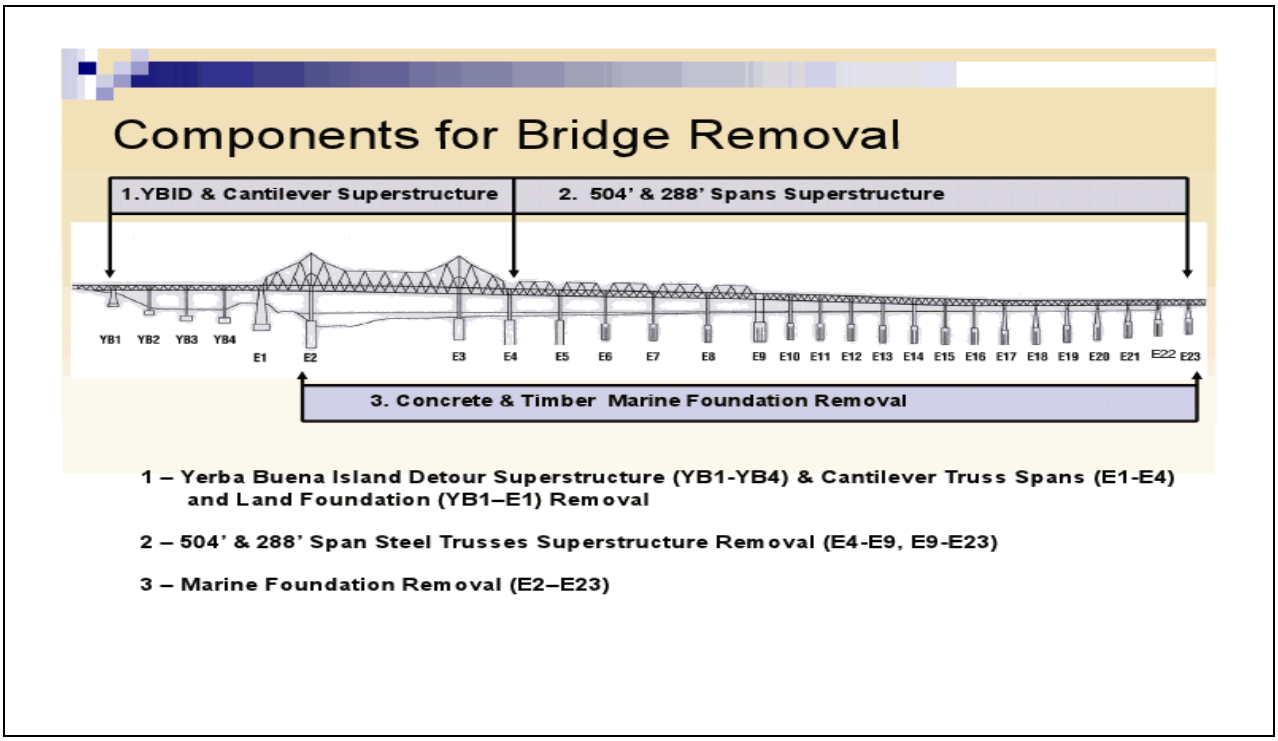

Figure 1. SFOBB Sections for Removal (Caltrans 2011).

a. Cantilever Superstructure

The Cantilever Superstructure section is comprised of three major elements: two cantilever anchor arm elements that are 154.8 meters (508 feet) long and 156 meters (512 feet) long, respectively; and a 426.7-meter (1 ,400-foot) long main span over the navigation channel consisting of a suspended segment which is supported on either side by anchor arms. The superstructure of this segment includes the trusses, road deck and steel support towers. Caltrans estimates approximately 440 24- to 36-inch diameter steel piles will be required to construct temporary supports for this section.

b. 504' & 288' Truss Spans Superstructure

This Superstructure segment of the bridge is comprised of two truss spans. The 504' Span consists of five, 153.6-meter (504-foot) long steel truss spans. The 288' Span consists of fourteen 87.8-meter (288-foot) long steel truss spans. The vertical clearance beneath the 504-foot spans is approximately 50 meters (165 feet) above mean high water levels, while the vertical clearance beneath the 288-foot spans varies greatly as the structure descends towards the Oakland shoreline. The superstructure of this segment includes the above trusses, road deck and steel and/or concrete support towers. Caltrans estimates approximately 1250 18- to 36-inch diameter steel pipe piles will be required to construct temporary supports for these sections.

Pile Supported Trestles and Falsework Required for Superstructure Removal. To remove the structures described above, two trestles and additional in-water falsework would be needed. These temporary structures, to be designed by the contractor, may be required to facilitate support of the existing east span until it is completely removed. Since the temporary structures will be contractor-designed, their exact nature (size, type, number of piles, *etc*.) will not be known until the dismantling begins. However, Caltrans has developed conservative estimates (maximum pile number, type and size anticipated) as to the approximate size, location and number of piles needed for these temporary structures. The anticipated temporary structures and size and quantity of piles needed to support these structures are described below.

Caltrans estimates that a maximum of 2,540 temporary piles may be installed to support all temporary structures. The steel pipe piles are expected to be 18 inches to 36 inches in diameter. There will also be 14-inch H-piles used for the YBI Access Trestle. When no longer needed, all temporary piles will be retrieved or cut off 0.46 meter (1.5 feet) below the mudline, per United States Coast Guard requirements. Additional piles (included in the 2,540 total) may be needed for other temporary structures for access, spuds, fenders, etc.

Two trestles may be needed to facilitate construction access and allow for the off-haul of materials. One of the trestles will extend into the Bay from the YBI shoreline (YBI Access Trestle). The other trestle will extend into the Bay from the Oakland shoreline (Oakland Access Trestle).

Caltrans anticipates that the YBI Access Trestle will be a small, approximately 650 square-meter (7,000 square foot), H-pile supported trestle constructed on the southeast side of YBI. The YBI Access Trestle would primarily be used for the off-haul of materials during the dismantling of the cantilever superstructure. Installation of the YBI Access Trestle is anticipated as one of the first orders of work for the dismantling and would likely be constructed during summer or fall 2012. This trestle is expected to be constructed in roughly the same footprint as a trestle constructed at YBI earlier for the SFOBB project, but has since been removed. Approximately 100 14-inch H-piles will be required for construction of the YBI Access Trestle. Although eelgrass has been documented in Coast Guard Cove near the proposed YBI Trestle, this structure is not expected to be constructed on any eelgrass beds, as the closest documented eelgrass to the YBI Trestle varied in distance from 30 - 130 meters when present, and no eelgrass was documented in four out of nine years surveyed.

The Oakland Access Trestle will be an approximately 8,920-square-meter (96,000 square foot) pipe pile-supported trestle constructed parallel to the southern side of the existing east span. The trestle would likely have fingers extending under the bridge, perpendicular to the main trestle to allow for access between the foundations. Caltrans anticipates that the trestle would extend westward from the Oakland shoreline, potentially as far as Pier E9 of the existing east span. The trestle would be used for construction access during the dismantling of the 504-foot and 288-foot superstructures and/or marine foundation removal. The Oakland Access Trestle may be

constructed between 2014 and 2017, depending on construction schedules. Approximately 700 18 to 36-inch diameter steel piles will be required for this trestle.

***Pile Installation*.** All pipe piles for the temporary structures and falsework required for demolition work will be installed with a vibratory hammer to drive the majority of the total pile lengths. The remainder of each pile length may, if not completed with the vibratory hammer, be impact-driven. Impact hammering will be done with the use of a marine pile driving energy attenuator *(i.e.,* air bubble curtain system), or other equally effective sound attenuation method (*e.g.,* dewatered cofferdam). A maximum of twenty piles may be impact-driven per day. In the event a pipe pile is entirely installed with a vibratory hammer, it will still be subject to final "proofing" with an impact hammer (a limited number of blows with an impact hammer intended to test integrity and seating of the pile).

The H-piles used for the YBI Access Trestle will be driven with an impact hammer. These piles will be driven in waters zero to three meters deep, and will not have a sound attenuation device implemented during construction due to site specific constraints which make it difficult to properly implement a bubble curtain.

Impact pile driving will be restricted to the period between June lst and November 30th. Vibratory driving and proofing of piles may be performed year-round.

c. Substructure - Marine Foundations

The in-water or marine foundations vary in type. Piers E2 through E5 consist of concrete caissons founded on deep bedrock. Piers E6 through E23 consist of lightly reinforced concrete foundations that are supported by timber piles (piers are numbered from west to east beginning at YBI with E1, and spanning across the Bay, ending at Oakland with E23). In the 2001 BO, methods for dismantling the concrete foundations were outlined, however, Caltrans has modified the description and currently proposes to use expansive cracking mortar to break the concrete into pieces small enough for removal and transport. This method is being considered to reduce the duration of time, labor and costs associated with other removal methods. A water quality impact study to identify and address potential effects resulting from the use of expansive cracking mortar is being prepared by Caltrans. A copy of the study will be provided to NMFS, the Regional Water Quality Control Board (RWQCB), and other appropriate resource agencies once finalized.

d. Additional Activities

Dredging. Dredging for the project remains the same as what was considered in previous BOs, and is incorporated here for reference. Dredging (either mechanical or hydraulic) will be required to create a barge access channel to dismantle the existing bridge and to remove piers from the existing bridge. Caltrans anticipates that 190,680 cubic yards of material will be dredged to create the barge access channel for dismantling the existing bridge. This material will be disposed of at either the San Francisco Deep Ocean Disposal Site (SF-DODS), at an upland wetland reuse site, or at a landfill reuse site. Information on dredging, disposal, impacts and mitigation measures is

presented in the Dredged Material Management Plan (DMMP), included as Appendix M of the FEIS. Updated dredge volume estimates and mitigation measures were provided to the Corps Dredged Material Management Office (DMMO) in September and November 2011 (M. Davignon, DMMO, pers. comm 2012). Sediment for disposal will be tested for contaminants prior to disposal to determine the most appropriate disposal site. At this time, the Corps DMMO believes the majority of the dredge material will be disposed of at the SF-DODS, but it has not been determined where all of the material will go. If a portion of the material does go to an upland wetland site, it will most likely go to a beneficial reuse site like the Montezuma Wetlands Restoration Project.

Removal of the existing piers will require 22,724 cubic yards of material to be dredged. This material will be disposed of at the Alcatraz Island site (SF-11).

Removal of Several Original Timber Piles. The final remaining activity identified by Caltrans is the proposed removal of a small number of original timber foundation piles from the existing east span for scientific purposes. There are two types of foundations that support the existing east span: concrete caissons founded on deep bedrock and reinforced concrete foundations that are supported by timber piles. The Toll Bridge Seismic Safety Peer Review Panel has requested that during the dismantling, Caltrans remove a few timber piles in an intact state for analysis of degradation during the intervening seventy-five years since their installation. These piles will most likely be removed from a pier closer to the Oakland shoreline and will be vibrated out from the mud.

2. Proposed Avoidance and Minimization Measures

To reduce potential impacts to federal and state listed fish species, critical habitat and EFH (including Habitat Areas of Particular Concern [HAPC])), Caltrans will limit both the size of piles and duration of impact pile driving, to the greatest extent feasible. Proposed avoidance and minimization measures are summarized below:

• Steel pipe pile sizes will be limited to 36-inches in diameter or smaller.

• Pile driving will occur only during daylight hours from one hour after sunrise to one hour before sunset during the seasonal salmonid and green sturgeon migration periods (December 1st – May 31st). Pile driving operations occurring outside the seasonal salmonid and green sturgeon migration period (June 1st - November 30th) shall direct illumination away from the water.

• All pipe piles will be initially installed with a vibratory hammer. The vibratory hammer will be used to drive the majority of the total pile lengths. In the event a pipe pile installed with a vibratory hammer does not achieve appropriate depth, it may be subject to being driven with an impact hammer.

• Use of a marine pile driving energy attenuator (*e.g.*, bubble curtain) will be required during impact driving of all pipe piles, with the exception of pile proofing and driving the H-piles.

• A maximum of 10% of the piles installed completely with a vibratory hammer may be proofed with an impact hammer, without the use of a marine pile driving energy attenuator.

• Proofing of piles will be limited to a maximum of two piles per day, for less than 1 minute per pile, administering a maximum of twenty blows per pile.

• Impact pile driving (with the exception of pile proofing) will be restricted to the period between June 1st and November 30th to avoid the migration period for salmonids and spawning adult green sturgeon.

• When construction activity occurs within 1,000 meters (3,200 feet) of an eelgrass bed or sand flat, measures (such as use of turbidity curtains) will be taken to ensure, to the extent practical, that turbidity generated by these activities does not exceed 50 Nephelometric Turbidity Units (NTU) or result in incremental increase greater than 10% of the background NTU at a distance greater than 30 meters (100 feet) from the activity.

3. Monitoring

a. Hydroacoustic and Biological Monitoring During Pile Driving

To assess the level of impact to fisheries, biological and hydroacoustic monitoring will be implemented within the vicinity of pile driving operations. Caltrans will perform hydroacoustic and bird predation monitoring during impact pile driving events for each of the temporary structures identified above. Hydroacoustic and bird predation monitoring will also be performed during the removal of concrete marine foundations if undertaken via mechanical means.

Monitoring will be representative of the different locations, equipment and methods used for pile installation, sound attenuation, and removal of the marine foundations. If sound estimates are consistent with anticipated levels per same bridge section, location, substrate type and water depth, Caltrans may not conduct hydroacoustic monitoring for all pile impact hammering. Caltrans will not stop monitoring without obtaining approval by NMFS. Real-time hydroacoustic monitoring will be conducted to ensure that underwater sound levels analyzed for in-water pile driving are not exceeded beyond the area anticipated. Bird predation monitoring will be performed by a qualified biologist. A draft monitoring and reporting program will be submitted to NMFS for review and comment 60 days prior to the start of in-water impact pile driving or marine foundation removal. Preliminary findings (real-time data) from hydroacoustic monitoring will be provided to NMFS' Office of Protected Resources within 24 hours of monitoring.

b. Water Quality Monitoring

Turbidity monitoring will be performed prior to and during dredging, excavation or fill activities. Monitoring will be conducted in accordance with methods and standards outlined in the Water

Quality Self-Monitoring Program required by the RWCQB Order No. R2-2002-0011, or as required by the RWQCB.

B. Description of the Action Area

The action area is defined as all areas affected directly or indirectly by Federal action and not merely the immediate area involved in the action (50 CFR § 402.02). The SFOBB East Span Seismic Project site, including the area around the bridge piers and the area necessary to accommodate construction-related equipment such as work barges and cranes, is located in San Francisco Bay, between YBI and Oakland. For the SFOBB East Span Seismic Project, NMFS defines the action area for the remaining project activities, to be: 1) the central and south San Francisco Bay, extending for a radial distance of approximately 3,981 m around the east span of the SFOBB associated with underwater sound pressure, and 2) the portion of the Bay extending approximately 2000 m from the south side of Alcatraz Island where the SF-11 dredge disposal site is located, and 3) the ocean floor and water column at the ocean disposal site. These areas, except for the ocean disposal site, are shown in Figure 2. This action area has been determined based on the direct and indirect effects of the project's pile driving and dredging/disposal activities during dismantling sections of the existing bridge.

Figure 2. SFOBB Action Area indicating the SF-11 dredge disposal site and the 3981 m radial distance for sound pressure impacts.

III. ANALYTICAL FRAMEWORK

A. Jeopardy Analysis

In accordance with policy and regulation, the jeopardy analysis in this BO relies on four components: (1) the Status of the Species, which evaluates the salmonid ESUs and DPSs and the North American green sturgeon southern DPS's 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 the 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 the 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 the species in the action area; and (4) Cumulative Effects, which evaluates the effects of future, non-Federal activities in the action area on the 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 the listed species in the wild.

The jeopardy analysis in this BO places an emphasis on the range-wide likelihood of both survival and recovery of the listed species and the role of the action area in the survival and recovery of the 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 populations will be impacted, we assess whether this impact is likely to affect the ability of the populations to support the survival and recovery of the DPS or ESU.

B. Adverse Modification Determination

This biological opinion does not rely on the regulatory definition of destruction or adverse modification of critical habitat at 50 CPR 402.02[3]. 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 BO relies on four components: (1) the Status of Critical Habitat, which evaluates the range-wide and watershed-wide condition of critical habitat for the salmonid ESUs and DPSs and North American green sturgeon southern DPS in terms of primary constituent elements (PCEs – sites for spawning, rearing, and migration), 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

[3] This regulatory definition has been invalidated by Federal Courts.

factors responsible for that condition, and the conservation value of the 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 PCEs 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 PCEs 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 listed salmonids and green sturgeon 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 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, the biological assessment for this project, and project meeting notes if applicable. Information was also provided in e-mails, site visits, and telephone conversations between February 2011 and January 2012. For information that has been taken directly from published, citable documents, those citations have been referenced in the text and listed at the end of this document.

A complete administrative record of this consultation is on file at the NMFS North Central Coast Office (Administrative Record Number 151422SWR99SR190).

IV. STATUS OF THE SPECIES AND CRITICAL HABITAT

This BO analyzes the effects of the bridge dismantling and dredging activities for the San Francisco-Oakland Bay Bridge East Span Seismic Project on the following Federally-listed species ESUs, DPSs, and designated critical in the action area that may be affected:

Sacramento River winter-run Chinook salmon ESU (*Oncorhynchus tshawytscha*)
Endangered (June 28, 2005, 70 FR 37160)

Critical habitat (June 16, 1993, 58 FR 33212)

Central Valley spring-run Chinook salmon ESU (*Oncorhynchus tshawytscha*)
Threatened (June 28, 2005, 70 FR 37160)
Critical habitat (September 2, 2005, 70 FR 52488)

Central Valley steelhead DPS (*Oncorhynchus mykiss*)
Threatened (January 5, 2006, 71 FR 834)
Critical habitat (September 2, 2005, 70 FR 52488)

Central California Coast steelhead DPS (*Oncorhynchus mykiss*)
Threatened (January 5, 2006, 71 FR 834)
Critical habitat (September 2, 2005, 70 FR 52488)

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

A. Species Description and Life History

1. Chinook Salmon

a. General Life History for Chinook salmon

Chinook salmon return to freshwater to spawn when they are three to eight 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 Sacramento River winter-run Chinook salmon enter San Francisco Bay from November through June (Hallock and Fisher 1985), and delay spawning until spring or early summer. Adult Central Valley spring-run Chinook salmon leave the ocean to begin their upstream migration in late January and early February (CDFG 1998) and enter the Sacramento River between March and September, primarily in May and June (Yoshiyama *et al*. 1998, Moyle 2002). Lindley *et al*. (2007) indicates adult Central Valley spring-run Chinook salmon enter native tributaries from the Sacramento River primarily between mid-April and mid-June. Central Valley spring-run Chinook salmon adults enter freshwater in the spring, hold 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 gravel beds that are located at the tails of holding pools (USFWS 1995). 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 degrees Fahrenheit (^{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 (newly emerged juveniles) begin to emerge from the gravel in late June to early July and continue through October (Fisher 1994). 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 (Keljson *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. In the Sacramento River and other tributaries, juveniles may begin migrating downstream almost immediately following emergence from the gravel with emigration occurring from December through March (Moyle 2002). 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 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 (Levy and Northcote 1982; Levings 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). Keljson *et al*. (1982) 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. During the night, juveniles were distributed randomly in the water column, but would school up during the day into the upper three meters of the water column. Juvenile Sacramento River winter-run Chinook salmon migrate to the sea after only rearing in freshwater for four to seven months, and occur in the delta from October through early May (CDFG 1998). Juvenile 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 the mainly ocean-type life history observed (*i.e.*, fall-run Chinook salmon) 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.

b. Species Status - Sacramento River winter-run Chinook Salmon

Sacramento River winter-run Chinook salmon were originally listed as threatened in August 1989, under emergency provisions of the ESA, and formally listed as threatened in November 1990 (55 FR 46515). The ESU is represented by a single extant naturally spawning population that is confined to the upper Sacramento River in California's Central Valley. NMFS designated critical habitat for winter-run Chinook salmon on June 16, 1993 (58 FR 33212). The ESU was reclassified as endangered on January 4, 1994 (59 FR 440), due to increased variability of run sizes, expected weak returns as a result of two small year classes in 1991 and 1993, and a 99 percent decline between 1966 and 1991. After completing status reviews in 2005, NMFS reconfirmed the endangered status of Sacramento River winter-run Chinook salmon on June 28, 2005 (70 FR 37160).

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, 299 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 listing of Sacramento River winter-run Chinook salmon as endangered, major impacts to the population occurred from warm water releases from Shasta Dam, juvenile and adult passage constraints at the Red Bluff Diversion Dam, water exports in the southern delta, acid mine drainage from Iron Mountain Mine, and entrainment at a large number of unscreened or poorly-screened water diversions (NMFS 1997). The naturally spawning component of this ESU has exhibited marked improvements in abundance and productivity in the early and mid-part of this decade. Population estimates in 2001 (8,224), 2002 (7,441), 2003 (8,218), and 2004 (7,701) show a recent increase in the escapement of Sacramento River winter-run Chinook salmon. These increases in abundance are encouraging, relative to the years of critically low abundance of the 1980s and early 1990s when numbers dipped as low as 200 (Good et al. 2005). However, returns of several West Coast Chinook salmon and coho salmon stocks were lower than expected in 2007, 2008, 2009, and 2010 numbers and show a precipitous decline with fish numbers of 2,542, 2,830, 4,658, and 1,596 respectively for these years (NMFS 2011 [JPE letter]).

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).

Several actions have been taken to improve habitat conditions for Sacramento River winter-run Chinook salmon, including: improved management of Central Valley water that has increased freshwater survival, changes in ocean and inland fishing harvest that have increased ocean survival and adult escapement, and implementation of habitat restoration efforts throughout the Central Valley. However, this population remains below established recovery goals (NMFS 1997) and the naturally-spawned component of the ESU is dependent on one extant population in the Sacramento River. There is particular concern about risks to the ESU's genetic diversity, life-history variability, local adaptation, and spatial structure (June 28, 2005, 70 FR 37160).

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c. Species Status - Central Valley spring-run Chinook Salmon

Central Valley spring-run Chinook salmon were listed as threatened on September 16, 1999 (64 FR 50394). This ESU consists of spring-run Chinook salmon occurring in the Sacramento River Basin. After completing the status reviews in 2005, NMFS reconfirmed the threatened status of Central Valley spring-run Chinook salmon on June 28, 2005 (70 FR 37160). As part of the listing determinations, NMFS made several changes involving West Coast hatchery populations. Central Valley spring-run Chinook salmon from the Feather River and Feather River Hatchery (FRH) have been included as part of the ESU (70 FR 37160). Central Valley spring-run Chinook salmon

in the Feather River 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 Feather River Hatchery (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).

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 (CDFG 1998). The ESU has been reduced to only three naturally-spawning populations that are free of hatchery influence from an estimated 17 historic populations[4]. 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. Although the recent 5-year mean abundance for these three populations remains relatively small (ranging from 500 to over 4,500 spawners), short and long-term productivity trends are positive, and populations sizes have shown continued increases over the abundance levels of the 1980s.

Several actions have been taken to improve habitat conditions for Central Valley spring-run Chinook salmon, including: improved management of Central Valley water; various 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 below levels observed from the 1960s through 1990. 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 (BRT) (Good *et al*. 2005) concluded that the ESU is likely to become endangered within the foreseeable future.

Data from the 2007 adult Central Valley spring-run Chinook salmon return counts and estimates indicates a decline in returning adults across the range of Central Valley spring-run Chinook salmon within the Central Valley of California. From 2007-2009 the Central Valley experienced drought conditions and low river and stream discharges, a contributing factor to population declines. Additionally, ocean conditions are suspected as the principal short term cause because of the wide geographic range of declines (Southwest Fisheries Science Center 2008). With a few exceptions, Central Valley spring-run Chinook populations have declined over the past 10 years,

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

particularly since 2006. The only Central Valley spring-run Chinook salmon populations that seemed to have improved are in Battle Creek and Clear Creek. Overall, the status of the Central Valley spring-run Chinook salmon ESU has probably deteriorated since the status reviews in 2005, and the species likely has an increased risk of extinction (Williams *et al.* 2011). 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 2011b).

2. Steelhead

a. General Life History - Steelhead

Steelhead are an anadromous form of *Oncorhynchus mykiss*, spending some time in both freshwater and saltwater. The older juvenile and adult life stages occur in the ocean, until the adults ascend freshwater streams to spawn. 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, Shapolov and Taft (1954) reported that repeat spawners are relatively numerous (17.2 percent) in California streams; and may spawn one to four times over their lifetime. Eggs (laid in gravel nests called redds), alevins (gravel dwelling hatchlings), fry (juveniles newly emerged from stream gravels), and young juveniles, remain in freshwater until they become large enough to migrate to the ocean to finish rearing and maturing to adults. General reviews for steelhead in California document much variation in life history (Shapovalov and Taft 1954, Barnhart 1986, Busby *et al*. 1996, McEwan 2001). Although variation occurs, coastal California steelhead usually live in freshwater for two years, then spend one or two years in the ocean before returning to their natal stream to spawn. Steelhead from the tributaries of San Francisco Bay typically migrate to freshwater between November and April, peaking in January and February. They migrate to the ocean as juveniles from March through June, with peak migration occurring in April and May (Fukushima and Lesh 1998).

Steelhead fry generally rear in edgewater habitats and move gradually into pools and riffles as they grow larger. Cover is an important habitat component for juvenile steelhead, both as a velocity refuge and as a means of avoiding predation (Shirvell 1990, Meehan and Bjornn 1991). Steelhead, however, tend to use riffles and other habitats not strongly associated with cover during summer rearing more than other salmonids. Young steelhead feed on a wide variety of aquatic and terrestrial insects, and emerging fry are sometimes preyed upon by older juveniles. Rearing steelhead juveniles prefer water temperatures of 7.2-14.4 degrees Celsius (˚C) and have an upper lethal limit of 23.9˚C (Barnhart 1986, Bjornn and Reiser 1991). They can survive in water up to 27˚C with saturated dissolved oxygen conditions and a plentiful food supply. Fluctuating diurnal water temperatures also aid in survivability of salmonids (Busby *et al*. 1996).

Juvenile steelhead emigrate episodically from natal streams during fall, winter, and spring high flows. Barnhart (1986) reported that steelhead smolts in California range in size from 140 to 210 millimeter (mm) fork length.

b. Species Status - Central Valley steelhead

Central Valley steelhead were listed as threatened on March 19, 1998 (63 FR 13347), with populations in the Sacramento and San Joaquin River basins in California's Central Valley. NMFS evaluated the listing status of Central Valley steelhead and on June 14, 2004, proposed maintaining the threatened listing determination (69 FR 33102). On January 5, 2006, NMFS made a final listing determination, reconfirming the threatened status of Central Valley steelhead (71 FR 834). As part of the listing determination, NMFS included Central Valley steelhead produced at the Coleman and FRH hatcheries as part of the 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. Historic Central Valley steelhead run sizes were estimated at one to two million spawners in the Central Valley prior to 1850, and approximately 40,000 spawners in the 1960s. Over the past 40 years, the naturally-spawned steelhead populations in the upper Sacramento River have declined substantially. Central Valley steelhead spawning above the Red Bluff Diversion Dam has a small population size (the most recent five-year mean is less than 2,000 adults) and exhibits strongly negative trends in abundnace and population growth rate. However, there have not been any escapment estimates made for the area above the Red Bluff Diversion Dam since 1993, due to changes in dam operations. The only recent DPS-level estimate of abundance is a crude extrapolation from the incidental catch of out-migrating juvenile steelhed captured in a midwater trawl sampling program for juvenile Chinook salmon below the confluence of the Sacramento and San Joaquin Rivers. Based on this extrapolation, it is estimated that 3,600 females spawned in the Central Valley.

Until recently, steelhead were thought to be extirpated from the San Joaquin River system. Recent monitoring has detected small self-sustaining populations of steelhead in the Stanislaus, Mokelumne, Calaveras, and other streams previously thought to be devoid of steelhead (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).

The 2005 status review concluded that the Central Valley steelhead DPS presently is in danger of extinction (Good *et al.* 2005). 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. Emigrating Central Valley steelhead use the lower reaches of the Sacramento River and the delta for rearing and as a migration corridor to the ocean. Juvenile steelhead in the Sacramento River Basin migrate downstream during most months of the year, but the peak period of emigration occurs in the spring, with a much smaller peak in the fall. The most recent reviews, indicate that the Central Valley steelhead DPS may have worsened, from when it was considered endangered if extinction in 2005. Catch data from the Chipps Island monitoring program suggests that natural steelhead production has continued to decline. The most recent biological information indicates that the extinction risk of this DPS has increased since the 2005 status review. Several of the listing factors contributed to the decline including the drought and ocean conditions (Williams *et al.* 2011). Based on this information, NMFS choose 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 2011c).

c. Species Status - Central California Coast steelhead

Central California Coast steelhead were listed as threatened on August 18, 1997 (62 FR 43937), with populations in coastal California streams from the Russian River to Aptos Creek, and several tributaries of San Francisco, San Pablo and Suisun Bays. NMFS evaluated the listing status of Central California Coast steelhead and on June 14, 2004, proposed maintaining the threatened listing determination (69 FR 33102). On January 5, 2006, NMFS made a final listing determination reconfirming the threatened status of Central California Coast steelhead (71 FR 834). As part of the new listing determination, NMFS included Central California Coast steelhead produced at the Don Clausen Hatchery and Kingfisher Flat Hatchery/Scott Creek (Monterey Bay Salmon and Trout Project) as part of the DPS.

Historically, approximately 70 populations[5] of steelhead existed in the CCC steelhead DPS (Spence *et al.* 2008). 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 dependent upon immigration from nearby CCC steelhead DPS populations to ensure their viability (McElhaney *et al.* 2000, Bjorkstedt *et al.* 2005).

[5] 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).

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 1997). 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 1997, and 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 strays to support dependent populations may no longer be able to do so, placing dependent populations at increased risk of extirpation. However, because CCC steelhead have maintained a wide distribution throughout the DPS, roughly approximating the known historical distribution, CCC steelhead likely possess a resilience that is likely to slow their decline relative to other salmonid species in worse condition. A recent status review concludes 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[6] (Spence *et al.* 2008). Although there were average returns (based on the last ten years of data) of adult CCC steelhead during 2007/08, research monitoring data from the 2008/09 and 2009/10 adult CCC steelhead returns indicate a decline in returning adults across their range compared to the last ten years. The most recent status update concludes that steelhead in the CCC steelhead DPS remain "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 August 15, 2011, NMFS chose to maintain the threatened status of the CCC steelhead DPS (76 FR 50447).

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

3. Green Sturgeon

a. General Life History – Green Sturgeon

North American green sturgeon are the most widely distributed, and most marine-oriented of sturgeon species belonging to the family Acipenseridae. Like all sturgeon, North American green sturgeon are anadromous, long-lived, and a slow growing species (Adams *et al.* 2002). Along the Pacific Coast, North American green sturgeon have been documented offshore from Ensenada, Mexico to the Bering Sea, Alaska and found in freshwater rivers from the Sacramento River to British Columbia (Moyle 2002).

Two sub-populations, or DPS of North American green sturgeon have been identified along the Pacific Coast. These DPS were identified based on evidence of spawning site fidelity (indicating multiple DPS tendencies), and on genetic analysis that indicates differences at least between the Klamath River and San Pablo Bay samples (Adams *et al*. 2002, Israel *et al*. 2004). The two identified DPS are: (1) a northern DPS consisting of populations in coastal watersheds northward of and including the Eel River; and (2) a southern DPS consisting of coastal and Central Valley populations south of the Eel River, with the only known spawning population occurring in the Sacramento River.

Data from commercial trawl fisheries and tagging studies indicate green sturgeon occupy waters within the 110 m contour on the continental shelf (NMFS 2005, Erickson and Hightower 2007). During the late summer and early fall, subadults and non-spawning adult green sturgeon frequently can be found aggregating in estuaries along the Pacific coast (Emmett *et al.* 1991, Moser and Lindley 2007). Particularly large concentrations of green sturgeon from both the northern and southern populations occur in the Columbia River estuary, Willapa Bay, Grays Harbor and Winchester Bay, with smaller aggregations in Humboldt Bay, Tillamook Bay, Nehalem Bay, San Francisco and San Pablo Bays (Emmett *et al.* 1991, Moyle *et al.* 1992, and Beamesderfer *et al.* 2007).

Of the two DPS, only the southern DPS is listed as a threatened species under the ESA. Co-occurrence of both northern and southern DPS green sturgeon within the Pacific Coast range is known, thus green sturgeon observed outside of natal rivers may belong to either DPS. Therefore, the geographical area occupied by the southern DPS is defined as the entire west coast range occupied by green sturgeon in North America. Within this range, southern DPS green sturgeon have been confirmed to occur from Graves Harbor, Alaska, to Monterey Bay, California (Lindley *et al*. 2008). Thesy are known to occur in nearshore marine waters, and are commonly observed in coastal bays, estuaries, and coastal marine waters from southern California to Alaska.

There is limited available data for green sturgeon on habitat usage, distribution and activities while present in nearshore coastal marine waters. New information regarding the migration and habitat use of the southern DPS green sturgeon has emerged. Lindley *et al*. (2008) report large-

scale migrations of green sturgeon along the Pacific Coast. It appears that southern DPS green sturgeon are migrating considerable distances up the Pacific Coast into other estuaries, particularly the Columbia River.

Kelly *et al.* (2007) indicated that green sturgeon enter the San Francisco Estuary during the spring and remain until autumn (see Table 6 in text). The authors studied the movement of adults in the San Francisco Estuary and found them to make significant long-distance movements with distinct directionality. The movements were not found to be related to salinity, current, or temperature, and Kelly *et al*. (2007) surmised that they are related to resource availability and foraging behavior. Acoustical tagging studies on the Rogue River (Erickson *et al*. 2002) have shown that adult green sturgeon will hold for as much as 6 months in deep (> 5m), low gradient reaches or off channel sloughs or coves of the river during summer months when water temperatures were between 15°C and 23°C. When ambient temperatures in the river dropped in autumn and early winter (<10°C) and flows increased, fish moved downstream and into the ocean. Erickson *et al.* (2002) surmised that this holding in deep pools was to conserve energy and utilize abundant food resources. Benson *et al.* (2007) found similar behavior on the Klamath and Trinity River systems with adult sturgeon acoustically tagged during their spawning migrations. Most fish held over the summer in discrete locations characterized by deep, low velocity pools until late fall or early winter when river flows increased with the first storms of the rainy season. Fish then moved rapidly downstream and out of the system. Recent data gathered from acoustically tagged adult green sturgeon revealed comparable behavior by adult fish on the Sacramento River based on the positioning of adult green sturgeon in holding pools on the Sacramento River above the Glenn Colusa Irrigation District (GCID) diversion (RM 205). Studies by Heublein (2006, 2009) and Vogel (2008) have documented the presence of adults in the Sacramento River during the spring and through the fall into the early winter months. These fish hold in upstream locations prior to their emigration from the system later in the year. Like the Rogue and Klamath river systems, downstream migration appears to be triggered by increased flows, decreasing water temperatures, and occurs rapidly once initiated. It should also be noted that some adults rapidly leave the system following their suspected spawning activity and enter the ocean only in early summer (Heublein 2006). This behavior has also been observed on the other spawning rivers (Benson *et al*. 2007*)* but may have been an artifact of the stress of the tagging procedure in that study.

Confirmed spawning populations of North American green sturgeon currently are found in only three river systems, the Sacramento and Klamath Rivers in California, and the Rogue River in southern Oregon (Erickson *et al*. 2002, Farr and Kern, 2005). During the late summer and early fall, sub-adults and nonspawning adult green sturgeon frequently can be found aggregating in estuaries along the Pacific coast (Emmett *et al.* 1991). Relatively large concentrations occur in the Columbia River estuary, Willapa Bay, and Grays Harbor, with smaller aggregations in San Francisco Estuary (Emmett *et* al 1991, Moyle *et al.* 1992).

Adult green sturgeon are believed to spawn every two to four years and generally exhibit fidelity to their spawning site. Green sturgeon reach sexual maturity only after several years of growth;

first spawning generally occurs at 15 years of age for males, and 17 years for females. Green sturgeon may migrate long distances upstream to reach spawning habitat. Southern DPS green sturgeon adults typically begin their upstream spawning migrations into the San Francisco Bay by late February to early March, reach Knights Landing by April, and spawn between March and July (Heublein 2006). Peak spawning is believed to occur between mid-April to mid-June and thought to occur in deep, fast water (> 3 m) of large rivers (Emmett *et al*. 1991, Adams *et al*. 2002).

Juvenile green sturgeon spend from one to four years in fresh and estuarine waters before they enter the ocean (Nakamoto *et al*. 1995, Adams *et al.* 2002). Juvenile green sturgeon have been salvaged at the Harvey O. Banks Pumping Plant and the John E. Skinner Fish Facility in the south Delta, and captured in trawling studies by the CDFG during all months of the year (CDFG 2002). The majority of these fish were between 200 and 600 mm indicating they were from 2 to 3 years of age based on Klamath River age distribution work by Nakamoto *et al*. (1995). The lack of a significant proportion of juveniles smaller than approximately 200 mm in the Delta indicates juvenile southern DPS green sturgeon likely hold in the mainstem Sacramento River, as suggested by Kyndard *et al*. (2005). Laboratory studies conducted by Allen and Cech, Jr. (2007) also indicated that juveniles spend approximately the first six months in fresh to brackish water and then transition into salt water at about 1.5 years of age (752 ± 7 mm). At approximately 100 to 170 dph, juvenile green sturgeon were able to tolerate prolonged exposure to salt water, however, there was decreased growth and activity levels, and mortality for some individuals at 100 dph. This data is consistent with the study conducted by Nakamoto *et al.* (1995), which indicated juveniles spend one to four years in fresh and estaurine waters, and disperse into salt water when at lengths of 300-750 mm.

Young green sturgeon appear to rear for the first one to two months in the Sacramento River between Keswick Dam and Hamilton City (CDFG 2002). Juvenile green sturgeon first appear in USFWS sampling efforts at RBDD in June and July at lengths ranging from 24 to 31 mm fork length (CDFG 2002, USFWS 2002). The mean yearly total length of post-larval green sturgeon captured in rotary screw traps at the RBDD ranged from 26 mm to 34 mm between 1995 and 2000 indicating they are approximately 2 weeks old. The mean yearly total length of post-larval green sturgeon captured in the GCID rotary screw trap, approximatley 30 miles downstream of RBDD ranged from 33 mm to 44 mm between 1997 and 2005 (CDFG, unpublished data), indicating they are approximately three weeks old (Van Eenennaam *et al*. 2001).

Both adult and juvenile green sturgeon are primarily benthic feeders (Moyle 2002). Adult green sturgeon are believed to feed mainly upon benthic invertebrates such as clams, mysid and grass shrimp, and amphipods (Radtke 1966, Adams *et al*. 2002), and to some extent on fish. Adult sturgeon caught in Washington State waters were found to have fed on Pacific sand lance (*Ammodytes hexapterus*) and callianassid shrimp (Moyle *et al.* 1992). Dumbauld *et al*. (in prep) noted that large green sturgeon collected in Willapa Bay, Washington in 2003 fed on thalassinid shrimp and fish. Adults captured in the Sacramento-San Joaquin Delta are known to feed on invertebrates such as shrimp, mollusks, amphipods, and additionally upon small fish (Adams *et al.*

2002).

Juvenile green sturgeon in the San Francisco Estuary have been shown to feed on opossum shrimp (*Neomysis mercedie*) and amphipods (*Corophium spp*.) (Moyle 2002). Radtke (1966) examined 74 juvenile southern DPS green sturgeon caught with gill nets and otter trawl in the Delta. *Corophium spp*. appeared to be the most important food of smaller green sturgeon and was the only item found in the eight smaller green sturgeon (190–390 mm) examined in the fall. All those examined in the spring and summer had eaten *Corophium*, which made up over half the volume of their diet during these seasons. *Neomysis awatschensis* (opossum shrimp) was also utilized heavily during spring and summer. Little is known of the behavioral dynamics of these juveniles, such as habitat preference and water column usage; however, based on diet work reported above and feeding morphology, juveniles are presumed to be benthically oriented.

Migratory corridors are downstream of the spawning areas and include the mainstem Sacramento River, delta, and estuary. These corridors allow the upstream passage of adults and the downstream emigration of juveniles. Migratory habitat condition is strongly affected by the presence of barriers which can include dams, unscreened or poorly screened diversions, and degraded water quality. Both spawning areas and migratory corridors are comprised of rearing habitat for juveniles, which feed and grow before and during their one to four year residence in fresh and estuarine waters. Rearing habitat condition and function may be affected by variation in annual and seasonal flow and temperature characteristics.

b. Population Trend – southern DPS green sturgeon

The precise population size of southern DPS green sturgeon is unknown, but is clearly much smaller than the northern DPS, and is, therefore more vulnerable to catastrophic events. Population abundance information concerning the southern DPS green sturgeon is described in the NMFS status reviews (Adams *et al*. 2002, BRT 2005). Limited population abundance information comes from incidental captures of southern DPS green sturgeon from the white sturgeon monitoring program by the CDFG sturgeon tagging program (CDFG 2002). CDFG utilizes a multiple-census or Peterson mark-recapture method to estimate the legal population of white sturgeon captures in trammel nets. By comparing ratios of white sturgeon to green sturgeon captures, CDFG provides estimates of adult and subadult southern DPS green sturgeon abundance. Estimated abundance 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 CDFG does not consider these estimates reliable. Fish monitoring efforts at RBDD and GCID on the upper Sacramento River have captured between 0 and 2,068 juvenile southern DPS green sturgeon per year (Adams *et al*. 2002).

Recent spawning population estimates using sibling-based genetics by Israel (2006b) indicates a maximum spawning population of 32 spawners in 2002, 64 in 2003, 44 in 2004, 92 in 2005, and 124 in 2006 above RBDD (with an average of 71). Based on the length and estimated age of post-

larvae captured at RBDD (approximately two weeks of age) and GCID (downstream; approximately three weeks of age), it appears the majority of southern DPS green sturgeon are spawning above RBDD. Note, there are many assumptions with this interpretation (*i.e*., equal sampling efficiency and distribution of post-larvae across channels) and this information should be considered cautiously.

Juvenile entrainment data from the Sacramento-San Joaquin Delta pumping facilities of the Central Valley Project and State Water Project provide an indication of how green sturgeon abundance has changed since 1968. The estimated average number of green sturgeon entrained each year at the State of California's John Skinner Fish Facility prior to 1986 was 732; from 1986 on, the average number decreased to 47. At the Federal Tracy Fish Collection Facility, the average prior to 1986 was 889; from 1986 to 2001 the average was 32 (70 FR 17386). Additional analysis of fish entrainment at the these fish facilities indicates that take of both southern DPS green sturgeon and white sturgeon per acre-foot of water exported has decreased substantially since the 1960s. Decreases in numbers of green sturgeon entrained in these facilities occurred while water export levels at both facilities have increased substantially (*i.e.* more water was pumped, but fewer green sturgeon were entrained).

Catches of subadult and adult southern DPS green sturgeon by the California Department of Water Resources Interagency Ecological Program (IEP) between 1996 and 2004 ranged from one to 212 green sturgeon per year (212 occurred in 2001), however, the portion of these captures consisting of southern DPS green sturgeon is unknown as the fish were primarily captured in San Pablo Bay which is known to consist of a mixture of northern and southern DPS green sturgeon.

Recent habitat evaluations conducted in the upper Sacramento and Feather Rivers suggest that, as for anadromous salmonids, large amounts of potential spawning habitat were made inaccessible or altered by dams (BRT 2005). Current spawning habitat for green sturgeon has been reduced to a limited area of the upper Sacramento River. There are at least two records of confirmed adult sturgeon observation in the Feather River (Beamesderfer *et al*. 2004). However, there are no observations of juvenile or larval sturgeon even prior to the 1960s when Oroville Dam was built (BRT 2005). There are unconfirmed reports that green sturgeon may spawn in the Feather River during high flow years (CDFG 2002).

While there is no direct record of green sturgeon occurrence in the San Joaquin River upstream of the Delta, indirect evidence has been discussed in a variety of sources (Moyle 2002, Lindley *et al*. 2004). Spawning in the San Joaquin River system has not been recorded, but alterations of the San Joaquin River tributaries (Stanislaus, Tuolumne, and Merced Rivers) and its mainstem occurred early in the European settlement of the region. During the later half of the 1800s, impassable barriers were built on these tributaries where the water courses left the foothills and entered the valley floor. Therefore, these low elevation dams have blocked potentially suitable spawning habitats located further upstream for over a century. Additional destruction of riparian and stream channel habitat by industrialized gold dredging further disturbed any valley floor

habitat that was still available for sturgeon spawning. It is likely that both white and green sturgeon utilized the San Joaquin River basin for spawning prior to the onset of European influence. This assumption is based on past use of the region by populations of Central Valley spring-run Chinook salmon and Central Valley steelhead which require similar spawning habitat to sturgeon. Although these two populations of salmonids have either been extirpated or greatly diminished in their use of the San Joaquin River basin over the past two centuries, their historical presence indicates that suitable spawning habitat for sturgeon once existed, such as clear, deep, cold and cobble-bottom stream reaches.

The most recent status review update concluded that 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 (BRT 2005). Based on this information, the southern DPS green sturgeon was Federally-listed as threatened on April 7, 2006 (71 FR 17757).

B. Critical Habitat Status

1. Salmonid Critical Habitat

Designated critical habitat for Sacramento winter-run Chinook includes the Sacramento River from Keswick Dam in Shasta County (River Mile [RM] 302) to Chipps Island (RM 0) at the westward margin of the Sacramento-San Joaquin Delta; all waters from Chipps Island westward to Carquinez Bridge, including Honker Bay, Grizzly Bay, Suisun Bay, and Carquinez Strait; all waters of San Pablo Bay westward of the Carquinez Bridge; and all waters of San Francisco Bay north of the SFOBB (June 16, 1993, 58 FR 33212). The critical habitat designation identifies physical and biological features of the habitat that are essential to the conservation of the species and that may require special management consideration and protection.

Critical habitat has been designated for Central Valley spring-run Chinook salmon, including approximately 1,150 miles of stream habitat within the Central Valley and an additional 254 square miles of estuarine habitat in Suisun, San Pablo, and San Francisco Bays (70 FR 52488).

Central Valley steelhead designated critical habitat includes approximately 2,317 miles of stream habitat within the Central Valley and an additional 254 square miles of estuarine habitat in Suisun, San Pablo and San Francisco Bays (70 FR 52488).

Critical habitat has been designated for Central California Coast steelhead, including approximately 1,676 miles of stream habitat in central coastal California and an additional 386 square miles of estuarine habitat in San Francisco and San Pablo bays (70 FR 52488).

The condition of salmon and steelhead critical habitat, specifically its ability to provide for their conservation, has been degraded from conditions known to support viable salmonid populations.

NMFS has determined that present depressed population conditions are, in part, the result of the following human-induced factors affecting critical habitat[7]: logging, agricultural and mining activities, urbanization, stream channelization, dams, wetland loss, and water withdrawals, including unscreened diversions for irrigation. Impacts of concern include alteration of streambank and channel morphology, alteration of water temperatures, loss of spawning and rearing habitat, fragmentation of habitat, loss of downstream recruitment of spawning gravels and large woody debris, degradation of water quality, removal of riparian vegetation resulting in increased streambank erosion, loss of shade (higher water temperatures) and loss of nutrient inputs (Busby *et al.* 1996, 58 FR 33212, 70 FR 52488). Water development has drastically altered natural hydrologic cycles in many California streams. 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. Overall, current condition of salmonid critical habitat is degraded, and does not provide the full extent of conservation value necessary for the recovery of these species.

2. Green Sturgeon

Critical habitat was designated for the southern DPS of green sturgeon on October 9, 2009 (74 FR 52300) and includes coastal United States marine waters within 60 fathoms depth from, and including, Monterey Bay, California, north to Cape Flattery, Washington, including the Strait of Juan de Fuca, Washington, to its United States boundary.

The current condition of critical habitat for the southern DPS of green sturgeon is degraded over its historical conditions (71 FR52084, 74 FR 52300). 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 particular, passage 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 the delta and estuary. Loss of individuals during this phase of the life history of green sturgeon represents losses to multiple year classes rearing in the Delta, which can ultimately impact the potential population structure for decades to come.

C. Global Climate Change

Global climate change presents an additional potential threat to salmonids and southern DPS green sturgeon, and their respective critical habitat. Modeling of climate change impacts in California suggests that average summer air temperatures are expected to increase (Lindley *et al*.

[7] Other factors, such as over fishing and artificial propagation have also contributed to the current population status of steelhead. All these human induced factors have exacerbated the adverse effects of natural factors such as drought and poor ocean conditions.

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 is likely to 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 percent to 200 percent) in rainfall amounts while other models show decreases of 15 percent to 30 percent (Hayhoe *et al*. 2004). Many of these changes are likely to further degrade salmonid and southern DPS green sturgeon habitat by, for example, reducing stream flows during the summer and raising summer water temperatures. Estuarine productivity is likely to change based on changes in freshwater flows, nutrient cycling, and sediment amounts (Scavia et al. 2002). In marine environments, ecosystems and habitats important to sub adult and adult salmonids are likely to experience changes in temperatures, circulation and chemistry, and food supplies (Feely et al. 2004, Brewer 2008, Osgood 2008, Turley 2008). The projections described above are for the mid to late 21st Century. In shorter time frames, natural climate conditions are more likely to predominate (Cox and Stephenson 2007, Smith *et al.* 2007).

V. ENVIRONMENTAL BASELINE

The environmental baseline is an analysis of the effects of past and ongoing human and natural factors leading to the current status of the species, its habitat, and the ecosystem in the action area. The environmental baseline includes the past and present impacts of all Federal, State, or private actions and other human activities in the action area, the anticipated impacts of all proposed Federal projects in the action area that have already undergone formal or early section 7 consultation, and the impact of State or private actions which are contemporaneous with the consultation in process (50 CFR §402.02).

A. Environmental Setting in the Action Area

San Francisco Bay is the largest estuary on the west coast of North America. Located about halfway up the California coast from the Mexican border, it is the natural exit point of 40 percent of California's freshwater outflow. California's two largest rivers, the Sacramento and San Joaquin, merge to form the estuary. They drain part of the Sierra Nevada and Cascade mountains and form a large and convoluted delta in the Central Valley. The freshwater runoff in the delta flows seaward, mixing with ocean water through Suisun Bay, San Pablo Bay and lastly San Francisco Bay. San Francisco Bay empties into the Pacific Ocean through the Golden Gate.

The climate is Mediterranean; most precipitation falls in winter and spring as rain throughout the Central Valley and as snow in the Sierra Nevada and Cascades. The freshwater outflow pattern is seasonal; highest outflow occurs in winter and spring. In summer, freshwater inflow to San Francisco Bay is controlled mainly by water released from Central Valley reservoirs.
Ocean conditions affect the estuary. The California Current system dominates California's nearshore ocean environment. Off northern and central California, surface waters are driven south by northwesterly winds in spring and summer and, as a result of Ekman transport of surface water, cold, nutrient-rich water is upwelled to the surface and transported offshore. This creates one of the most productive ocean regions in the world. Ocean temperature is a major factor determining the distribution of fish and invertebrates along the coast and consequently, the marine fauna of the estuary. San Francisco Bay is in a transitional zone containing both cold water species from the north and sub-tropical fauna from the south (Parrish *et al.* 1981). In addition to the longitudinal temperature gradient and seasonal variation due to upwelling, there are large inter-annual temperature differences during El Niño events.

The northern portion of the action area, north of the SFOBB, is located in an area commonly termed the Central Bay. The Central Bay contains many of the bay's deepest areas as well as shallow shoals mainly along the eastern side. The southern portion of the action area, south of the SFOBB, includes the northernmost section of the South Bay. The South Bay has a central channel that narrows southward as well as broad shoals on either side of the channel. The deep channel (deeper than 15 m) running under the SFOBB and east of YBI within the action area is influenced by swift currents (up to three knots or greater) and has a substrate composed of unconsolidated sediments primarily consisting of a deep layer of soft bay mud, clay and silt overlaying the Franciscan Assemblage bedrock. Closer to the shoreline of YBI the substrate transitions shoreward from soft bottom substrate consisting of a pebble and sandy layer to an intertidal hard substrate composed of large boulders and rock and concrete rip-rap. Additionally, located within Coast Guard Cove, along the northeastern side of YBI, shallow subtidal and intertidal habitat exists with patches of eelgrass sparsely distributed. Besides salmonids and green sturgeon, the action area provides habitat within the water column, benthic substrate and shoreline of YBI, for an assemblage of marine algae, fish and macroinvertebrate species, as well as birds and marine mammals.

The disposal site is located near the center of central San Francisco Bay, just south of Alcatraz Island, where strong tidal currents (4 knots maximum) exist. The water depth at the disposal site near Alcatraz Island is 48 feet MLLW. During April, there may be a strong vertical salinity gradient, depending on recent rainfall events, which would result in fresher, lighter water comprising the upper layer of the water column. The sediment at the disposal site near Alcatraz Island historically was likely coarse-grain sediment, but has likely changed due to the deposition of dredged sediment which primarily consists of fine-grain material.

SF-DODS is located in the Pacific Ocean off the continental shelf west of the Farallon Islands in water ranging from 8,200 - 9,840 feet (2,500 - 3,000 meters) deep. The configuration of SFDODS is an oval with major and minor axes of 22,500 feet and 13,500 feet, respectively. The current velocity is about 0.5 knots. The sediment is composed of sand, silt and clay.

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

1. Salmonids

Central San Francisco Bay, including the action area, is within the designated critical habitat for Sacramento River winter-run Chinook salmon. However, the action area does not possess critical habitat for Central Valley spring-run Chinook salmon, and Central Valley steelhead, although they do use it as a migration corridor. Both central and south San Francisco Bay in the action area are designated critical habitat for Central California Coast steelhead (70 FR 52488). PCEs of designated critical habitat for Sacramento River winter-run Chinook, Central Valley spring-run Chinook salmon, Central Valley steelhead, and Central California Coast steelhead in the action area include estuarine areas free of obstruction and excessive predation. Essential features include the estuarine water column, foraging habitat, and food resources used by salmonids (primarily CCC-steelhead in the action area), as part of their juvenile downstream migration or adult spawning upstream migration (58 FR 33212, 69 FR 71880). PCEs within the action area are degraded due to a variety of historical and on-going disturbance, described below. These activities have likely reduced availability of natural cover and forage items for steelhead. Natural cover for CCC steelhead in the action area may exist in eelgrass beds located along YBI if they are still present. Benthic habitat in the action area consists of Bay sand and mud.

The action area within the central bay includes a very small portion of the migratory pathway for the populations of Sacramento River winter-run Chinook salmon, Central Valley spring-run Chinook salmon, and Central Valley steelhead, as well as that portion of the Central California Coast steelhead DPS which spawns in several tributaries of central San Francisco, San Pablo, and Suisun Bays. Within the south bay, all adult and juvenile Central California Coast steelhead migrating from the Guadalupe River, Stevens Creek, San Francisquito Creek, Coyote Creek, Upper Penitencia Creek, Alameda Creek, and possibly San Leandro Creek (Leidy 2000) migrate under the SFOBB.

Returning adult salmon and steelhead migrate from the Pacific Ocean, through San Francisco Bay and upstream to spawning areas of their natal streams. Juvenile salmonids migrate downstream and through the bay, becoming smolts en route to the Pacific Ocean where they rear and become adults. Upstream migrations for adult steelhead and winter-run Chinook salmon through the bay typically begin in early December. Adult spring-run Chinook salmon migrate upstream through the bay during the spring months. Steelhead and Chinook salmon smolts migrate downstream through the bay during the late winter and spring months.

Historically, the tidal marshes located downstream of the confluence of the Sacramento and San Joaquin Rivers to the entrance of San Francisco Bay provided a highly productive estuarine environment for juvenile anadromous salmonids. During the course of their downstream migration, juvenile salmon and steelhead may still utilize the estuary for seasonal rearing, although recent data suggest that migration to the sea is rapid. This tendency to rapidly move through the estuary is contrary with salmonid migration in estuaries located at higher latitudes, as well as some of the coastal lagoon estuaries located along the central and northern California coast. MacFarlane and Norton (2002) found that juvenile Central Valley fall-run Chinook salmon travel downstream at a rate of approximately 1.6 km/day between Chipps Island (River Kilometer [RK] 68) and the Golden Gate Bridge (RK 3). Other findings from their research indicate that these fish: 1) show little increase in mean length or weight while in the estuary, suggesting that feeding and rearing activities in the estuary replace energy spent reaching the ocean; 2) their condition declined in the estuary, but improved markedly upon entering the ocean; and 3) whole body and organ contaminant concentrations showed a slight increase as the fish migrate from the delta through the bay, but body burden levels were well below published concentration levels that would be expected to cause chronic toxicity problems. Therefore, NMFS assumes that juvenile Chinook salmon present within the estuary are primarily transiting quickly out to sea, and not utilizing the bay as rearing habitat. Additionally, data suggest that migrating Central Valley fall-run Chinook salmon juveniles tend to occupy the deeper, more centrally located, channels during their outmigration (Jahn 2004).

Information regarding the size and timing of anadromous salmonid migrations through the action area is also available from CDFG's San Francisco Bay Study. Between 1980 and 1995, the San Francisco Bay study sampled several open water locations within the original action area for the 2001 BO with midwater trawls, bottom (otter) trawls, and beach seines (Baxter *et al*. 1999). The results of this study indicate that juvenile Chinook salmon are distributed within the Central Bay (and also likely found within the action area due to close proximity of sampling locations) during the period between January and June, and generally absent between June through November. However, the percentage of the population likely to be found between January and June within the action area is thought to be very low relative to the whole population, based on Chinook salmon adult run timing.

2. <u>Green Sturgeon</u>

As with salmonids, information regarding the spatial and temporal distribution of green sturgeon in the estuary is available from CDFG's San Francisco Bay Study. Between 1980 and 1995, the San Francisco Bay Study sampled several stations each month using midwater and bottom trawls (Baxter *et al*. 1999). The data show that most green sturgeon collected by trawls in the estuary range from about 200 to 1200 mm in length. However, the trawling methods used are not designed to adequately sample sturgeon, and therefore cannot be used to accurately estimate abundance of this species.

San Francisco Bay is within the range of designated critical habitat for southern DPS green sturgeon. It serves as an important habitat for all lifestages, as it supports rearing and serves as an important migratory/connectivity corridor between the Sacramento River system and nearshore coastal marine waters. Juveniles (1-4 years of age) and subadults (from 4 to 9 years of age for males, and 4 to 13 years of age for females) are believed to be present in the bay throughout the year (CDFG 2002), including the action area. These lifestages utilize the action area for rearing and migration. Adults likely occur within tidally influenced areas of the sloughs surrounding the Bay, but may also be present year-round in the estuary and action area depending on reproductive status. Pre-spawning adults could be present from February through May, post-spawned adults could be present October through January, and non-spawning adults may be present June through October. Adults may utilize the action area as a migration corridor and for foraging.

C. Factors Affecting the Species and Critical Habitat in the Action Area

Profound alterations to the environment of the San Francisco Bay estuary, including the action area, 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 area, 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 following describes, in general, the human activities that have affected these fish and their habitats, including: 1) altered flows from dam construction and water development; 2) land use activities and urban development; 3) industrial and urban pollution; 4) dredging and related shipping activity; 5) introduction of non-native species; 6) ecosystem restoration; and 7) impacts of construction from the SFOBB East Span Seismic Project to date.

1. Dam Construction and Water Development

Hydropower, flood control, and water supply dams of the Central Valley Project, State Water Project, and other municipal and private entities have affected water quantity, timing, and quality in San Francisco Bay, including in the action area. Altered stream flows and inflow through the Delta and Carquinez Strait have affected the natural cycles by which salmonids and green sturgeon base their migrations. The seasonal distribution of freshwater inflow differs in that the magnitude and duration of peak flows during the winter and spring are significantly reduced by water impoundment in upstream reservoirs. Salmonids and green sturgeon need sufficient freshwater flow within the bays and estuaries adjacent to the Sacramento River (*i.e.*, the Sacramento–San Joaquin Delta, and the Suisun, San Pablo, and San Francisco Bays [including the action area]) to allow adults to successfully orient to the incoming freshwater flow and migrate upstream to natal spawning grounds. Overall, present day water management practices in the

Central Valley reduce natural flow variability by creating more uniform flows year-round that diminish migratory cues, natural channel formation, and food web functions.

2. Land Use Activities and Urban Development

Historically, the tidal marshes of San Francisco Bay provided a highly productive estuarine environment for juvenile anadromous fish species. Returning adult salmonids and green sturgeon navigate their way through San Francisco Bay, including in or near the action area, as they seek the upstream spawning grounds of their natal streams. Juvenile salmonids primarily use the bay as a migratory pathway during their outmigration to the Pacific Ocean. However, non-spawning adults, subadults and juvenile green sturgeon may utilize the estuary year-round for foraging habitat, rearing, and also as a migration corridor to the sea. Land use activities since the 1850's associated with urban, industrial, and agricultural development have altered fish habitat quality in the Bay, such as destruction of eelgrass beds or degradation of water quality, and contributed to declines in fish populations.

Urbanization has been a major influence on the land surrounding the estuary. In the past 150 years, the diking and filling of tidal marshes have decreased the surface area of San Francisco Bay by 37 percent. More than 500,000 acres of the estuary's historic tidal wetlands have been converted to farms, salt ponds, and urban uses. Less than 45,000 acres of the estuary's historic tidal marshes remain intact, a reduction of 92 percent (San Francisco Estuary Project 1992). Today, nearly 30 percent of the land in the nine counties surrounding San Francisco Bay is urbanized. The increase in urban land reflects the growth of the human population. There are now more than 7.5 million individuals living in the bay area, making the region the fourth most populous metropolitan area in the United States. These changes have reduced the acreage of valuable farm land, wetlands, and riparian areas, and have increased pollutant loadings to the estuary. Non-point sources of pollution, such as urban and agricultural runoff, continue to degrade water quality in the bay, including the action area. While the action area encompasses a small area of the entire bay, the distribution of tidal currents, volume and flow of water throughout the bay influences the transport of pollutants. Consequently contaminants originating miles away from the bay are often mixed throughout the estuary. These contaminants may impair the physiological development of salmonid smolts and juvenile green sturgeon, which would reduce their survival potential during later life history phases.

Additionally, installation of docks, shipping wharves, marinas, and miles of rock rip-rap for shoreline protection has also contributed greatly to habitat degradation within the estuary. Correlated with the increase in bay area development, is an increase in marine/ocean vessel traffic transiting through the bay, including the action area. Increased marine traffic is also responsible for more pollutants to enter bay waters (*e.g.* oil spills) as well as disturbance to estuarine species resulting from elevated noise levels within the air and estuarine waters of the bay. Thus, the majority of factors associated with land use activities and urban development contribute to the continued degradation and loss of habitat for anadromous fish species within the bay and action

area.

3. Industrial and Urban Pollution

Industrial, municipal, and agricultural wastes have been discharged into the waters of San Francisco Bay with major historical point sources including agricultural wastes primarily from the Central Valley, wastes from fish, fruit and vegetable canneries, and municipal sewage. Additionally, mining activities occurring in the 19th century contributed to a substantial increase in sediment deposition and residues leaching from abandoned mines in the lower portion of the estuary. Associated with this sediment were high levels of mercury, which was used to help extract gold. Contaminants in sediment located along the San Francisco Port's waterfront contain elevated levels of polycyclic aromatic hydrocarbons (PAHs), a possible result from the use of creosote-treated wood piles in the construction of the piers that line San Francisco's waterfront. In addition, Dillon and Moore (1990) reported that major pollutant sources for San Francisco Bay include the freshwater flow from the Sacramento-San Joaquin River systems, over 50 waste treatment plants, and about 200 industries which are permitted to discharge directly into the bay (citing Luoma and Phillips 1988).

Many of these contaminants have been found in the tissue of fish inhabiting the estuary, prompting the California Department of Health to issue warnings regarding consumption of fish from within the estuary. Although salmonids and spawning adult green sturgeon are migratory through the action area, they do forage during this migration and therefore are subjected to the contaminants found in their prey. Additionally, theses contaminants may impair the physiological development of salmonid smolts and juvenile green sturgeon, which would reduce their survival potential during later life history phases. Moreover, since sturgeon are long-lived, and a large species, they are likely to bioaccumulate high levels of contaminants during their lifespan.

Although large-scale pollution of the estuary was partially relieved by the passage of the Clean Water Act in 1972, resulting in the construction of sewage treatment plants in all cities surrounding the Bay, non-point sources of pollution, such as urban runoff, continue to degrade water quality in the Bay, including the action area.

4. Dredging and Disposal

Hydraulic dredging is a common practice within the San Francisco Bay to maintain water depths suitable for navigation for both private and commercial vessel traffic. Such dredging operations use a cutterhead dredge pulling water upwards through intake pipelines, past hydraulic pumps, and down outflow pipelines to disposal sites placing benthically-oriented fish such as green sturgeon at risk. In addition, dredging operations can re-suspend contaminants and elevate toxics such as ammonia, hydrogen sulfide, and copper and may result in impacts through changes in bathymetry (NMFS 2006). NMFS is concerned about chronic effects that may occur as a result of the uptake of contaminants by green sturgeon during juvenile rearing and during both adult and

juvenile migration through the bay. Studies on white sturgeon in estuaries indicate that the bioaccumulation of pesticides and other contaminants adversely affects growth and may result in decreased reproductive success, green sturgeon are believed to experience similar risks from contaminants (73 FR 52084). Because salmonids do not spend long time periods in the Bay, they are less likely to experience these impacts.

The action area is located within a main navigation channel between the central and south San Francisco Bay, and near YBI and the Coast Guard Station at Coast Guard Cove. Therefore, this area has likely been subjected to maintenance dredging activities more frequently than other areas in the Bay in order to accommodate draft requirements for vessels. For this reason, the deep channel within the action area presumably possesses degraded habitat, due to frequent disturbance. Since all adult and juvenile Central California Coast steelhead migrating from tributaries to the south Bay (Guadalupe River, Stevens Creek, San Francisquito Creek, Coyote Creek, Upper Penitencia Creek, Alameda Creek, and possibly San Leandro Creek [Leidy 2000]) migrate under the SFOBB, they may have experienced greater risk of exposure to dredging activities, especially if dredging was conducted during a time of year when they were migrating under the SFOBB. Similarly, some green sturgeon may pass under the SFOBB and be subject to the same risks as CCC steelhead.

5. Introduction of Non-Native Species

As native fishes in the San Francisco Bay-Delta estuary became depleted in the late 19th Century, non-native species were brought to the bay and delta including American shad, striped bass, common carp, and white catfish. As their populations boomed, those of native fishes declined further. Introduction of non-native species accelerated in the 20th Century through deliberate introductions of fish; and unintended introductions of fish and invertebrates occurred from the release of ballast water from ships returning from foreign ports. Establishment of non-native species was probably facilitated by altered hydrologic regimes and reduction in habitats for native species. The introduction and spread of non-native species throughout the San Francisco Bay-Delta estuary has affected many native species, including listed salmonids (Cohen and Carlton 1995), and presumably green sturgeon, through predation and competition for food and habitat.

As currently seen in the San Francisco estuary, non-native invasive species can alter the natural food webs that existed prior to their introduction. Perhaps the most significant example is illustrated by the Asiatic freshwater clams *Corbicula fluminea* and *Potamocorbula amurensis*. The arrival of these clams in the estuary disrupted the normal benthic community structure and depressed phytoplankton levels in the estuary due to the highly efficient filter feeding of the introduced clams (Cohen and Moyle 2004). The decline in the levels of phytoplankton reduces the population levels of zooplankton that feed upon them, and hence reduces the forage base available to juvenile salmonids and green sturgeon transiting within the estuary, including those transiting the action area. A reduction in feeding can adversely impact the health and

physiological condition of these fish species as they rear and migrate through the estuary to the Pacific Ocean.

6. Ecosystem Restoration

Preliminary, significant steps towards the largest ecological restoration project yet undertaken in the United States have occurred during the past ten years in California's Central Valley. The CALFED Bay-Delta Program and the Central Valley Project Improvement Act's Anadromous Fish Restoration Program, in coordination with other Central Valley and Bay Area efforts, have implemented habitat restoration actions, including stream and wetland restoration projects, in close proximity to the action area. Restoration of wetland areas typically involves flooding lands previously used for agriculture, thereby creating additional wetland areas and rearing habitat for juvenile salmonids, green sturgeon, other fish species, and birds. Restoration of streams usually entails reducing erosion and sediment entry to the streams and enhancing riparian canopy and instream habitat. We anticipate these restoration projects will improve the habitat conditions for these animal species throughout the Bay, and thereby lead to potential increases in species numbers and distribution in the action area.

7. Impacts of construction from the SFOBB East Span Seismic Project to Date

a. Pile Driving

Pile driving associated with the construction of the SFOBB has occurred intermittently since the project's inception within the action area. Both permanent and temporary piles, ranging in size and installation methods, have been installed since 2003. Monitoring requirements for the installation of the large diameter (2.5 and 1.8 m) permanent piles, primarily for piles installed for the SAS Marine Foundations E2/T1, Skyway Structure, and Oakland Approach Structure required a caged fish hydroacoustic study and monitoring program, referred to as the Fisheries and Hydroacoustic Monitoring Program. The first phase of the monitoring project occurred during construction in November 2003 through January 2004. The second phase occurred during September 2004 through October 2004. Data from the reports show that caged fish[8] (shiner surfperch) immersed in water within the action area during pile driving suffered barotrauma effects, with 71 percent of the fish examined showing injuries to swim bladders and kidneys after exposure to unattenuated peak sound pressure levels (SPLs) between 207 and 209 decibels (dB) re one micropascal (re: 1µ Pa) (Illingworth and Rodkin 2004). Additionally, approximately 100 fish (perch and anchovies) that floated to the surface during piscivorous bird monitoring were collected and examined. These fish exhibited severe injuries to internal organs, including ruptured swim bladders as a result of exposure to unattenuated SPLs from pile driving. The report also noted that several hundred more fish were taken by gulls. However, the study did show use

[8] The caged fish monitoring study originally included the use of caged steelhead from the CDFG Nimbus hatchery. However due to excessive mortalities (95%) within the steelhead treatment groups, steelhead could not be included in analyses for the study.

of a bubble curtain for sound attenuation did in fact reduce peak SPLs, effectively reducing dB levels to 150 dB (re: 1µ Pa) at the 4,400 meter compliance criterion for the original project.

Similarly, more recent reports submitted for the hydroacoustic monitoring period during the installation of temporary towers D and F of the SAS also indicate fish mortality and bird predation/foraging occurrences resulting from high SPLs during unattenuated sound impact hammer pile driving activities. During the driving of the piles at Temporary Tower D, measurements were taken for the largest piles installed (42-inch diameter piles) on June 23, 2008. Piles driven with the Menck MHU 500T impact hammer were driven without any sound attenuation and resulted in the maximum peak of 217 dB peak (re: 1µ Pa) and 191 dB sound exposure level (SEL) at 20 meters north, and 206 dB peak (re: 1µ Pa) and 179 dB SEL (re: 1µ Pa^2-sec) at 135 meters north. In the initial project proposal for the SFOBB East Span Seismic Project, Caltrans and NMFS anticipated the temporary piles required to build falsework would be substantially smaller than the permanent piles (18 to 24 inches in diameter), and therefore SPLs would be lower and not at levels injurious to fish. However, changes to the project during the course of various planning phases resulted in plans consisting of more temporary piles than anticipated, and piles twice as large as what was originally proposed (42 to 48-inch diameter piles). Unfortunately this increase in number and size did not result in any sound attenuation methods being developed for the piles. Therefore, sound attenuation was not incorporated for the installation of in-water temporary piles required for falsework necessary to construct the Marine Foundations E2/T1, Skyway Structure, Oakland Approach Structure and most recently the temporary towers (D, F, and G) for the SAS. Fish kills have been documented as occurring as a result of pile driving within the action area (Garcia and Associates 2008, 2009). Although no records of listed salmonids or green sturgeon have been reported by Caltrans, there have been observations of mortality, incapacitation and stunning of other fish species during monitoring activities concurrent with pile driving. Given that many of these fish are forage species, these incidents of impacts effectively degraded anadromous fish habitat quality within the action area by decreasing the availability of food resources as well as exposing salmonids and green sturgeon to increased risk of injury as a result of high SPLs. Moreover, since monitoring of pile driving activities occurred for only 10 percent of the time, the possibility exists of unrecorded impacts to listed anadromous fish. Additionally, some temporary piles were driven during peak salmonid migration periods (December through May).

The remaining piles for temporary falsework needed to construct Temporary Tower G at YBI were driven into place between March 4, 2009 and May 15, 2009. As described in the April 10, 2009, supplemental biological opinion, NMFS developed a reasonable worst case scenario for the effects of this pile driving for temporary falsework at YBI on listed salmonids and green sturgeon. In summary, that reasonable worst case scenario assumed: 1) twenty-five percent of the CCC steelhead population migrate to the east side of YBI en route to and from the Golden Gate; 2) juvenile, subadult and non-spawning adult green sturgeon could be present in the action area year-round; 3) roughly two percent of adult green sturgeon spawners could be present in the action area February through May; 4) remaining pile driving will occur in areas greater than five meters deep

during peak migration periods for spawning CCC adult steelhead (February through May,) and for spawning adult green sturgeon (February through May); 5) a maximum of three piles will be installed per day (with an impact hammer) intermittently over the course of four months; and 6) some pile installation will occur at night. The 4982 m diameter of the impact area corresponding to the 206 peak dB and 187 SEL during that phase of construction was the greatest distance considered due to the maximum peak dB level obtained from initial hydroacoustic measurements during the construction of Temporary Tower D. With these assumptions, we expected roughly two percent of the outmigrating juvenile and post-spawned adult population of steelhead originating from south San Francisco Bay tributaries were likely to be injured or killed by sound pressure levels exceeding 206 dB (re: 1 µPa), 187 SEL (re: 1 µPa^2-sec) during the remaining pile driving in 2009. We also estimated that a small number of juvenile, subadult, and adult spawning green sturgeon were likely to be injured or killed by these sound pressure levels.

Results from Caltran's hydroacoustic and biological monitoring indicate that the maximum sound pressure levels expected did not extend beyond the area of impact analyzed in the April 10, 2009, biological opinion during pile driving for temporary falsework at YBI. However, additional fish kills did occur (*e.g.*, pacific herring [*Clupea pallasii*]) as documented in the reports submitted for hydroacoustic and biological monitoring, taken during the installation of Temporary Tower G between March 4 and May 19, 2009. Hydroacoustic measurements taken during the installation of the 42 and 48-inch diameter piles indicate that SPLs ranged from 166-223 peak dB (re: 1 µPa), at both deep and shallow water sensors out from 500 m in to 14 m distances from the piles. Accumulated SELs ranged between 176 -226 dB (re: 1µ Pa^2-sec) at distances out from 560 m in to 17 m, respectively. On July 23, 2009, NMFS received notification from Caltrans that during impact hammer pile driving on May 7, 2009, pacific herring were killed, and the biological monitoring reports submitted for other monitored pile driving events document several other bird predation events. However, as with the installation of Temporary Towers D and F, Caltran's biologists did not see any injury or mortality for ESA-listed fish species. Based on this information, and the lack of anadromous dead fish sighted by Caltrans' biological monitors during this pile driving, NMFS assumes the losses of listed species during this pile driving were as described in the April 10, 2009, BO. Incidental take was expected for no more than two percent adult and juvenile CCC steelhead, and adult spawning green sturgeon, and for only a very small number of juvenile, subadult and non-spawning adult green sturgeon.

Similarly, during the installation of twenty-two 36-inch diameter steel piles for the construction of the T1 Temporary Access Trestle for the SAS, the biological monitors observed a small amount of bird strikes during one pile driving event. However, no ESA-listed fish were observed. Although there were some problems encountered with implementation of the bubble curtain (likely due to slope and substrate), due to the timing and short duration of this pile driving event and location, and no observed injuries or mortality of ESA-listed fish species in the action area, NMFS assumes that any losses that may have occurred were as described in the August 21, 2009 BO.

b. Dredging

Near the Oakland shore, dredging was required for the SFOBB East Span Seismic Project for barge access, foundation construction, and pile cap construction. The barge access channel is located on the north side of the new, replacement bridge. The material was disposed of at the deep ocean disposal site (SF-DODS), approximately 50 nautical miles west of the Golden Gate Bridge; thus, no impacts to anadromous fish or their habitat were likely from dredge disposal due to the location and depth of the site. However, disturbance to aquatic substrate including eelgrass beds within the original action area occurred as a result of project activities. As part of the habitat restoration mitigation for this project, Caltrans proposed mitigation for impacts to special aquatic sites in the intertidal areas just to the north of the Oakland Touchdown, and at off-site locations. Caltrans, in coordination with NMFS Restoration Center and Habitat Conservation Division are currently working on these projects to ensure that success criteria has or will be met and will provide benefits to anadromous fish, primarily steelhead and possibly green sturgeon. The restoration approach is distinct from the creation of new eelgrass habitat in that it focuses on restoring areas that are historically known to have supported eelgrass habitat. Caltrans and NMFS intend that this approach maximize the potential for planting success by incorporating site manipulation, monitoring and data collection.

VI. EFFECTS OF THE ACTION

The remaining bridge demolition and dredging activities for the SFOBB East Span Seismic Safety Project are expected to result in short-term adverse effects to listed salmonids, primarily Central California Coast (CCC) steelhead, and southern DPS green sturgeon, and their respective critical habitats. For the three listed salmonid ESUs originating from the Central Valley (Central Valley steelhead, Central Valley spring-run Chinook salmon, Sacramento River winter-run Chinook salmon), NMFS expects that adult fish generally remain on the north side of San Francisco Bay after entering the estuary through the Golden Gate, migrating rapidly around Angel Island and through San Pablo Bay towards the Delta and their natal Central Valley streams. Although a few adult salmon have been recorded feeding near YBI in the summer, the number of adults that uses this area is likely small. For salmonid smolts originating from Central Valley streams, it is generally thought that they, too, utilize the north side of the Bay as their primary migration corridor (MacFarlane and Norton 2002, Jahn 2004). The analyses of impacts on salmonids and green sturgeon from prior construction activities are reported above in the Environmental Baseline, and are included below and in our integration and synthesis of effects.

A. Dismantling of the Existing Bridge

1. Pile Driving and Underwater Sound Pressure

a. Impacts on Fish

The underwater sound pressure waves that have the potential to adversely affect listed anadromous fish species originate with the contact of the hammer with the top of the steel pile. The impact of the hammer on the top of the steel pile causes a wave to travel down the pile and causes the pile to resonate radially and longitudinally like a gigantic bell. Most of the acoustic energy is a result of the outward expansion and inward contraction of the walls of the steel pipe pile as the compression wave moves down the pile from the hammer to the end of the pile buried in the bay bottom. Water is virtually incompressible and the outward movement of the pipe pile (by a fraction of an inch) followed by the pile walls pulling back inward to their original shape, sends an underwater pressure wave propagating outward from the pile in all directions. The steel pipe pile resonates sending out a succession of waves even as it is pushed several inches deeper into the bay bottom.

In 2004, NMFS, FHWA and Caltrans formed the Fisheries Hydroacoustic Working Group (FHWG) to address the issue of potential impacts to listed species from exposure to underwater sounds produced by pile driving. As a result of this, Caltrans contracted with prominent experts in the field of underwater acoustics to review existing literature and conduct research on the effects of underwater sound on fish (Hastings and Popper 2005, Popper 2006). At a FHWG meeting in Vancouver, Washington in June 2008, an Agreement in Principle between NMFS, Caltrans and others was reached regarding the establishment of interim thresholds to be used to assess physical injury to fish exposed to underwater sound produced during pile driving. Specifically, this included a single strike peak SPL of 206 dB (re: 1 μPa) and an accumulated SEL of 187 dB (re: 1 μPa ^{2}sec) for fish greater than 2 grams or 183 dB (re: 1 μPa ^{2}sec) for fish less than 2 grams. The decision to include the SEL metric along with peak dB SPL metric was based upon the primary rationale that this SEL metric provided a way to sum the energy over multiple impulses, which cannot be accomplished with peak pressure. Using SEL, the exposure of fish to a total amount of energy (*i.e*. dose) can be used to determine a physical injury response. If either threshold is exceeded, then physical injury is assumed to occur. There is uncertainty as to the behavioral response of fish to high levels of underwater sound produced when driving piles in or near water. Based on the information currently available, and until new data indicate otherwise, NMFS believes a 150 dB root-mean-square pressure (RMS) threshold for behavioral responses for salmonids and green sturgeon is appropriate.

Fish may be injured or killed when exposed to elevated underwater sound pressure levels generated by steel piles installed with impact hammers. Pathologies to fish associated with very high sound levels are collectively known as *barotraumas*. Barotraumas are pathologies associated with exposure to drastic changes in pressure. These include hemorrhage and rupture of internal organs, including the swim bladder and kidneys in fish. Death can be instantaneous, occur within minutes after exposure, or occur several days later. Gisiner (1998) reports swim bladders of fish can perforate and hemorrhage when exposed to blast and high-energy impulse noise underwater. If the swim bladder bursts and the air escapes from the body cavity or is forced out of the pneumatic duct, the fish may sink to the bottom. If the swim bladder bursts but the air stays inside the body cavity, the fish is likely to stay afloat but have some difficulty in maneuvering or

maintaining orientation in the water column. With salmonids, the swim bladder routinely expands and contracts as they swim near the surface or swim in deeper water near the bottom. At high sound pressure levels of pile driving, the swim bladder may rapidly and repeatedly expand and contract, hammering the internal organs that cannot move away since they are bound by the vertebral column above and the abdominal muscles and skin that hold the internal organs in place below the swim bladder (Gaspin 1975). This pneumatic pounding may result in the rupture of capillaries in the internal organs as indicated by observed blood in the abdominal cavity, and maceration of the kidney tissues. The pneumatic duct, which connects the swim bladder with the esophagus, may not make a significant difference in the vulnerability of the salmonids since it is so small relative to the volume of the swim bladder (Gaspin 1975). Green sturgeon are likely to suffer similar effects to those of salmonids since they possess similar anatomy and physiology (*e.g.*, physostomous[9] swim bladder). More recent research shows Chinook salmon can experience a range of physical injuries when exposed to SPLs beginning at 203 dB SEL (re: 1µ Pa^2-sec) (Halvorsen *et al*. 2011).

Fish can also die when exposed to lower sound pressure levels if exposed for longer periods of time. Hastings (1995) found death rates of 50 percent and 56 percent for gouramis (*Trichogaster sp.*) when exposed to continuous sounds at 192 dB (re: 1 µPa) at 400 Hz and 198 dB (re: 1 µPa) at 150 Hz, respectively, and 25 percent for goldfish (*Carassius auratus*) when exposed to sounds of 204 dB (re: 1 µPa) at 250 Hz for two hours or less. Hastings (1995) also reported that acoustic "stunning," a potentially lethal effect resulting in a physiological shutdown of body functions, immobilized gourami within eight to thirty minutes of exposure to the aforementioned sounds.

High sound pressure levels can also result in hearing damage to fish (Carslon *et al*. 2007). Structural damage to the fish inner ear by intense sound has been examined by Enger (1981) and Hastings *et al.* (1995, 1996) with scanning electron microscopy. Hastings *et al.* (1996) found destruction of sensory cells in the inner ears of oscars (*Astronotus ocellatus*) four days after being exposed to continuous sound for one hour at 180 dB (re:1 µPa) at 300 Hz. Hastings (1995) also reported that 13 out of 34 goldfish exposed for two hours to sound pressure levels ranging from 192 to 204 dB (re:1 µPa) at either 250 or 500 Hz experienced equilibrium problems that included swimming backwards and/or upside down and wobbling from side to side. These fish recovered within one day suggesting that the damage was not permanent. This fish behavior could have been caused by post-traumatic vertigo (lack of balance and dizziness caused by a problem in the inner ear) similar to that experienced by humans after a severe blow to the body or head.

Additional detrimental effects on fish from loud sounds include stress, increasing risk of mortality by reducing predator avoidance capability, and interfering with communication necessary for navigation and reproduction. Scholik and Yan (2001) reported temporary threshold shifts for

[9] Physostomous fish are those species that possess swim bladders connected to the esophagus by a thin tube called the *ductus pneumatucus*. Gas pressure (air) is regulated in these fish by swallowing air to fill the swim bladder or releasing it into the gut through the tube.

fathead minnows (*Pimephales promelas*) exposed to 24 hours of white noise with a bandwidth of 300 – 4000 Hz and overall sound pressure level of only 142 dB (re:1 μPa). Their results indicated that the effects could last longer than 14 days. Even if threshold shifts do not occur, loud sounds can mask the ability of aquatic animals to hear their environment, thus increasing their vulnerability to predators or ability avoid areas that may pose safety risks and possibly affect migration behavior.

Pile driving and the resulting underwater sound pressure may result in "agitation" of salmonids and green sturgeon indicated by a change in swimming behavior detected by Shin (1995) with salmonids, or "alarm" detected by Fewtrell *et al.* (2003). Salmonids and green sturgeon may exhibit a startle response to the first few strikes of a pile. The startle response is a quick burst of swimming that may be involved in avoidance of predators (Popper 1997). A fish that exhibits a startle response may not necessarily be injured, but it is exhibiting behavior that suggests it perceives a stimulus indicating potential danger in its immediate environment. However, fish do not exhibit a startle response every time they experience a strong hydroacoustic stimulus. From the recent pile driving studies along the west coast, biologists have observed that fish may startle and swim away from the stimulus at the start of pile driving, but that they observed the fish to recover, and in some cases turn around and pass by the area of impact multiple times (M. Molnar, pers. comm. 2011). Thus a ramping up of the hammer during the initial phase of pile driving is not necessarily suitable or reliable fish avoidance or minimization measure as has been proposed in some pile driving projects.

A study in Puget Sound, Washington suggests that pile driving operations disrupt juvenile salmon behavior (Feist *et al*. 1992). Though no underwater sound measurements are available from that study, comparisons between juvenile salmon schooling behavior in areas subjected to pile driving/construction and other areas where there was no pile driving/construction indicate that there were fewer schools of fish in the pile-driving areas than in the non-pile driving areas. The results are not conclusive but there is a suggestion that pile-driving operations may result in a disruption in the normal migratory behavior of the salmon in that study, though the mechanisms salmon may use for avoiding the area are not understood at this time. Since green sturgeon share similar migration patterns to those of Chinook salmon, it is reasonable to assume that similar behavioral patterns would result from pile driving operations for green sturgeon.

b. Assessment of Project Pile Driving Effects

The results of the above pile driving projects and information available in the literature are helpful in assessment of the potential effects of pile driving associated with bridge demolition activities for the SFOBB East Span Seismic Project, but considerable uncertainty remains. Effects on an individual fish during pile driving at the SFOBB East Span Seismic Project will be dependant on a number of variables associated with environmental conditions at the project site and variables associated with the specific construction schedule, including:

1. Size and force of the hammer strike
2. Distance from the pile
3. Depth of the water around the pile
4. Depth of the fish in the water column
5. Amount of air in the water
6. The texture of the surface of the water (size and number of waves on the water surface)
7. Bottom substrate composition and texture
8. Size of the fish
9. Species of fish
10. Presence of a swim bladder
11. Physical condition of the fish
12. Effectiveness of bubble curtain and/or other sound pressure attenuation technology

Studies researching the effectiveness of bubble curtains or other sound attenuation devices have indicated that in many cases, sound pressure levels can be decreased effectively by 10 dB or more if properly implemented. Caltrans will use specially designed bubble curtains for sound attenuation during impact pile driving (excluding pile proofing). Therefore, an estimation of sound pressure levels derived from current data for pile driving with the use of sound attenuation will be used to assess the potential area of impact during situations when the maximum sound pressure levels are anticipated to occur. Sound estimates for pile proofing and impact hammering of the H-piles will be analyzed assuming no sound attenuation methods will be implemented.

As stated above, a dual metric criteria of 206 dB (re: 1 µPa) peak SPL for any single strike and an accumulated SEL of 187 dB (re: 1 µPa ^{2}-sec) are currently used by NMFS and Caltrans as thresholds to correlate physical injury to fish greater than 2 grams in size from underwater sound produced during the installation of piles with impact hammers. As distance from the pile increases, sound attenuation from geographical spreading and transmission loss reduces sound pressure levels and the potential harmful effects to fish also decrease. Disturbance and noise associated with construction at the pile driving site may also startle fish and result in dispersion from the action area. Currently, there is very little data available regarding effects of pile driving directly focused on green sturgeon. However, during the construction of the Benicia-Martinez Bridge in 2002, unattenuated piles driven with a large impact hammer did result in the mortality of a white sturgeon. The piles for the bridge piers were 2.5-m diameter steel piles, with each pier consisting of about eight piles each. Piles were driven in water about 12 and 15 m deep in the main channel. Peak underwater sound pressure levels ranged from 227 dB (re: 1 µPa) at approximately five meters from the pile to 178 dB at approximately 1,100 m from the pile (Illingworth and Rodkin 2007, D. Woodbury, pers. comm. 2012).

Water depth at the pile driving site will also influence the rate of sound attenuation. In deep water areas high sound pressure waves are likely to travel further out into San Francisco Bay than they would otherwise travel if encapsulated within an air bubble curtain, or conducted within a dewatered cofferdam, thereby resulting in adverse impacts to salmonids and green sturgeon over a

larger area. In contrast, within shallow water, much of the acoustic energy is expected to be absorbed by the bottom and reflected off the surface back down to the bottom and even backwards towards the pile. Thus, the rate of attenuation is much higher in shallower water and the expected area of adverse effects is expected to be reduced. The bridge demolition and dredging activities associated with the SFOBB East Span Seismic Project are located in an area of strong tidal currents, and the majority of temporary piles to be installed for bridge dismantling are expected to occur in waters greater than 5 m deep (15 to 25 m), and therefore may have less sound propagation loss resulting in acoustic energy reaching greater distances from the pile driving area. Only along the southeast side of YBI where the H-piles are to be installed are water depths shallow enough (0-3 meters) that sound is not expected to travel great distances into the deeper water column if unattenuated. Without minimizing sound propagation through attenuation measures such as a bubble curtain or other means, sound pressure levels are expected to travel greater distances and these deeper channel areas are the known migration corridors for CCC steelhead to and from south Bay tributaries, and are likely migration corridors for both adult and juvenile green sturgeon traveling between natal streams in the Sacramento River Delta and the Golden Gate Bridge. Therefore, the specific construction schedule determined by the contractor will also greatly influence the level of potential impact on listed CCC steelhead and green sturgeon. If the contractor drives the deeper water piles during the summer and fall months, between June and November, no listed salmonids are expected to be impacted. Juvenile, subadult, and both adult spawners and non-spawning green sturgeon however, could be present in the project area. Tracking studies conducted in the San Francisco Bay by CALFED (NMFS and the University of California at Davis collaboration) recorded three adult green sturgeon within or near the action area. They were recorded near a monitor at Pier 30 in May and August 2007 and February 2009 (California Fish Tracking Database, unpublished data 2011). Two of these fish were recorded in the Sacramento River before and after they transited the Bay, suggesting that these were spawning adults (California Fish Tracking Database, unpublished data 2011). The third fish was only recorded in the Bay and is believed to be a non-spawning summer resident. Since the specific construction schedule and sequence of pile driving and pile "proofing" activities has not been precisely established at this time, and due to limited information on the percentage of green sturgeon likely to be within the action area, the vulnerability of listed southern DPS green sturgeon to deep water pile driving is uncertain. Additionally, without knowing the exact timing of pile proofing during migration periods for salmonids, principally CCC steelhead, the exact number of CCC steelhead affected during this time is unknown. Because of these uncertainties, we used a reasonable worst case scenario[10], below, to estimate the amount of green sturgeon and CCC steelhead affected.

The temporary trestles and falsework necessary for dismantling all sections of the existing bridge will require a total of 2,540 steel pipe piles and H-piles (Table 1) as follows. For the Cantilever Superstructure approximately 440 24-inch and 36-inch diameter piles will be required. The 504' Superstructure will require 450 24-inch and 36-inch diameter piles. The 288' Superstructure

[10] This worst case scenario is the same approach as described in both the April 10 and August 21, 2009, Supplemental Biological Opinions.

needs 700 18-inch to 36-inch piles. The Oakland Access Trestle will also require 700 18-inch to 36-inch piles. Construction of the YBI Access Trestle along the southeast side of YBI will require 100 H-piles. In addition, there may be up to 150, 18-inch to 36-inch other piles for temporary structures, fenders, access, etc. The contractor will install all piles with a vibratory hammer, and then drive some of them with an impact hammer when necessary. Final proofing may be done on 10% of the steel pipe piles installed entirely with a vibratory hammer to ensure load bearing capacity. For the piles located west of Pier E9, the 24-inch impact driven piles will require approximately 133 strikes per pile, with no more than 20 piles installed per day. The 36-inch impact driven piles at this location are expected to require 158 strikes, and no more than 20 installed per day. Piles east of Pier E9 will require approximately 124 strikes for the 24-inch piles, and 107 strikes for the 36-inch piles, with no more than 20 piles being driven on a given day. The H-piles needed to construct the YBI Access Trestle will be driven with an impact hammer and are expected to require no more than 60 strikes per pile for 10 piles a day. The location of the YBI Access Trestle would make incorporation of a bubble curtain difficult, so one will not be used during impact hammering of the H-piles. Pile "proofing" will occur for no more than two piles per day, requiring only 20 strikes per pile for both the 24- and 36-inch piles. Pile proofing is not expected to exceed more than two minutes per day; due to the short duration required for proofing no sound attenuator device will be used.

In order to minimize the adverse effects of impact pile driving to Federally-listed salmonids and green sturgeon during the installation of piles, Caltrans has incorporated the following avoidance and minimization measures (repeated here from the Project Description): 1) all pile installation with be installed with a vibratory hammer to the greatest extent feasible; 2) an impact hammer will be restricted to the period between June 1st and November 30th (excluding pile proofing) to avoid salmonid and spawning adult green sturgeon migration periods; 3) Caltrans will incorporate an air bubble curtain sound attenuation system to reduce sound pressure and exposure levels during impact pile driving for all impact hammer driven piles (excluding "proofing" of piles, and the H-piles); 4) the H-piles necessary for construction of the YBI Access Trestle will be installed in shallow water zero to three meters deep and installation will also be restricted to the period of June 1st to November 30th; 5) only two piles will be proofed for a duration of no more than 2 minutes a day for the 10% of piles that may require testing for load bearing capacity, no more than 244[11] will be tested for the entire duration of this project (2012-2017); and 6) a biological and hydroacoustic monitoring program will be implemented to obtain real-time data during impact pile driving to ensure effectiveness of the bubble curtain, and that sound pressure and exposure levels do not exceed what has been analyzed in this BO.

[11] The 100 H-piles will not need to be proofed, so only 10% of 2440 piles may need to be tested.

Table 1. Size and number of steel piles required for trestles and falsework.

Temporary Structure	Pile Sizes and Type	Maximum Number of Piles
Cantilever Superstructure Temporary Supports	24- to 36-inch diameter steel pipe	440
504' Superstructure Temporary Supports	24- to 36-inch diameter steel pipe	450
288' Superstructure Temporary Supports	18- to 36-inch diameter steel pipe	700
Oakland Access Trestle	18- to 36-inch diameter steel pipe	700
YBI Access Trestle	14-inch steel H-piles	100
Other (spud, fenders, access, etc.)	18-to 36-inch diameter steel pipe	150
Total Piles For Project		**2540**

NMFS has analyzed the effects of the proposed pile driving for the remaining trestles and falsework necessary for bridge demolition, including the proposed avoidance and minimization measures. In *A Compendium of Pile Driving Sound Data* (Illingworth and Rodkin 2007) the most recent pile driving case studies are compiled in order to provide information regarding the underwater sound pressure levels generated with the installation of steel piles and hammer types. Several pile driving case studies conducted for this project as well as others within the San Francisco Bay and other bays, estuaries and rivers along California's north coast region are included in the compendium. NMFS and Caltrans used data taken from these studies and the dual metric threshold criteria for onset of physical injury, and current threshold criteria for sub-injury to estimate the area of impact for this project. As a result, NMFS does not anticipate SPLs and SELs and RMS values to be exceeded beyond the following distances surrounding each pile during each construction phase, for fish greater than or equal to 2 grams:

- For attenuated piles (using an air bubble curtain, or other device), 206 dB peak SPL at 1 m (2 m diameter), 187 dB accumulated SEL at 34 m (68 m diameter), and 150 dB RMS at 398 m (796 m diameter);

- For proofed piles, 206 dB peak SPL at 7 m (14 m diameter), 187 dB accumulated SEL at 19 m (38 m diameter), and 150 dB RMS at 3981 m (7962 m diameter);

- For the steel H-piles, 206 dB peak SPL at 10 m (radial distance) , 187 dB accumulated SEL at 65 m (radial distance), and 150 dB RMS at 1311 m.

As distance from the pile increases, sound pressure levels decrease and the potential harmful effects to fish also decrease. Hence the distance to reach the 150 dB RMS corresponding to sub-injurious sound levels (*i.e.* non-lethal, behavioral responses), is not expected to extend beyond a 3981 m radius from the east span of the bridge for any pile driving event. This larger area defines

the total area of impact expected from pile driving for the entire duration of bridge dismantling activities.

Estimates were made based upon the largest pile size and type anticipated to be used for this project, during attenuated and unattenuated impact hammer pile driving, which are the 36-inch steel pipe piles, and 14-inch steel H-piles. This reasoning assumes installing the largest piles with the same number of strikes as the smaller piles is expected to result in the largest area of impact. Using the attenuated (assuming 10 dB reduction) reference values of 189 dB peak (re: 1 µPa), 160 dB SEL (re: 1 μPa^2-sec) and 174 dB RMS measured at 10 meters, and estimating a total of 3160 strikes per day (158 strikes per pile, 20 piles maximum) with a transmission loss (TL) of 15 dB[12]; results in the distance to reach the injury and sub-injury thresholds provided above for attenuated impact hammer installation of the piles. For installation of the H-piles, Caltrans assumes a higher TL of 17 dB, due to site specific conditions. However, since Caltrans will need to also proof a small subset of the piles (10%) with an impact hammer, the largest area of impact is based upon the unattenuated RMS threshold distance of 3981 m (7962 diameter) for the 36-inch piles.

Given the uncertainties described above associated with these types of projects, NMFS has developed a reasonable worst case scenario of likely effects to fish from pile driving. Below, we review project specific uncertainties associated with the likely effects, and then describe the scenario we used and the results in terms of likely effects on listed salmonids and green sturgeon.

Summer and Fall. The project's pile driving activities occurring from June 1st through November 30th for the temporary structures are not expected to result in adverse effects to listed salmonids because no life stage is expected to be present during construction between June 1st and November 30th. Additionally, during this time, the project's pile driving activities are not expected to result in impacts to adult spawning green sturgeon. However, juvenile, sub-adult and some non-spawning adult green sturgeon have the potential to be within the action area year-round. The incorporation of a bubble curtain during this timeframe, when impact hammer pile driving occurs is expected to reduce the area where injury may occur, and also reduce the area where sub-injury is possible.

Another concern is that any pile driving that occurs after dusk during the summer and fall months, could overlap with the period when the majority of downstream fish movement occurs. Shapovalov and Taft (1954) report that emigrating juvenile steelhead move downstream at all hours of the day and night, but the bulk of downstream fish movement occurs during the night or at least in the early morning or late evening. Because they share other migration similarities with salmonids, such as outmigrating through the estuary in the spring months, green sturgeon may possess a similar behavior. Artificial lights that are used on the pile driving platforms after dark may also attract fish to the immediate vicinity of the operation and into the area of lethal sound

12 NMFS recommends using the Practical Spreading Loss model ($TL = 15*\log(R_1/R_0)$), unless data are available to support a different model.

pressure levels. Although juvenile green sturgeon swimming behaviors encountered within the estuary is not clear, research by Van Eenennaam *et al*. (2001) indicates that juvenile green sturgeon exhibit nocturnal activity patterns in freshwater whereby they move higher into the water column at night. If this same type of nocturnal behavior occurs in the estuary, their vulnerability to pile driving impacts could increase at night. However, the majority of the remaining pile driving activities for the project are not expected to occur at night, and if night work is necessary it will be restricted to the period of June 1st through November 30th, and Caltrans will direct illumination away from the water.

Winter and Spring. Pile proofing may occur year-round, which has the potential to affect migrating salmonids (primarily CCC steelhead), from December 1st through May 31st, and green sturgeon. However, the duration for pile proofing during peak (February-May) migration periods is expected to occur for no more than two minutes a day, thus the area of impact where injury may occur in any given pile proofing scenario is only expected to be a 19 m radial (38 m diameter) distance. Beyond the 19 m radius, extending out to the 3981 m (7962 m diameter) distance is where sub-injurious effects may occur. Although this is a seemingly large area during peak migration times, the limited duration is not expected to substantially alter migration behavior. Sound pressure levels extending out to this distance would only reach to the north, south and east of the pile driving area as YBI blocks the area to the west. Additionally, the area within 3981 m radius from the pile during proofing is predominantly located in deeper waters in the Bay where currents are stronger and fish are expected to quickly transit through during migration. No more than 244 piles total will be proofed in this manner over the duration of this project phase (2012-2017), and an even smaller subset of those will be proofed during winter and spring months, so NMFS anticipates, given the short duration of each proofing event, nearly all of salmonid and green sturgeon migration periods will be free from disturbances resulting from pile driving. Moreover, NMFS expects any migrating fish that may be disturbed but not injured during a pile proofing event will quickly return to normal behavior patterns once pile driving ceases. No lasting adverse effects are likely mainly due to their larger bodies (above two grams), and because pile driving activities will occur only in the daytime during migration season which would avoid crepuscular and nocturnal periods when salmonid and sturgeon migratory activity is likely the highest.

c. Amount of Salmonids and Green Sturgeon Affected

Overall, the largest area of potential injury occurring from any pile driving event associated with dismantling of the bridge is in the deeper water habitat is 34 m (68 m diameter), and occurs during the summer and fall months when all listed salmonids are absent. However, several lifestages of green sturgeon have the potential to be present during this time, but this impact area is small compared with the size of the action area, and overall habitat range within the San Francisco Bay for green sturgeon. Moreover, this area of the Bay has been disturbed during the past several years' construction of SFOBB East Span and is also a navigation channel. The presence of barges, boats, recently constructed towers and work equipment in the nearshore and navigation

channel along the eastern side of YBI extending to Oakland have disturbed the water column and benthic substrate. Therefore, NMFS expects it to be unlikely for juvenile, subadult and non-spawning adult green sturgeon to be present during construction in this area, as these life stages of green sturgeon are more likely to be located in areas of the Bay that possess higher quality habitat, and less frequent disturbance. Although temporary disturbances to the water column and associated habitat during pile driving may disrupt foraging or other behavior of juvenile, sub-adult and non-spawning green sturgeon, this temporary loss of foraging habitat and disturbance is minimal, given the small footprint of the pile driving when these age groups are expected to be present compared to the available habitat within the Bay for green sturgeon.

As described above, while little information is available to determine how and where listed anadromous salmonids and green sturgeon migrate through and utilize San Francisco Bay, general inferences can be made based upon known behavior patterns of salmon, steelhead and green sturgeon and their likely migration corridors within the Bay. As mentioned previously, only a very small percentage of fish from the three Central Valley ESUs will likely be present in the SFOBB East Span Seismic Project action (during the associated bridge demolition and dredging activities) area and vulnerable to the adverse effects of high sound pressure levels. However, CCC steelhead, which spawn in tributaries flowing into the south San Francisco Bay, are likely to be present in greater percentages within the action area since they must pass under the SFOBB. These steelhead are most likely to be exposed to harmful sound levels during pile driving (mainly proofing). Considering the bathymetry of San Francisco Bay and the distribution of tidal currents, NMFS believes it is likely that between 20 and 30 percent (average of 25%) of the steelhead run from south San Francisco Bay streams pass east YBI and through the SFOBB East Span Seismic Project action area, based on the division of flow around YBI and our assumption that steelhead numbers will be distributed in the flows around YBI proportionally similar to the flow division.

Adult and juvenile salmonids, and green sturgeon, are likely to take advantage of tidal currents to travel through San Francisco Bay on their migration routes. The large volume of tidal exchange at the SFOBB East Span Seismic Project construction site is expected to assist with the transport of listed salmonids and green sturgeon both to and away from areas of high sound pressure levels during pile driving. However, it is possible that an individual fish will make multiple passes through the construction area and be vulnerable more than once to harmful sound pressure levels during pile driving. The potential for multiple exposures depends on how the movements of salmonid smolts and adults, and juvenile and adult green sturgeon, are influenced by tidal currents, which is currently unknown; although this scenario is most likely to be a concern for juvenile and subadult green sturgeon since they inhabit the bay year-round.

The precise size of the steelhead run in south San Francisco Bay tributaries and precise abundance of green sturgeon in the San Francisco Bay and its tributaries is unknown. Therefore, determining the precise number of threatened CCC steelhead and juvenile and subadult southern DPS green sturgeon that may be injured or killed by the SFOBB East Span Seismic Project pile driving activities is difficult at best, and not possible at this time. In lieu of precisely determining the

number of individual CCC steelhead adversely affected, estimates of the area of potential impact due to pile driving and a percentage of the population passing through this area of impact were calculated by NMFS. For estimating the number of juvenile and subadult green sturgeon adversely affected, NMFS used the likely area of potential impact due to pile driving and the potential life stage (juvenile, subadult, and adult) of green sturgeon likely present or passing through the active pile driving area to assess the level of impact. For the purposes of this analysis, the zones of potential impact are defined as the area where there may be injury, mortality, and behavioral impacts to listed anadromous salmonids and green sturgeon. Based on current pile driving research, the area of injury and mortality of salmonids green sturgeon is defined as the area with sound pressure levels exceeding 206 dB (re: 1 μPa), or 187 SEL (re: 1 μPa^2-sec). This zone of impact is within the 34 m distance (68 m diameter) from an active pile driving operation corresponding to the installation of the largest 36-inch diameter piles, the 65 m zone corresponding to the impact driven 14-inch H-piles, and the 19 m zone corresponding to the proofing of the largest 36-inch piles. Within these zones[13], salmonids (primarily CCC steelhead) and green sturgeon could experience a range of physical injuries, including damage to the inner ear, eyes, blood, nervous system, kidney, and liver. These injuries could result in the delayed mortality of some of these fish.

Adult salmonids, due to their large size, can usually tolerate higher pressure levels (40-50 psi) (Hubbs and Rechnitzer 1952) and immediate mortality rates of adults are expected to be less than that experienced by juvenile salmonids. Given that adult green sturgeon are on average significantly larger than salmon, they could, presumably, tolerate higher levels of sound pressure and be less affected by pile driving activities. Similarly, juvenile green sturgeon are typically around 600 mm in length by the time they inhabit the estuary, close in size to some adult salmonids, therefore it is anticipated that they will also be more resilient and capable of recovering quickly from temporary disturbances associated with pile driving. However, they are vulnerable to injury or death from pile driving (especially if within close proximity), as demonstrated by the lethal SPLs resulting in the death of a white sturgeon (likely a juvenile) documented during the construction of the Benicia-Martinez Bridge installation. Although it should be noted that the piles used for construction of the Benicia-Martinez Bridge were 96-inch diameter piles compared to the largest 36-inch piles that will be used for this project.

Beyond the physical injury range, extending out to the 150 dB RMS (re: 1 μPa) isopleth[14] at a distance 398 m from the pile during attenuated impact hammering of 36-inch piles, the 3981 m distance during unattenuated pile proofing, and the 1311 m distance during impact hammering the H-piles, NMFS estimates fish greater than 2 grams will be agitated or disturbed, but survive exposure to SPLs and not sustain permanent harm or injury. These fish may demonstrate temporary abnormal behavior indicative of stress or exhibit a startle response. As described previously, a fish that exhibits a startle response is not injured, nor is its fitness likely to be

[13] Excluding the summer and fall months when salmonid species are likely to be absent.

14 An isopleth is a contour line in water column that has the same pressure at all points, in this example the isopleth is the underwater pressure threshold level (e.g. 150 db RMS) at the given distance away from the pile.

reduced, but it is exhibiting behavior that suggests it perceives a stimulus indicating potential danger in its immediate environment, and startle responses are likely to extinguish after a few pile strikes.

In summary, based upon the information above, our reasonable worst case scenario assumes: 1) twenty-five percent of the south bay CCC steelhead population migrate to the east side of YBI en route to and from the Golden Gate; 2) juvenile, subadult and adult green sturgeon could be present in the action area year-round; 3) roughly three percent of adult spawning green sturgeon could be present in the action area February through May; 4) remaining pile driving will occur in areas greater than five meters deep during peak migration periods for spawning CCC adult steelhead and spawning adult green sturgeon (February through May); 5) a maximum of two piles will be proofed per day (with an impact hammer) intermittently over the course of these four months; 6) some pile installation may occur at night in the summer and fall months (June through November); and 7) the 3981 m radial distance of the impact area corresponding to the 150 dB RMS is the greatest distance considered for the entire demolition phase due to the data taken from hydroacoustic measures during the construction of this project and others. With these assumptions, roughly .0003 percent of the outmigrating juvenile and post-spawned adult population of steelhead originating from south San Francisco Bay tributaries will be injured, killed or harassed by sound pressure levels exceeding 206 dB (re: 1 µPa), 187 SEL dB (re: 1 µPa $^{2-}$sec), or 150 dB RMS (re: 1 µPa) during the remaining pile driving over 5 winter-spring seasons (2013-2017). The .0003 percentage of steelhead is determined based upon the following assumptions, that approximately 25 percent of the south Bay CCC steelhead population are estimated to transit east of YBI through the action area, and two piles will be proofed with an impact hammer within a given 24 hour period for only a two minute duration during the entire migration season (December 1st to May 31st). The worst case scenario then, is that *all* pile proofing will occur during migration season, for two minutes per day annually during these six months which equates to approximately .001 percent of time. In NMFS judgment, this percentage of time is so small that very few, if any, CCC steelhead are likely to be adversely affected. To be adversely affected a CCC steelhead would have to be within 3981 meters of a pile during the 2 minute proofing. The probability that this will occur is very low.

For green sturgeon, primarily juvenile and subadult green sturgeon and some adults located within the San Francisco Bay within a distance of 3981 m of pile driving will be injured, killed, agitated or disturbed or by sound pressure levels exceeding 206 dB (re: 1 µPa), 187 SEL dB (re: 1 µPa $^{2-}$ sec), and 150 dB RMS (re: 1 µPa). For the three percent spawning adult green sturgeon that may be injured, killed, agitated or disturbed, estimation, NMFS based this upon an average abundance estimate of 71 returning annual spawners (Israel 2006b), and the 2007 and 2009 tracking data provided by CALFED, with three adults recorded within the action area (one summer resident and two spawning adults) between February and August (see *Effects of the Action* pages 43-44).

NMFS assumes that the use of a vibratory hammer will effectively minimize sound pressure waves to levels at or below the dual metric criteria thresholds (*i.e.*, 206 peak dB, or 187 dB SEL).

If Caltrans installs the majority of temporary piles with a vibratory hammer, and only uses an impact hammer for minimal re-taps and pile proofing, the remaining pile driving activities are not anticipated to result in substantial incidence of physical injury or mortality to fish; and our reasonable worst case scenario may not be realized.

2. Removal of Marine Foundation-Additional Methods

Preliminary information for removal of marine concrete foundations with an expansive cracking mortar indicates that the area can safely be contained from debris or turbidity associated with concrete break-down through the use of a cofferdam or turbidity curtains. Unless results from the Caltrans study indicate there are unacceptable toxicity risks other negative impacts from this type of compound not previously considered, NMFS assumes this approach to foundation removal will not injure fish but may result in temporary impacts habitat from brief episodes of turbidity or perhaps shifts in pH of the water column.

3. Turbidity

Pile driving, and removal of the concrete marine foundations, and old timber piles are also expected to create temporary increases in turbidity in the adjacent water column. These minor and localized elevated levels of turbidity will quickly disperse from the project area with tidal circulation. Listed anadromous salmonids and green sturgeon in the San Francisco Bay estuary commonly encounter, and typically avoid, areas of increased turbidity due to storm flow runoff events, wind and wave action, and benthic foraging activities of other aquatic organisms. Therefore, the minor and localized areas of turbidity associated with this project's in-water construction is not expected to impair or harm listed salmonids or green sturgeon and will not result in long-term impacts to aquatic habitat.

4. Dredging and Disposal

Potential effects are entrainment of juvenile fish (Dutta and Sookachoff 1975, Boyd 1975, Armstrong *et al.* 1982, Tutty 1976). Potential indirect effects include behavioral (Sigler *et al.* 1984, Berg and Northcote 1985, Whitman *et al.* 1982, Gregory 1988) and sub-lethal impacts from exposure to increased turbidity (Sigler 1988, Sigler *et al.* 1984, Kirn *et al.* 1986, Emmett *et al.* 1988, Servizi 1988); redistribution and/or release of contaminants, with increased potential for chronic or acute toxicity; mortality from predatory species that benefit from activities associated with dredged material disposal; changes in the native sediment characteristics near disposal sites; and shifts in sediment dynamics that may alter available food supply (Morton 1977).

The proposed disposal of a portion of the dredged material at SF-DODS is unlikely to adversely affect listed salmonids or green sturgeon due to its location and depth. The SF-DODS is located approximately 50 miles offshore of San Francisco in the Pacific Ocean, and is between 8,200 - 9,840 feet (2,500 - 3,000 meters) deep. Listed anadromous fish species are unlikely to occur at

this area since adult and sub-adult salmonids in the ocean are typically foraging on the continental shelf in shallower water due to the distribution of their prey species (euphausids and small schooling fish), and adult green sturgeon are generally found within the 110-m contour of the continental shelf. Considering the very low likelihood of listed anadromous fish species within the area affected at SF-DODS during a disposal event, this portion of the project is unlikely to adversely affect listed salmonids or green sturgeon. Therefore, the SF-DODS portion of the action area is not considered further in this opinion. However, for removal of the existing piers, it is anticipated that 22,724 cubic yards of material will be dredged. This material will be disposed of at the Alcatraz Island site (SF-11).

a. Entrainment.

Dredging techniques expected to be employed for this project can be categorized as either hydraulic or mechanical. Both methods may be used, and dredging for barge access to dismantle the existing bridge could take several months to complete. Entrainment of listed fish (primarily juveniles) can occur when hydraulic dredging is used; mechanical dredging is unlikely to entrain fish. If the dredging draghead is in operation while held above the surface of material being removed and fish are present, they may be unable to overcome the water velocities near the dredging draghead and be pulled into the hold of the ship. Dutta (1976) reported that salmon fry were entrained by suction dredging in the Fraser River. Braun (1974a, b), in testing mortality of entrained salmonids, found that 98.8 percent of entrained juveniles were killed. Boyd (1975) indicated that suction pipeline dredges operating in the Fraser River during fry migration took substantial numbers of juveniles. Further testing in 1980 by Arseneault (1981) resulted in entrainment of chum and pink salmon, but in low numbers relative to the total number of salmonids out-migrating (0.0001 to 0.0099 percent). Based the small chance of entrainment, and the likely location of salmonids in the upper part of the water column, NMFS does not expect salmonids will be entrained. Green sturgeon, because of their known foraging behavior on the substrate of channels and estuaries, could be entrained. Juvenile, subadult and non-spawning adult green sturgeon may be present year-round within the active dredging area, although their numbers are expected to be low because most of the action area is not high quality foraging habitat for sturgeon. NMFS expects only a few, if any, green sturgeon may be entrained and killed, as any green sturgeon present will probably leave the area due to the disturbance produced by the draghead.

b. Turbidity.

There is little direct information available to assess the effects of turbidity in San Francisco Bay on juvenile or adult green sturgeon. Review of the literature regarding the effects of turbidity associated with dredging operations on anadromous salmonids indicates turbidity may interfere with visual foraging, increase susceptibility to predation, and interfere with migratory behavior. Similar effects are assumed for green sturgeon. Moreover, if fish are present during a disposal event, they may be smothered or otherwise negatively affected by large amounts of sediment

being delivered at one time, rather than brief bursts of turbidity that would be encountered episodically and usually dissipated after a short duration through tidal action.

The Port of Oakland evaluated turbidity plumes associated with clamshell dredging operations for its 50-foot port deepening project. The results indicated that increases in turbidity were localized, with the most concentrated portion of the plume located near the bottom and decreasing concentrations nearer the surface (Port of Oakland 1998). The lateral extent of a turbidity plume during dredging depends on the tide, currents, and wind conditions during the dredging activities. Depending on the body of water and the hydraulics of the system, sediment plumes can extend approximately several hundred to 1,000 m from the operation.

LaSalle (1988) described the physical characteristics of sediment dispersal during hopper dredging activities. Hopper dredges are a type of mechanical dredge in which the "hopper" is the container for dredged material. As the hopper dredge is filled, dredged material is often stored in the hopper until overflow of material begins. In general, sediment concentrations at the bottom are up to 500 mg/l and 100-150 mg/l at the surface, given no overflow occurs. When overflow does occur, sediment concentrations in the upper water column may reach levels as high as 1000 mg/l. LaSalle (1988) cautioned that site specificity is a very important consideration.

Because fish tend to avoid areas of high turbidity and return when concentrations of solids are lower, impacts are expected to be temporary. For the SFOBB East Span Seismic Project, turbidity levels that may induce mortality are not expected to occur due to the location of both the dredge and disposal sites. Estuarine currents and water column mixing are expected to rapidly disperse and dissipate concentrations of solids as they settle. However, turbidity may alter the behavior of adult, subadult and juvenile green sturgeon and salmonids. They are likely to avoid areas of increased turbidity at the dredge site and disposal events near Alcatraz Island. This alteration of behavior may adversely affect feeding and interfere with migratory behavior, although the effects are not expected to be at a level that adversely affects growth or reproductive success.

c. Contaminants.

In the aquatic environment, most anthropogenic chemicals and waste materials, including toxic organic and inorganic chemicals, eventually accumulate in the sediment. Contaminated sediments may be directly toxic to aquatic life or can be a source of contaminants for bioaccumulation in the food chain (Ingersoll 1995). Fine sediments in the project dredging areas increase the likelihood of a problem with contaminants, because this fraction consists of particles with relatively large ratios of surface area to volume, which increase the sorptive capacity for contaminants.

Environmental contaminants discharged into aqueous systems tend to associate with particulate material in the water column and with consolidated bedded sediments. Caltrans performed sampling, chemical analyses and acute toxicity bioassays of bay sediments from the project area to determine the suitability of dredged material for disposal. Chemical analyses were performed for

priority pollutant metals; total and dissolved sulfides; total recoverable petroleum hydrocarbons (TRPH); phthalate esters; PAHs; pesticides; polychlorinated biphenyls (PCBs); mono-, di-, tri- and tetrabutyltin and total organic carbon (TOC). Biological analyses were conducted for 96-hour layered-solid-phase bioassay, 10-day solid phase bioassay and 28-day bioaccumulation. The results of these studies showed a general absence of significant contamination, with low or non-detectable concentrations of chemical contaminants of concern except at two groups of dredge sites, SFOBB-N-2/SFOBB-N-5 and SFOBB-N-1 (USACOE letter dated October 31, 2001).

Material from the upper 12 feet of testing locations SFOBB-N-2 and SFOBB-N-5 is not suitable for unconfined aquatic disposal, because test results showed significant solid phase toxicity to *Nephtys* (a marine polychaete or "catworm") when compared to the reference sites. This material will be disposed of at an upland location. Material from the upper 12 feet of Site SFOBB-N-1 is also unsuitable for unconfined aquatic disposal or to wetland surfaces due to excessive bioaccumulation of individual constituents of PAHs and will be disposed of at a confined upland location.

Although the DMMO of the U.S. Army Corps of Engineers determined that the majority of dredged material from the SFOBB East Span Seismic Project is suitable for unconfined aquatic disposal, contaminants are present. They include oil and grease, TRPH, chlorinated pesticides (DDD, DDE, and DDT[15]), metals (arsenic, cadmium, chromium, copper, lead, mercury, nickel, selenium, silver, and zinc), organotins, and 12 PAHs. Given that the concentrations are at a low enough level, these contaminants are anticipated to re-suspend and rapidly disperse, and are unlikely to result in any acute toxicity to listed salmonids and green sturgeon.

d. Anaerobic Sediments

Two common by-products produced in anaerobic sediments containing adequate concentrations of organic matter are ammonia (NH_3) and hydrogen sulfide (H_2S), which are highly toxic and produced by anaerobic aquatic microorganisms. Dillon and Moore (1990) report that NH_3 can exert toxicity at relatively low concentrations on fish and other aquatic organisms. The release of NH_3 during dredging and the disposal of dredged material could affect aquatic species as it is re-suspended in the water column. NMFS expects that acute, short-term effects due to increased levels of NH_3 at either the dredge site or the SF-11 disposal site are unlikely to occur due to tidal influence and water column mixing at the disposal site, and (to a slightly lesser extent) at the

[15]These are Persistent Organochlorine Compounds that are pesticides used historically for mosquito abatement and as insecticides; they are no longer commercially manufactured. DDT is gradually metabolized into DDE and DDD. Commercial DDT was a mixture of DDT, DDE and DDD. DDT: dichloro-diphenyl-trichloro-ethane; or (1,1,1-trichloro-2,2-bis(p-chlorophenyl)ethane). DDE (1,1-dichloro-2,2-bis(chlorophenyl) ethylene); DDD: (1,1-dichloro-2,2-bis(p-chlorophenyl) ethane).

dredge site. The un-ionized form of NH_3 has potential for adversely affecting listed salmonids and green sturgeon, but the limited concentrations NMFS anticipates at the dredge and disposal sites are unlikely to directly affect these species. Typically, when un-ionized NH_3 is exposed to water it is rapidly diluted and converted to a less toxic ammonium ion. Similarly, H_2S undergoes a chemical reaction when exposed to water. It is oxidized and converted to elemental sulfur, which is less toxic to fish and other aquatic life.

For both of these by-products, the degree of hazard exhibited to salmonids and green sturgeon is dependent upon the temperature, pH and dissolved oxygen content of the water. However, temperature and pH are not considered a significant concern given the location of the removal and disposal sites, *i.e.*, deep waters that are tidally influenced with consistent water column mixing. Because the dredge removal and disposal sites are located in a large, open body of water the principal impact from anaerobic sediments is the probable decrease in DO content as the sediments are exposed and disposed of and temporarily re-suspended in the water column. When anaerobic sediments are exposed to the water column, the aforementioned chemical reactions for NH_3 and H_2S will deplete DO. Salmonids and green sturgeon that may be exposed to low levels of DO could be adversely impacted. Assuming that there are no restrictions present to prevent escape from these areas of low DO, green sturgeon behavior may be affected in a similar manner as described above for turbidity, *i.e.*, avoidance of the increased concentration levels of NH_3 and H_2S, and decreased DO near the sites. However, if there are particulates or suspended solids in the sediment that could impede or prevent escape by green sturgeon, the resulting impacts may be in the form of physical injury or mortality. NMFS considers the potential for this occurrence to be a very low probability due to the large, open area within the action area under the SFOBB, and the location of the SF-11 disposal site, south of Alcatraz Island. Both of these areas are expected to provide large enough, unconfined areas to disallow fish impediment.

e. Benthic Resources

Oliver *et al.* (1977) noted two phases of succession in benthic communities after disturbance (such as dredging or burial by disposal of dredged material). In the first phase, opportunistic species such as polychaetes move into a disturbed area. In the second phase, organisms surrounding the disturbed area re-colonize the affected site. Reilly *et al.* (1992) concluded that dredging-induced habitat alterations are minor compared to the large-scale disturbance of habitat in San Francisco Bay occurring from natural physical forces, such as seasonal and storm-generated waves, although these events would primarily occur in shallow water. However, dredged material may have substantially different characteristics than material that is resuspended through natural forces.

The SF-11 disposal site near Alcatraz Island has been used for decades and has a low biological standing crop of invertebrates. Although benthic invertebrates have been shown to be key food sources for juvenile and adult green sturgeon, (Radtke 1966, Moyle *et al.* 2002, Moyle 2002, Adams *et al*. 2002), it is unlikely a significant loss of prey species will occur from these activities

on the bottom at either the dredge or disposal sites. There will be some short-term impact to invertebrate colonies as a result of dredging or disposal. Rates of recovery listed in the literature can range from several months to several years for estuarine muds (McCauley *et al.* 1976, Oliver *et al.* 1977, Currie & Parry 1996, Tuck *et al*.1998, Watling *et al.* 2001). Recolonization can also take up to 1 to 3 years in areas of strong current but up to 5 to 10 years in areas of low current (Oliver *et al.* 1977). Thus, forage resources for fish that feed on the benthos may be substantially reduced before full recovery of the site is achieved. Based on available literature, NMFS assumes recovery of prey resources will not occur within one year. However, because the dredge area and disposal sites are located within highly disturbed portions of the bay, NMFS assumes there are better foraging habitats located elsewhere, therefore this would be of minimal impact to green sturgeon.

f. Disposal at Upland or Wetland sites

If any material is disposed of at upland or wetland wetland site, the DMMO anticipates that it will go to The Montezuma Wetlands Restoration Project (M. D'Avignon, DMMO, pers. comm. 2012). This area encompasses approximately 1800 acres in Solano County near the Montezuma Slough and Grizzly Island Wildlife Area. The goal of this restoration project is to provide habitat for both locally endangered species of plants and animals. However, no dredge material will be disposed of at any unconfined upland or wetland site if contaminant/toxicity tests indicate it would be unsafe to do so for the surrounding environment or aquatic and wetland species. Based on this information, NMFS does not anticipate adverse effects to listed salmonids or green sturgeon from upland or wetlands disposal.

g. Dredging and Disposal Summary

Due to the limited amount of data on the distribution and abundance of salmonids and green sturgeon in the portions of the action area affected by dredging and disposal, NMFS cannot predict the precise number of salmonids and green sturgeon affected by dredging and disposal activities. NMFS estimates that only a small percentage of the salmon and green sturgeon present in the action area is likely to be affected due to: 1) the small size of the affected areas relative to the action area; 2) limited locations and duration of dredging and disposal; 3) the temporary nature of the effects; and 4) the broad distribution of salmonids and green sturgeon in the Bay. A very small number of green sturgeon may be entrained and killed if hydraulic dredging equipment is used.

B. Impacts to Critical Habitat

The action area located within the Central Bay is designated critical habitat for Sacramento River winter-run Chinook, Central Valley spring-run Chinook and Central Valley steelhead. The entire San Francisco Bay is designated critical habitat for CCC steelhead, and is designated critical habitat for southern DPS green sturgeon. Temporary impacts to designated critical habitat for

salmonids and designated critical habitat of southern DPS green sturgeon are expected during construction of the falsework and trestles required for demolition of the old bridge, and dredging for barge access of the SFOBB East Span Seismic Project. Pile driving and dredging will adversely affect the water column and benthic substrate of San Francisco Bay within the action area. Impacts to the water column from high sound pressure levels were discussed previously, as were impacts to water quality associated with dredging. There will also be temporary impacts associated with shading and foraging habitat loss within the action areas while temporary structures are in place. However, temporary structures will not be directly located where eelgrass beds have been documented and are not expected to pose impacts to eelgrass from shading. Removal of the old structure will ultimately reduce shading in the project area.
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These impacts are unlikely to reduce the value of critical habitat for these species in the action area once removal of the existing bridge is complete. Most critical habitat in the action area is either 1) expected to quickly return to pre-project conditions (*e.g.*, sound pressure levels and turbidity generated by construction activities will no longer be present). During construction activities, impacts to the value of critical habitat for these species in the action area is expected to be minimal because of limited extent of most effects and or the short duration of effects (*e.g.*, pile proofing). Habitat outside of the affected areas or times will not be affected.

As described above, impacts to benthic organisms at the dredging and disposal sites may last for several years following disturbance from activities associated with this project. NMFS expects these impacts will be discountable to the value of green sturgeon critical habitat considering the current low value of these areas as habitat and the large amount of critical habitat available to green sturgeon elsewhere in San Francisco Bay.

Caltrans established a SFOBB East Span Seismic Project mitigation fund for the restoration of Federal-and State-listed salmonid habitat in the central and south Bay. These projects were designed to restore and enhance anadromous salmonid habitat within San Francisco Bay tributaries. Properly designed and implemented restoration actions are expected to provide significant benefits (as discussed in the Environmental Baseline) to steelhead and designated critical habitat in San Francisco Bay tributaries. Of the projects completed, only the Indigenous Oyster Habitat Project, located at the Marin Rod and Gun Club in San Pablo Bay at Point San Quentin, adjacent to the Marin County side of the Richmond-San Rafael Bridge, is thought to potentially provide similar habitat enhancements for green sturgeon. Caltrans and NMFS are currently working on an eelgrass project that may provide habitat enhancements for salmonids and green sturgeon.

VII. CUMULATIVE EFFECTS

Cumulative effects are defined in 50 CFR 402.02 as "those effects of future State or privately sponsored activities, not involving Federal activities, that are reasonably certain to occur within

the action area of the Federal action subject to consultation." For the purposes of this consultation, the action area is located within the central and south San Francisco Bay in an area encompassing a 3981 m radius (7962 m diameter) surrounding the east span of the SFOBB, an area extending approximately 2000 m south of Alcatraz Island at the SF-11 disposal site, and the SF-DODS ocean disposal site. Non-Federal actions that may affect the action area include State angling regulation changes, voluntary State or privately sponsored habitat restoration activities, State hatchery practices, discharge of storm water and agricultural runoff, increased population growth, recreational harvest, and urbanization. State angling regulations are generally moving towards greater restrictions on sport fishing to protect listed fish species. Farming activities within or adjacent to the action area may have negative effects on San Francisco Bay water quality due to runoff laden with agricultural chemicals. Future urban development within the Bay may also adversely affect water quality and estuarine productivity within the action area.

VIII. INTEGRATION AND SYNTHESIS OF EFFECTS

A. Effects to Species

The remaining dismantling and dredging/disposal activities associated with the SFOBB East Span Seismic Project are expected to result in adverse effects to Federally-listed anadromous salmonids and green sturgeon during construction[16]. For the three listed Central Valley ESUs (Central Valley steelhead DPS, Central Valley spring-run Chinook salmon, Sacramento River winter-run Chinook salmon), the remaining activities of the SFOBB East Span Seismic Project are expected to result in adverse effects to a small number of fish from these ESUs, because few individuals are likely to be present within the area of direct construction impacts. Harmful sound levels from pile driving are predicted to extend several thousand meters from the pile. However, given the geography and bathymetry of San Francisco Bay, and the location of the active pile driving areas along the east side of YBI, combined with the known behavior patterns of salmonids and adult spawning green sturgeon, it is probable that the majority of Central Valley anadromous salmonids are likely to be on the north side of San Francisco Bay en route between the Golden Gate and their natal Central Valley streams. Similarly, adult spawning green sturgeon will likely to be located on the north side of San Francisco Bay during migration, en route between the Golden Gate Bridge and the Sacramento River during construction activities. Since this portion of San Francisco Bay is several kilometers from the area that will be subject to the highest sound pressure levels, only very small numbers of three Central Valley ESU salmonids and adult spawning green sturgeon are anticipated to be in the action area and exposed to harmful sound pressure levels. Thus impacts to Central Valley salmonid numbers are very small and likely exert no discernible effect on future adult returns.

CCC steelhead must pass through the action area on route to natal streams within the south Bay, and during juvenile emigration from south Bay tributaries to the Pacific Ocean. CCC steelhead

[16] Remaining activities to construct the new east span are unlikely to result in adverse effects to listed salmonids or sturgeon (over water work) and are not considered further here.

was listed as threatened under the ESA because their numbers are dramatically reduced from historical estimates. This DPS does retain resiliency in the face of natural environmental fluctuations, but is at risk because its small numbers and other factors reduce its ability to persist in the face of natural disturbances. For CCC steelhead, up to .0003 percent annually of the outmigrating juvenile and post-spawned adult population originating from south San Francisco Bay tributary streams may be adversely affected during 2012-2017 by pile driving during dismantling of the bridge. This impact occurs to populations that have likely suffered recent losses from pile driving that occurred during the installation of temporary piles since the project began construction (now part of the Environmental Baseline).

Numerically, south San Francisco Bay steelhead represent a very small portion of the entire CCC steelhead, but these south Bay tributaries represent a significant and unique portion of the geographic distribution of this DPS. While the magnitude of loss is very small, these combined losses of adult and juvenile salmonids associated with the bridge demolition and dredging activities of the SFOBB East Span Seismic Project may manifest as a reduction in the number of adults returning for the next generation of the south Bay CCC steelhead populations because, for example, these losses are in addition to the most recent, previous pile driving impacts in 2009 (see Environmental Baseline). However, the likely impacts of this project are not expected to appreciably reduce the resiliency of these south Bay populations, (*i.e.*, their likelihood of survival and recovery) because salmonids have evolved and are adapted to variable systems (Bisson *et al*. 1997); and favorable water years and ocean conditions are likely to allow for subsequent years with greater population abundance that will replace the small number of steelhead killed by this project. Improvements to baseline conditions as a result of the restoration efforts funded by Caltrans and others to restore, enhance, or create salmonid habitat may improve reproductive success and survival of CCC steelhead. In consideration of the above, the demolition activities associated with the SFOBB East Span Seismic Project are not anticipated to reduce the likelihood of the survival and recovery of the local CCC steelhead populations or the Central California Coast DPS.

For adult green sturgeon, NMFS estimates that approximately three percent of spawning adult green sturgeon may potentially be injured or killed by the project's remaining activities. This estimate is based upon an average annual abundance estimate of 71 returning spawners and the 2007 tracking data provided by CALFED, with three adults recorded within the action area (one summer resident and two spawning adults) between February and August. Although it is not possible to predict the exact percentage of juvenile green sturgeon that may be adversely affected by pile driving activities, NMFS assumes that the majority of the juvenile, subadult and non-spawning adult green sturgeon will be located in areas with better quality habitat, possessing abundant food resources such as intertidal sloughs. The dredging areas are also relatively distant from the primary migration routes of adult green sturgeon, but a small amount of green sturgeon may be entrained and killed if hydraulic dredging is used. Therefore, it is expected the remaining activities of the SFOBB East Span Seismic Project will result in injury or mortality to a small portion of threatened adult, sub-adult, and juvenile green sturgeon, although the exact number affected remains uncertain. Green sturgeon may also be behaviorally affected by the projects activities. However, these behavioral changes are not expected exert any discernible effects on

the fitness of individual fish.

Similar to CCC steelhead, the potential impacts from pile driving that have occurred from the installation of piles since the project began construction may have caused injury or mortality or adverse behavioral changes to green sturgeon, potentially reducing levels of juvenile production and adult returns. Although the population of green sturgeon is low, and a small number of green sturgeon may have been harmed or killed by previous pile driving activities at this site, the possible injury or mortality resulting from exposure to high SPLs during prior and remaining pile driving activities, or entrainment during dredging activities of a small number of juvenile or subadult green sturgeon is not expected to appreciably decrease the number of returning adults, because of the number of juveniles produced by these populations. Since no spawning or freshwater rearing habitat will be affected by the proposed pile driving or dredging activities or operations, impacts on spawning survival and survival from egg to juvenile are not expected. In addition, because green sturgeon are long-lived species, it is presumed that adults not harmed or killed by this project will continue to spawn in future years and produce juveniles to replace any lost during construction of the project. Therefore, the abundance, distribution, and reproduction of the southern DPS green sturgeon is not likely to be appreciably reduced by the associated effects of the project's actions during bridge demolition and dredging for the SFOBB East Span Seismic Project.

B. Effects to Designated Critical Habitat

Within the action area, only the central Bay is designated critical habitat for the three listed Central Valley ESUs (Central Valley steelhead DPS, Central Valley spring-run Chinook salmon, Sacramento River winter-run Chinook salmon). Both the central and south San Francisco Bay is designated critical habitat for CCC steelhead. Impacts to designated critical habitat of anadromous salmonids are expected during bridge demolition and construction as a result of pile driving. Pile driving will adversely affect critical habitat within the action area through temporary elevated SPLs and turbidity, as well as temporary loss of foraging habitat and shading while temporary structures are in place. However, as discussed previously, restoration efforts resulting in improved access to significantly better habitat conditions in Bay tributaries and wetlands are expected to result in long-term increase in the value of critical habitat for CCC steelhead in south San Francisco Bay. Additional restoration actions implemented by the mitigation fund established by Caltrans are also expected to improve the value of critical habitat in central and south San Francisco Bay CCC steelhead streams.

The entire San Francisco Bay is critical habitat for green sturgeon. Impacts to the water column and bay substrate are expected to occur as a result of pile driving and dredging/disposal activities. Pile driving will adversely affect critical habitat within the action area though temporarily elevated SPLs and temporary increases in turbidity. Similarly, dredging and disposal, and removal of old timber piles associated with bridge dismantling are expected to result in adverse effects to critical habitat through temporary increases in turbidity, temporary increase in amounts of contaminants in the water column and temporary disturbance of benthic substrate. Because no spawning or freshwater rearing habitat will be affected by the proposed actions, and only a small portion of

their estuarine foraging and rearing habitat is affected temporarily by the proposed actions, impacts from the project's activities are not expected to reduce the value of critical habitat for green sturgeon for the conservation of this species.

IX. CONCLUSION

After reviewing the best available commercial and scientific information regarding the current status of listed anadromous salmonids and green sturgeon, the environmental baseline for the action area, the effects of the proposed action, and the cumulative effects, it is NMFS' biological opinion that the proposed bridge demolition and dredging activities for the SFOBB East Span Seismic Project are not likely to jeopardize the continued existence of CCC steelhead, Central Valley steelhead, Central Valley spring-run Chinook salmon, Sacramento River winter-run Chinook salmon or southern DPS green sturgeon.

After reviewing the best available commercial and scientific information regarding the environmental baseline for the action area, the effects of the proposed action, and the cumulative effects, it is NMFS' biological opinion that the proposed remaining activities for the SFOBB East Span Seismic Project are not likely to adversely modify or destroy the critical habitat of CCC steelhead, Central Valley steelhead, Central Valley spring-run Chinook salmon, Sacramento River winter-run Chinook salmon, or southern DPS green sturgeon.

X. SUPPLEMENTAL INCIDENTAL TAKE STATEMENT

Section 9 of the ESA and Federal regulation pursuant to section 4(d) of the ESA prohibit the take of endangered and threatened species, respectively, without special exemption. Take is defined as to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture or collect, or to attempt to engage in any such conduct. Harm is further defined by NMFS as an act which actually kills or injures fish or wildlife. Such an act may include significant habitat modification or degradation which actually kills or injures fish or wildlife by significantly impairing essential behavioral patterns, including breeding, spawning, rearing, migrating, feeding, or sheltering. Incidental take is defined as take that is incidental to, and not the purpose of, the carrying out of an otherwise lawful activity. Under the terms of section 7(b)(4) and section 7(o)(2), taking that is incidental to and not the purpose of the agency action is not considered to be prohibited taking under the ESA provided that such taking is in compliance with the terms and conditions of this supplemental incidental take statement.

A. Amount or Extent of Take Anticipated

It is anticipated that take associated bridge demolition and dredging activities for the SFOBB East Span Seismic Project will be in the form of injury and mortality as a result of construction activities associated with bridge dismantling for listed CCC steelhead and Central Valley salmonids (Central Valley steelhead, Central Valley spring-run Chinook salmon, Sacramento

River winter-run Chinook salmon), and green sturgeon.

1. Pile Driving

Pile driving with an impact hammer is expected to result in incidental take in the form of injury, mortality to salmonids and green sturgeon through exposure to temporary high SPLs (> 206 dB peak SPL or 187 dB SEL) within the water column during the installation of the temporary trestles and falsework require for bridge dismantling. The number of salmonids and green sturgeon that may be incidentally taken during activities is expected to be small. Because finding dead or injured fish will be difficult due to their small size in relation to the size of the action area, the difficulty in observing dead or injured fish in the waters of the bay due to depth and the presence of predators and scavengers such as birds, NMFS will use the area of sound pressure wave impacts extending into the water column from each pile, and the time period for pile driving as a surrogate for number of fish. For salmonids and southern DPS green sturgeon, those fish located within the 38 m diameter from the pile during attenuated pile driving of the 36-inch diameter steel piles, within the 14 m diameter for unattenuated pile proofing of the 36-inch piles, and within the 65 m distance from the Yerba Buena Island shoreline during the installation of the H-piles may be injured or killed. Beyond these distances, extending out to the 796 m, 3981 m and 1311 m diameters corresponding with SPLs > 150 dB RMS, of the above events fish may exhibit behavioral responses such as agitation or rapid bursts in swimming speeds. If Caltrans' monitoring indicates that sound pressure levels greater than 206 dB peak (re: 1 μPa), or 187 dB SEL (re: 1 $\mu Pa^2 sec$), or 150 dB RMS (re: 1 μPa) extend beyond these distances the amount of incidental take may be exceeded.

2. Dredging and Disposal

Dredging and disposal activities are not expected to result in incidental take of salmonids. Incidental take may occur as injury or mortality of juvenile and adult green sturgeon due to entrainment in a hydraulic dredge. However, entrainment of green sturgeon in a hydraulic dredge is expected to be very low due to the relatively limited area affected by dredging for this project. Because of the difficulty in observing green sturgeon entrainment in dredging equipment in a deep, dark, and turbid aquatic environment[17], NMFS will use the position of the draghead, during operation (i.e., flushing or sucking up water or sediment) of all dredging equipment as a surrogate for the amount of take. If any dredging draghead is operated at a height of more than three feet above the bottom of the estuary, incidental take may have been exceeded.

B. Effect of the Take

In the accompanying supplemental biological opinion, NMFS has determined that the anticipated take is not likely to result in jeopardy to Central Valley salmonids, CCC steelhead or the green sturgeon Southern DPS.

[17] Similarly, any sturgeon entrained would likely be ground up in the dredging equipment and difficult to find in the substrate removed by dredging.

C. Reasonable and Prudent Measures

NMFS believes that the following reasonable and prudent measures are necessary and appropriate to minimize the impacts of incidental take of listed salmonids and green sturgeon.

Caltrans shall:

1. Utilize measures to minimize and avoid the take of green sturgeon from dredging.
2. Utilize measures to minimize and avoid the take of salmonids and green sturgeon from dismantling the existing bridge.
3. Ensure the fisheries and hydroacoustic monitoring program is properly implemented.

D. Terms and Conditions

Caltrans must comply with the following terms and conditions, which implement the reasonable and prudent measures described above.

1. Utilize measures to reduce the take of green sturgeon from dredging.

    a. The draghead of dredges shall be operated with the intake at or below the surface of the material being removed. The intake may be raised a maximum of three feet above the bed for brief periods of purging or flushing of the intake system. At no time shall the draghead be operated at a level higher than three feet above the bed.

2. Utilize measures to reduce the take of listed salmonids and green sturgeon from dismantling the existing bridge.

    a. Ensure all avoidance and minimization measures as described in the Fisheries and Hydroacoustic Monitoring Program during pile driving are properly implemented.

3. Ensure the approved fisheries and hydroacoustic monitoring program is properly implemented.

    a. Real-time monitoring shall be conducted to ensure that underwater sound levels analyzed in this biological opinion do not exceed the distances for the piles described in this opinion. These distances are:

- Attenuated piles, 206 dB peak SPL at 1m (2 m diameter), 187 dB accumulated SEL at 34 m (68 m diameter), and 150 dB RMS at 398 m (796 m diameter);

- Proofing of piles, 206 dB peak SPL at 7 m (14 m diameter), 187 dB accumulated SEL at 19 m (38 m diameter), and 150 dB RMS at 3981 m (7962 m diameter);

- Steel H-piles, 206 dB peak SPL at 10 m, 187 dB accumulated SEL at 65 m (radial distance), and 150 dB RMS at 1311 m.

b. Caltrans shall monitor underwater sound during impact hammer pile driving activities as described in the final monitoring and reporting program. Caltrans shall submit to NMFS a draft monitoring and reporting program for review and approval 60 days prior to the start of in-water impact pile driving or marine foundation removal. This program shall include provisions to provide daily summaries of the hydroacoustic monitoring results (real-time data) to NMFS, as well as more comprehensive final summary reports on a monthly basis during the pile-driving season. Specifically, the monitoring and reporting program shall include:

- Preliminary daily biological and hydroacoustic monitoring reports are to be submitted by close-of-business (COB) the day following pile driving that provides real-time data regarding the distance (actual or estimated using propagation models) to the thresholds (206 dB Peak, 187 dB accumulated SEL, and 150 dB RMS) used in this biological opinion to determine adverse effects to listed species. If underwater sound exceeds these thresholds at the distances provided above from the piles being driven, then NMFS must be contacted within 24 hours before continuing to drive additional piles.

- A final hydroacoustic monitoring summary shall be submitted to NMFS, due 30 days following pile driving events for each temporary structure required for bridge removal. The reports must provide a review of the daily monitoring data and process, as well as any problems that were encountered;

- A description of the locations of hydroacoustic monitoring stations that were used to document the extent of the underwater sound footprint during pile driving activities, including the number, location, distances, and depths of hydrophones and associated monitoring equipment shall also be included in the reports;

- The reports must also provide the total number of pile strikes per pile, the interval between strikes, the peak SPL and SEL per strike, and accumulated SEL per day for each hydroacoustic monitor deployed;

- The reports will also include observations of bird predation and behavior; and evaluation of fish mortality and injury rates through the use of visual observations and collections during pile driving events.

c. All green sturgeon and salmonids killed and collected by this project must be immediately frozen and transferred to the NMFS Southwest Fisheries Science Center Santa Cruz Laboratory Tissue Repository within thirty days of collection.

REPORTING REQUIREMENTS

All reports and other materials to be submitted to NMFS described in the above terms and conditions shall be submitted to:

Jacqueline Meyer c/o the
North Central Coast Office Supervisor
National Marine Fisheries Service
777 Sonoma Ave., Room 325
Santa Rosa, California 95404
Phone (707) 575-6057
Fax (707) 578-3435

XI. REINITATION NOTICE

This concludes formal consultation on the proposed bridge demolition and dredging activities for the San Francisco - Oakland Bay Bridge East Span Seismic Project. As provided in 50 CFR §402.16, reinitiation of formal consultation is required where discretionary Federal agency involvement or control over the actions has been retained (or is authorized by law) and if: 1) the amount or extent of incidental take is exceeded; 2) new information reveals effects of agency actions that may affect listed species or critical habitat in a manner or to an extent not considered in this opinion; 3) the action is subsequently modified in a manner or to an extent not considered in this opinion; or 4) a new species is listed or critical habitat designated that may be affected by the action. In instances where the amount or extent of incidental take is exceeded, formal consultation shall be reinitiated immediately.

XII. CONSERVATION RECOMMENDATIONS

Section 7(a)(1) of the ESA directs Federal agencies to utilize their authorities to further the purposes of the ESA by carrying out conservation programs for the benefit of endangered and threatened species. Conservation recommendations are discretionary agency activities to minimize or avoid adverse effects of a proposed action on listed species or critical habitat, or to develop information.

1. To avoid adverse impacts to anadromous fish species, pile driving with an impact hammer during peak migration periods should be avoided.

2. To avoid attracting fish with lights during nighttime pile driving operations, all pile driving should be limited to daylight hours.

3. To minimize the effects of sound pressure waves to anadromous fish species, sound attenuation methods should be developed and incorporated into all pile driving projects.

4. To avoid entrainment of green sturgeon in hydraulic dredging equipment, the diameter of the draghead intake should be 10 inches or smaller.

5. Caltrans and other local, state, and Federal agencies should provide training for Caltrans environmental and engineering staff that will assist in avoiding or minimizing the impacts of transportation projects on ESA-listed salmonids, green sturgeon and their habitats.

6. Caltrans and other local, state, and Federal agencies should develop and implement pile driving projects using driving frames or pile installation methods that do not preclude the use of sound attenuation systems.

7. Caltrans and other local, state, and Federal agencies should include in bid packages to contractors specific requirements for scheduling construction activities that adhere to seasonal work windows in order to avoid principal migration times for anadromous fish species.

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

XIII. Literature Cited

Adams, P.B., C.B. Grimes, S.T. Lindley, and M.L. Moser. 2002. Status review for North American green sturgeon, *Acipenser medirostris*. NOAA, National Marine Fisheries Service, Southwest Fisheries Science Center, Santa Cruz, CA 50 pp.

Allen, M.A., and T.J. Hassler. 1986. Species Profiles: Life Histories and Environmental Requirements of Coastal Fishers and Invertebrates (Pacific Southwest), Chinook Salmon. U.S. Fish and Wildlife Service, Biological Report 82 (11.49).

Allen, P.J. and J.J. Cech Jr. 2007. Age/size effects on juvenile green sturgeon, *Acipenser medirostris,* oxygen consumption, growth, and osmoregulation in saline environments. Environmental Biology of Fishes 79:211-229.

Allen, P.J., B. Hodge, I. Werner, and J.J. Cech. 2006. Effects of ontogeny, season, and temperature on swimming performance of juvenile green sturgeon (*Acipenser medirostris*). Canadian Journal of Fisheries and Aquatic Sciences 63:1360-1369.

Armstrong, D.A., B.G. Stevens, and J.C. Hoeman. 1982. Distribution and abundance of Dungeness crab and Crangon shrimp, and dredged-related mortality of invertebrates and fish in Grays Harbor, Washington. Technical Report School of Fisheries. University of Washington, Washington Department of Fisheries, and Seattle District Corps of Engineers.

349 pp.

Arseneault, J.S. 1981. Memorandum on Fraser River dredge monitoring programme - 1980. Government of Canada, Fisheries and Oceans, Habitat Management Division. 8 pp.

Barnhart, R.A. 1986. Species profiles: life histories and environmental requirements of coastal fishes and invertebrates (Pacific Southwest), steelhead. United States Fish and Wildlife Service Biological Report 82 (11.60).

Baxter, R., K. Hieb, S. DeLeon, K. Fleming, and J. Orsi. 1999. Report on the 1980-1995 fish, shrimp, and crab sampling in the San Francisco Estuary, California. Edited by J. Orsi. Calif. Depart. Fish and Game, Tech. Rpt. 63, Nov. 1999. 503 pp.

Beamesderfer, R., M. Simpson, G. Kopp, J. Inman, A. Fuller, and D. Demko. 2004. Historical and current information on green sturgeon occurrence in the Sacramento and San Joaquin Rivers and tributaries. S.P. Cramer & Associates, Inc. 46 pp.

Beamesderfer, R.C.P., M.L. Simpson, and G.J. Kopp. 2007. Use of life history information in a population model for Sacramento green sturgeon. Environmental Biology of Fishes. 79 (3-4): 315-337

Benson, R.L., S. Turo, and B.W. McCovey Jr. 2007. Migration and movement patterns of green sturgeon (*Acipenser medirostris*) in the Klamath and Trinity Rivers, California, USA. Environmental Biology of Fishes 79:269-279.

Berg, L. and T.G. Northcote. 1985. Changes in territorial, gill-flaring and feeding behavior in juvenile coho salmon (*Oncorhynchus kisutch*) following short-term pulses of suspended sediment. Canadian Journal of Fisheries and Aquatic Sciences 42: 1410-1417.

Bjornn, T.C., and D.W. Reiser. 1991. Habitat requirements of salmonids in streams. Pages 83-138 *in* W.R. Meehan, editor. Influences of Forest and Rangeland Management on Salmonid Fishes and Their Habitats. American Fisheries Society Special Publication 19. American Fisheries Society. Bethesda, Maryland. 751 pages.

Biological Review Team (BRT). 2005. Green sturgeon (*Acipenser medirostris*), status review update. Prepared for the National Marine Fisheries Service. 36 pp.

Bisson, P.A., G.H. Reeves, R.E. Bilby, and R.J. Naiman. 1997. Watershed management and Pacific salmon; desired future conditions. In D.J. Stouder, P.A. Bisson, and R.J. Naiman (eds.), Pacific salmon and their ecosystems: status and future options, p. 447-474. Chapman and Hall, New York.

Boyd, F.C. 1975. Fraser River dredging guide. Technical Report Series No. PAC/T-75-2. Fisheries and Marine Service, Environment Canada.

Braun, F. 1974a. Monitoring the effects of hydraulic suction dredging on migrating fish in the Fraser River Phase I. Department of Public Works, Pacific Region, Canada.

Braun, F. 1974b. Monitoring the effects of hydraulic suction dredging on migrating fish in the Fraser River Phase II. Department of Public Works, Pacific Region, Canada.

Brewer, P.G. and J. Barry. 2008. Rising Acidity in the Ocean: The Other CO2 Problem. Scientific American. October 7, 2008.

Brown, K. 2007. Evidence of spawning by green sturgeon, *Acipenser medirostris*, in the upper Sacramento River, California. Environmental Biology of Fishes 79:297-303.

Busby, P.J., T.C. Wainwright, G.J. Bryant, L.J. Lierheimer, R.S. Waples, F.W. Waknitz, and I.V. Lagomarsino. 1996. Status Review of West Coast Steelhead from Washington, Idaho, Oregon, and California. National Marine Fisheries Service, August 1996. NOAA Technical Memorandum, National Marine Fisheries Service-NWFSC-27.

California Department of Fish and Game (CDFG). 1998. A report to the Fish and Game Commission: A status review of the spring-run Chinook (*Oncorhynchus tshawytscha*) in the Sacramento River drainage. Candidate Species Status Report 98-01. June 1998.

California Department of Fish and Game (CDFG). 2000. Spring-run Chinook salmon annual report. Prepared for the California Fish and Game Commission. Habitat Conservation Division, Native Anadromous Fish and Watershed Branch. Sacramento, 19 pages.

California Department of Fish and Game (CDFG). 2002. California Department of Fish and Game comments to NMFS regarding green sturgeon listing. California Department of Fish and Game. 79 pp. (plus appendices)

California Fish Tracking Database, unpublished data 2011. California Department of Fish and Game (CDFG). 2011. Interagency Ecological Program. Available: http://www.water.ca.gov/iep/activities/monitoring.cfm. (accessed July 2011).

California Department of Transportation. (Caltrans) 2011. Supplemental information regarding dismantling of the San-Francisco Oakland Bay Bridge. August 11, 2011. 11 pp. (plus figures).

Cech, Jr., J.J., S.I. Doroshov, G.P. Moberg, B.P. May, R.G. Schaffer, and D.W. Kohlhorst. 2000. Biological assessment of green sturgeon in the Sacramento-San Joaquin watershed (phase 1). Final report to the CALFED Bay-Delta Program. Project #98-C-15, Contract #B-81738. Cited in COSWEC 2004.

Chambers, J. 1956. Fish passage development and evaluation program. Progress Report No. 5.

U. S. Army Corps of Engineers, North Pacific Division, Portland, OR.

Cohen and Deng, X. 2000. Artificial reproduction and early life stages of the green sturgeon (*Acipenser medirostris*). Master's Thesis. University of California, Davis. 62 pp.

Cox, P. and D. Stephenson (2007). "A Changing Climate for Prediction." Science 317(5835): 207-208.

Currie, D. & G. Parry. 1996. Effects of scallop dredging on soft sediment community: a large-scale experimental study. Marine Ecology Progress Series 134: 131-150.

Demko, D.B., C. Gemperle, A. Phillips, and S.P. Cramer. 2000. Outmigrant trapping of juvenile salmonids in the lower Stanislaus River, Caswell State Park site, 1999. Prepared for U.S. Fish and Wildlife Service. Prepared by S.P. Cramer and Associates, Inc. Gresham, OR. 146 pp plus appendices.

Deng, X., J.P. Van Eenemaan, and S.I. Doroshov. 2002. Comparison of early life stages and growth of green and white sturgeon. American Fisheries Society Symposium 28:237-248.

Dillon, T.M., and D.W. Moore. 1990. Assessment of dredged material toxicity in San Francisco Bay. Miscellaneous Paper EL-90-20, U.S. Army Corps of Engineers Waterways Experiment Station, Vicksburg, MS.

Dumbauld, B.R., D.L. Holden, and O.P. Langness. In prep. Do sturgeon limit burrowing shrimp populations in Pacific Northwest estuaries. 23pp.

Dunford, W.E. 1975. Space and food utilization by salmonids in marsh habitats in the Fraser River Estuary. M.S. Thesis. University of British Colombia, Vancouver, B.C., 81 pages.

Dutta, L.K. and P. Sookachoff. 1975. Assessing the impact of a 24" suction pipeline dredge on chum salmon fry in the Fraser River. Fish. And Marine Serv., Environment Canada, Tech. Rep. Ser. No. PAC/T-75-26. 24 pp.

Dutta, L.K., 1976. Dredging: Environmental effects and technology. Pages 301-319 *In:* Proceedings of WODCON VII. World Dredging Conference, San Pedro, California.

Emmett, R.L., G.T. McCabe, Jr. and W.D. Muir. 1988. Effects of the 1980 Mount St. Helens eruption on Columbia River estuarine fishes: implications for dredging on Northwest estuaries. Pages 74-91 In: C. A. Simenstad (ed.) Effects of dredging on anadromous Pacific coast fishes. Washington Sea Grant Program. Washington State University. Seattle, Washington.

Emmett, R.L., S.A. Hinton, S.L. Stone, and M.E. Moncao. 1991. Distribution and abundance of

fishes and invertebrates in West Coast estuaries, Volume II: Species life history summaries. ELMR Report NO. 8. NOAA/NOS Strategic Environmental Assessments Division, Rockville, MD. 329 pp.

Enger, P.S. 1981. Frequency Discrimination in Teleosts – Central Peripheral? Institute of Zoophysiology, University of Oslo 3, Norway. Chapter 12.

Erickson, D.L. and M.A. H. Webb. 2007. Spawning periodicity, spawning migration, and size at maturity of green sturgeon, *Acipenser medirostris* in the Rogue River, Oregon, USA. Environmental Biology of Fishes 79:255-268.

Erickson, D.L. and M.A. H. Webb. 2007. Ocean distribution and abundance of green sturgeon. American Fisheries Society Symposium 56:197-211

Erickson, D.L., J.A. North, J.E. Hightower, J.Weber, and L.Lauck. 2002. Movement and habitat use of green sturgeon *Acipenser medirostris* in the Rogue River, Oregon, USA. Journal of Applied Icthyology 18:565-569.

Farr, R.A., and J.C. Kern. 2005. Green sturgeon population characteristics in Oregon. Final progress report. Sport Fish Restoration Project F-178-R, Oregon Department of Fish and Wildlife, Portland, Oregon. 73 pp.

Feely, R.A., C.L. Sabine, K. Lee, W. Berelson, J. Kleypas, V.J. Fabry, and F.J. Millero. 2004. Impact of anthropogenic CO2 on the CaCO3 system in the oceans. Science 305, 362-366.

Feist, M.L. Blake E., James J. Anderson and Robert Miyamoto. 1992. Potential impacts of pile driving on juvenile pink (*Oncorhynchus gorbuscha*) and chum (*O. kept*) salmon behavior and distribution. FRI-UW-9603. Fisheries Resources Institute, University of Washington. Seattle.

Fisher, F.W. 1994. Past and present status of Central Valley Chinook salmon. Conservation Biology 8(3):870-873.

Fukushima L., and E.W. Lesh. 1998. Adult and juvenile anadromous salmonid migration timing in California streams. California Department of Fish and Game 84(3):133-145.

Garcia and Associates. 2008. Caltrans Bay Bridge Project – SAS Temporary Pile Driving Biological Monitoring Reports (Bird Predation and Fish Monitoring Results). Reports to Caltrans: May 6-9, 12-14, and June 12-13, 23-24 2008.

Gaspin, Joel B. 1975. Experimental investigations of the effects of underwater explosions on swimbladder fish, 1: 1973 Chesapeake Bay Tests. Naval Surface Weapons Center Silver Springs Maryland 20910. NSWC/WOL/TR 75-58

Good, T.P., R.S. Waples, and P. Adams (editors). 2005. Updated status of federally listed ESUs of West Coast salmon and steelhead. United States Department of Commerce, NOAA Technical Memorandum. NMFS-NWFSC-66, 598 p.

Greene, C.R., Jr. Ph.D. 2001. Proposed construction impact avoidance and minimization measures for the San Francisco-Oakland Bay Bridge East Span Project. Greeneridge Sciences, Inc., Santa Barbara, California. September 30, 2001.

Gregory, R. S. 1988. Effects of Turbidity on benthic foraging and predation risk in juvenile Chinook salmon. Pages 64-73 In: C. A. Simenstad (ed.) Effects of dredging on anadromous Pacific coast fishes. Washington Sea Grant Program. Washington State University. Seattle, Washington.

Halvorsen, M.B., Casper, B.M., Woodley, C.M., Carlson, T.J., and Popper, A.N. (2011). Predicting and mitigating hydroacoustic impacts from pile installations. NCHRP Research Results Digest 363, Project 25-28, National Cooperative Highway Research Program, Transportation Research Board, National Academy of Sciences, Washington. D.C.

Hastings, M. C. 1995. Physical effects of noise on fishes, *Proceedings of INTER-NOISE 95, The 1995 International Congress on Noise Control Engineering – Volume II*, 979–984.

Hastings, M. C., Popper, A. N., Finneran, J. J., and Lanford, P. 1996. Effects of low frequency sound on hair cells of the inner ear and lateral line of the teleost fish *Astronotus ocellatus*, *Journal of the Acoustical Society of America*, 99(3): 1759-1766.

Hayhoe, K., D. Cayan, C. B. Field, P. C. Frumhoff, E. P. Maurer, N. L. Miller, S. C. Moser, S. H. Schneider, K. N. Cahill, E. E. Cleland, L. Dale, R. Drapek, R. M. Hanemann, L. S. Kalkstein, J. Lenihan, C. K. Lunch, R. P. Neilson, S. C. Sheridan, and J. H. Verville. 2004. Emissions pathways, climate change, and impacts on California. Proceedings of the National Academy of Sciences of the United States of America, volume 101: 12422-12427.

Healey, M.C. 1991. The life history of Chinook salmon (*Oncorhynchus tshawytscha*). Pages 311-393 *In*: C. Groot and L. Margolis (eds.), Life history of Pacific salmon. University of British Columbia Press, Vancouver, British Columbia.

Heublein, J.C. 2006. Migration of Green Sturgeon *Acipenser medirostris* in the Sacramento River. Masters Thesis. San Francisco State University. 63 pp.

Heublein, J.C., J.T. Kelly, C.E. Crocker, A.P. Klimley, and S.T. Lindley. 2009. Migration of green sturgeon, *Acipenser medirostris*, in the Sacramento River. Environmental Biology of Fish 84:245-258.

Hubbs, C.L. and A.B. Rechnitzer. 1952. Report on experiments designed to determine effects of

underwater explosions on fish life. Calif. Department of Fish and Game 38, pp. 333-366.

Illingworth and Rodkin, Inc. 2007. Compendium of Pile Driving Sound Data. Prepared for the California Department of Transportation, September 27, 2007.

Illingworth and Rodkin, Inc. 2008. Hydroacoustic Monitoring Report for Pile Driving of Temporary Piles for the Self-Anchored Suspension Bridge. Report to Caltrans. May 2008.

Ingersoll,.C.G. 1995. Sediment tests. Pages 231-254. In: G. M. Rand (ed.) Fundamentals of aquatic toxicology: effects, environmental fate, and risk assessment. Taylor and Francis Publishers, Washington, D.C.

Israel, J.A., and B. May. 2006a. Green sturgeon in Pacific estuaries: potential impacts of mixed stock fisheries. Presentation at Green Sturgeon Public Scoping Workshops, Sacramento, CA, May 31-June 1, 2006.

Israel, J.A. 2006b. Mixed stock analysis of North American green sturgeon. Presentation at UC Davis, April 4, 2006. Mixed stock analysis of North American green sturgeon. Presentation at UC Davis, April 4, 2006.

Israel, J.A., J.F. Cordes, M.A. Blumberg, and B. May. 2004. Geographic patterns of genetic differentiation among collections of greens sturgeon. North American Journal of Fisheries Management 24:922-937.

Jahn, A. 2004. On the Presence /Absence of Listed Salmonid ESUs in Central San Francisco Bay. Report for the Long Term Maintenance Strategy (LTMS) for the U.S. Army Corps of Engineers dredging program. LTMS Science Group. March 2004.

Kjelson, M.A., P.F. Raquel, and F.W. Fisher. 1982. Life history of fall-run juvenile Chinook salmon (*Oncorhynchus tshawytscha*) in the Sacramento-San Joaquin estuary, California. *In* V.S. Kennedy (editor), Estuarine comparisons, pages 393-411. Academic Press, New York, NY

Kelly, J.T., A.P. Klimley, and C.E. Crocker. 2007. Movement of green sturgeon, *Acipenser medirostris*, in the San Francisco Bay Estuary, California. Environmental Biology of Fishes 79:281-295.

Kirn, R.A., R.D. Ledgerwood and A.L. Jensen. 1986. Diet of subyearling Chinook salmon (*Oncorhynchus tshawytscha*) in the Columbia River estuary and changes effected by the 1980 eruption of Mount St. Helens. Northwest Science 60:191-195.

Klimley, P. A., W. Brostroff, et al. (2009). "Juvenile Salmonid Outmigration and Distribution in the San Francisco Estuary: 2006-2008 Interim Draft Report." Prepared for the U.S. Army Corps of Engineers.

Hearn, A.R. , Chapman, E.D., Klimley, A.P., LaCivita and W.N. Brostoff. 2010. Juvenile Salmonid Outmigration and Distribution in the San Francisco Estuary: 2006-2008 Interim Draft Report. Prepared for the U.S. Army Corps of Engineers.

Kynard, B., E. Parker, and T. Parker. 2005. Behavior of early life intervals of Klamath River green sturgeon, *Acipenser medirostris*, with a note on body color. Environmental Biology of Fishes 72:85-97.

LaSalle, M. 1988. Overview of Dredging Operations (Environmental). Pages 16-22. In C.S. Manooch, III (ed) Impacts of Dredging on Anadromous Fish: a transcript of presentations at a workshop, Raleigh, NC, Sept 18-19, 1987. NOAA Tech. Memo. National Marine Fisheries Service-SEFC-210.

Leidy, R.A. 2000. Steelhead. In: Goals Project. Baylands Ecosystem Species and Community Profiles: Life histories and environmental requirements of key plants, fish, and wildlife. Prepared by the San Francisco Bay Area Wetlands Ecosystem Goals Project, P.R. Olofson, editor. San Francisco Bay Regional Water Quality Control Board, Oakland, California.

Leidy, R. A., G. S. Becker & B. N. Harvey. 2003. Historical distribution and current status of Steelhead (*Oncorhynchus mykiss*), Coho salmon (*O. kisutch*) and Chinook salmon (*O. tshawytscha*) in streams of the San Francisco Estuary, California. Center for Ecosystem Management and Restoration, Oakland, CA, Oakland, CA.

Leidy, R. A., G. S. Becker & B. N. Harvey. 2005. Historical distribution and current status of steelhead/rainbow trout (*Oncorhynchus mykiss*) in streams of the San Francisco Estuary, California. Center for Ecosystem Management and Restoration, Oakland, CA, Oakland, CA.

Levings, C.D. 1982. Short term use of low-tide refugia in a sand flat by juvenile chinook, (*Oncorhynchus tshawytscha*), Fraser River estuary. Canadian Technical Reports of Fisheries and Aquatic Sciences, Number 1111. 7 pages.

Levy, D.A., and T.G. Northcote. 1982. Juvenile salmon residency in a marsh area of the Fraser River estuary. Canadian Journal of Fisheries and Aquatic Sciences 39:270-276.

Lindley, S.T., Schick, R., May B.P., Anderson J.J., Greene, S., Hanson, C., Low A., McEwan, D., MacFarlane R.B., Swanson, C., and J.G. Williams. 2004.6. Population structure of threatened and endangered Chinook salmon ESUs in California's Central Valley basin. NOAA TM NMFS SWFSC 360. 56 pp.

Lindley, S.T., R.S, Schick, E. Mora, P.B. Adams, J.J. Anderson, S. Greene, C. Hanson, B.P. May, D.R. McEwan, R.B. MacFarlane, C. Swanson, and J.G. Williams. 2007. Framework for assessing viability of threatened and endangered Chinook salmon and steelhead in the Sacramento-San Joaquin Basin. San Francisco Estuary and Watershed Science 5(1): Article 4. 26 pages. Available at: http://repositories.cdlib.org/jmie/sfews/vol5/iss1/art4.

Lindley, S.T., M.L. Moser, D.L. Erickson, M. Belchik, D.W. Welch, E. Rechisky, J.T. Kelly, J.C. Hublein, and A.P. Klimley. 2008. Marine migration of North American green sturgeon.

Luers, A.L., Cayan, D.R., and G. Franco. 2006. Our Changing Climate, Assessing the Risks to California. A summary report from the California Climate Change Center. 16 pages.

Luoma, S. N., and D. J. H. Phillips. 1988. Distribution, variability, and impacts of trace elements in San Francisco Bay. Mar. Pollut. Bull. 19:413-425.

Mayfield, R.B. and J.J. Cech. 2004. Temperature effects on greens sturgeon bioenergetics. Transactions of the American Fisheries Society 133:961-970.

McCauley, J.E., R.A. Parr, & D.T. Hancock. 1976. Benthic infauna and maintenance dredging: a case study. Water Research 11:233-242.

McDonald, J. 1960. The behavior of Pacific salmon fry during the downstream migration to freshwater and saltwater nursery areas. Journal of the Fisheries Research Board of Canada 17:655-676

McEwan, D. 2001. Central Valley steelhead. Pages 1-44 *in* R.L. Brown, editor. Contributions to the Biology of Central Valley Salmonids. Volume 1. California Department of Fish and Game Bulletin 179.

MacFarlane, B.R., and E.C. Norton. 2002. Physiological ecology of juvenile Chinook salmon (*Oncorhynchus tshawytscha*) at the southern end of their distribution, the San Francisco Estuary and Gulf of the Farallones, California. Fisheries Bulletin 100:244-257.

Tuck, I.D., S.J. Hall, & M.R. Robertson. 1998. Effects of physical trawling disturbance in a previously unfished sheltered Scottish sea loch. Marine Ecology-Progress Series, 162: 227-242.

Meehan, W.R., and T.C. Bjornn. 1991. Salmonid distribution and life histories. Pages 47-82 *in* Influences of Forest and Rangeland Management on Salmonid Fishes and Their Habitats. W.R. Meehan, editor. American Fisheries Society Special Publication 19. American Fisheries Society. Bethesda, Maryland.

Morton, J.W. 1977. Ecological effects of dredging and dredge spoil disposal: a literature review. U.S. Fish and Wildlife Service Technical Paper No. 94. 33 pp.

Moser, M.L. and S.T. Lindley. 2007. Use of Washington estuaries by subadult and adult green sturgeon. Environmental Biology of Fishes. 79:243-253.

Moyle, P.B. 2002. Inland fishes of California, 2nd edition. University of California Press, Berkeley and Los Angeles, CA. 502 pp.

Moyle P.B., P.J. Foley, and R.M. Yoshiyama. 1992. Status of green sturgeon, *Acipenser medirostris,* in California. Final Report submitted to the National Marine Fisheries Service, University of California, Davis, 11 pp.

Myers, J.M, R.G. Kope, G.J. Bryant, D. Teel, L.J. Lierheimer, T.C. Wainwright, W.S. Grant, F.W. Waknitz, K. Neely, S.T. Lindley, and R.S. Waples. 1998. Status review of Chinook salmon from Washington, Idaho, Oregon, and California. U.S. Dept. of Commerce, NOAA Technical Memorandum. National Marine Fisheries Service-NWFSC-35. 443 pp.

Nakamoto, R.J., T.T. Kisanuki, and G. H. Goldsmith. 1995. Age growth of Klamath River green sturgeon (*Acipenser medirostris*). U.S. Fish and Wildlife Service Project 93-FP-13, Yreka, CA, 20 pp.

National Marine Fisheries Service (NMFS). 1997. Status review update for West Coast Steelhead from Washington, Idaho, Oregon, and California. Prepared by the West Coast Steelhead Biological Review Team; unpublished manuscript dated July 7, 1997. 71 pp.

National Marine Fisheries Service (NMFS). 2006. Biological Opinion for the Stockton Deep Water Ship Channel Maintenance Dredging and Levee Stabilization Project. April 4, 2006.

National Marine Fisheries Service (NMFS) 2007. Biological Opinion for Dredging Activities at Port Sonoma. December 3, 2007.

National Marine Fisheries Service. 2008. Proposed Designation of Critical Habitat for the Southern Distinct Population Segment of North American Green Sturgeon. Biological Report. June 2008. Unpublished report. 75 pp.

National Marine Fisheries Service. 2011a. Central Valley Recovery Domain 5-Year Review: Summary and Evaluation of Sacramento River Winter-run Chinook Salmon ESU. NMFS, Southwest Region. Long Beach, California, 38 pp.

National Marine Fisheries Service. 2011b. Central Valley Recovery Domain 5-Year Review: Summary and Evaluation of Central Valley Spring-run Chinook Salmon ESU. NMFS, Southwest Region. Long Beach, California, 34 pp.

National Marine Fisheries Service. 2011c. Central Valley Recovery Domain 5-Year Review: Summary and Evaluation of Central Valley Steelhead DPS. NMFS, Southwest Region. Long Beach, California, 34 pp.

Nguyen, R.M. and C.E. Crocker. 2007. The effects of substrate composition on foraging behavior and growth rate of larval green sturgeon, Acipenser medirostris. Environmental Biology of Fishes 79:231-241.

Oliver, J.S., P.N. Slattery, L.W. Hulberg, and J.W. Nybakken. 1977. Patterns of succession in benthic infaunal communities following dredging and dredged material disposal in Monterey Bay. Technical Report D-77-27. U.S. Army Corps of Engineers, Waterways Experiment Station, Vicksburg, Mississippi.

Osgood, K. E. (editor). 2008. Climate Impacts on U.S. Living Marine Resources: National Marine Fisheries Service Concerns, Activities and Needs. U.S. Dep. Commerce, NOAA Tech. Memo. NMFSF/ SPO-89, 118 p.

Parrish, R.H., C.S. Nelson, and A. Bakun. 1981. Transport mechanisms and reproductive success of fishes in California Current. Biological Oceanography 1:175-203.

Popper, A. N. 1997. Sound detection by fish: structure and function *in* using sound to modify fish behavior at power production and water-control facilities. A workshop December 12-13, 1995. Portland State University, Portland Oregon Phase II: Final Report *ed.* Thomas Carlson and Arthur Popper 1997. Bonneville Power Administration Portland Oregon.

Port of Oakland. 1998. Oakland Harbor Navigation Improvement (-50 foot) Project. Final Environmental Impact Statement/Environmental Impact Report. May.

Radtke, L. D. 1966. Distribution of smelt, juvenile sturgeon, and starry flounder in the Sacramento-San Joaquin Delta with observations on food of sturgeon. Pages 115-129 *in*: J. L. Turner and D. W. Kelley (editors). Ecological studies of the Sacramento-San Joaquin Delta Part II: Fishes of the Delta. California Department of Fish and Game Fish Bulletin.

Reilly, F.J., J.U. Clarke, V.A. McFarland, C.H. Lutz, and A.S. Jarvis. 1992. Review and analysis of the literature regarding potential impacts of dredged material disposal in central San Francisco Bay on fisheries and contaminant bioavailability. U.S. Army Corps of Engineers, Waterways Experiment Station, Vicksburg, Mississippi.

Reiser, D.W., and T.C. Bjornn. 1979. Habitat requirements of anadromous salmonids. *In*: Influence of Forest and Rangeland Management on Anadromous Fish Habitat in the Western United States and Canada. W.R. Meehan, editor. U.S. Department of Agriculture Forest Service General Technical Report PNW-96.

San Francisco Estuary Project. 1992. State of the Estuary, A report on conditions and problems in the San Francisco Bay/Sacramento-San Joaquin Delta Estuary. Prepared under Cooperative Agreement #CE-009486-02 with the U.S. Environmental Protection Agency by the Association of Bay Area Governments, Oakland, California, June 1992. 270 pp.

Scavia, D., J.C. Field, D.F. Boesch, R.W. Buddemeier, V. Burkett, D.R. Cayan, M. Fogarty, M.A. Harwell, R.W. Howarth, C. Mason, D.J. Reed, T.C. Royer, A.H. Sallenger, and J.G. Titus. 2002. Climate Change Impacts on U.S. Coastal and Marine Ecosystems. Estuaries, volume 25(2): 149-164.

Schneider, S. H. 2007. The unique risks to California from human-induced climate change. California State Motor Vehicle Pollution Control Standards; Request for Waiver of Federal Preemption, presentation May 22, 2007.

Scholik, A. R. and Yan, H. Y. 2001. Effects of underwater noise on auditory sensitivity of a cyprinid fish, *Hearing Research*, 152: 17-24.

Servizi, J.A. 1988. Sublethal effects of dredged sediments on juvenile salmon. Pages 57-63 In: C. A. Simenstad (ed.) Effects of dredging on anadromous Pacific coast fishes. Washington Sea Grant Program. Washington State University. Seattle, Washington.

Shapovalov, L., and A.C. Taft. 1954. The life histories of the steelhead rainbow trout (*Salmo gairdneri gairdneri*) and silver salmon (*Oncorhynchus kisutch*) with special reference to Waddell Creek, California, and recommendations regarding their management. California Department of Fish and Game, Fish Bulletin No. 98. Sacramento.

Shin, Hyeon Ok. 1995. Effect of the piling work noise on the behavior of snakehead (*Channa argus*) in the aquafarm. J. Korean Fish. Soc. 28(4) 492-502.

Shirvell, C.S. 1990. Role of instream rootwads as juvenile coho salmon (*Oncorhynchus kisutch*) and steelhead trout (*O. mykiss*) cover habitat under varying stream flows. Canadian Journal of Fisheries and Aquatic Sciences 47:852-860.

Sigler, J. W., T.C. Bjorn and F.H. Everest. 1984. Effects of chronic turbidity on density and growth of steelheads and coho salmon. Trans. Am. Fish. Soc. 111:63-69.

Sigler, J.W. 1988. Effects of chronic turbidity on anadromous salmonids: recent studies and assessment techniques perspective. Pages 26-37 In: C. A. Simenstad (ed.) Effects of dredging on anadromous Pacific coast fishes. Washington Sea Grant Program. Washington State University. Seattle, Washington. Sonalysts, Inc. Waterford CT 06385.

Skinner, J. E. 1962. An historical review of the fish and wildlife resources of the San Francisco

Bay area. California Department of Fish and Game, Water Projects Branch Report no. 1, Sacramento, California: California Department of Fish and Game. 226 pp.

Smith, D.M., Cusack, S., Colman, A.W., Folland, C.K., Harris, G.R., and Murphy, J.M. 2007. Improved surface temperature prediction for the coming decade from a global climate model. Science 317:796-799.

Southwest Fisheries Science Center. 2008. Memorandum from Usah Varanasi (Northwest Fisheries Science Center) and Norm Bartoo (Southwest Fisheries Science Center) to D. robber Lohn (Nortwest Region, NMFS) and Rodney R. McInnis (Southwest Region, NMFS) evaluating the causes of low 2007 Coho and Chinook Salmon Returns. February 22.

Turley, C. 2008. Impacts of changing ocean chemistry in a high-CO2 world. Mineralogical Magazine, February 2008, 72(1). 359-362.

Tutty, B. D. 1976. Assessment of techniques used to quantify salmon smolt entrainment by a hydraulic suction hopper dredge in the Fraser River estuary. Fish. And Mar. serv. Environment Canada. Tech. Rept. Ser. No. PAC/T-76-16.

Van Eenennaam, J. P., J. Linares-Casenave, X. Deng, and S. I. Doroshov. 2005. Effect of incubation temperature on green sturgeon embryos, *Acipenser medirostris*. Environmental Biology of Fishes 72:145-154.

Van Eenennaam, J. P., J. Linares, S. I. Doroshov, D. C. Hillemeier, T. E. Willson, and A. A. Nova. 2006. Reproductive conditions of the Klamath River green sturgeon. Transactions of the American Fisheries Society 135:151-163.

Van Eenennaam, J. P., M. A. H. Webb, X. Deng, S. I. Doroshov, R. B. Mayfield, J. J. Cech, D. C. Hillemeier, and T. E. Willson. 2001. Artificial spawning and larval rearing of Klamath River green sturgeon. Transactions of the American Fisheries Society 130:159-165.

Vogel, D. A. 2008. Evaluation of Adult Sturgeon Migration at the Glenn-Colusa Irrigation District Gradient Facility on the Sacramento River. Final Report. Natural Resources Scientists, Inc. April 2008. 33 pp.

USACOE. October 31, 2001. Letter to Mr. Dennis Mulligan, California Department of Transportation, regarding review of the sediment test results.

U.S. Fish and Wildlife Service (USFWS). 2002. Spawning areas of green sturgeon *Acipenser medirostris* in the upper Sacramento River California. U.S. Fish and Wildlife Service, Red Bluff, CA.

Watling, L., R.H. Findlay, L.M. Lawrence & D.F. Schick. 2001. Impact of a scallop drag on the sediment chemistry, microbiota, and faunal assemblages of a shallow subtidal marine benthic community. Journal of Sea Research, 46: 309-324.

Whitman, R.P., T.P. Quinn and E.L. Brannon. 1982. Influence of suspended volcanic ash on homing behavior of adult Chinook salmon. Transactions of the American Fisheries Society 113:142-150.

Williams, T.H. S.T. Lindley, B.C. Spence, and D. A. Boughton. 2011. Status Review Update for Pacific Salmon and Steelhead Listed Under the Endangered Species Act: Southwest 17 May 2011 – Update to 5 January 2011 report. National Marine Fisheries Service Southwest Fisheries Science Center. Santa Cruz. CA.

Yoshiyama, R.M., F.W. Fisher, and P.B. Moyle. 1998. Historical abundance and decline of Chinook salmon in the Central Valley region of California. North American Journal of Fisheries Management 18:487-521.

A. Federal Register Notices Cited

58 FR 33212. National Marine Fisheries Service. Endangered and Threatened Species: Final Rule to Designate Critical Habitat for the Sacramento River winter-run Chinook Salmon. Federal Register 58:33212 June 16, 1993.

59 FR 440. National Marine Fisheries Service. Final Rule. Endangered and Threatened Species: Status of Sacramento River winter-run Chinook Salmon: Reclassified Endangered. Federal Register 59:440 January 4, 1994.

62 FR 43937: National Marine Fisheries Service. Final Rule Listing of Several Evolutionary Significant Units of West Coast Steelhead. Federal Register 62:43937-43954. August 18, 1997.

69 FR 33102. National Marine Fisheries Service. Proposed rule; request for comments. Endangered and Threatened Species: Proposed Listing Determinations for 27 ESUs of West Coast Salmonids. June 14, 2004.

70 FR 37160. National Marine Fisheries Service. Final Rule. Endangered and Threatened Species: Final Listing Determinations for 16 ESUs of West Coast Salmon, and Final 4(d) Protective Regulations for Threatened Salmonid ESUs. June 28, 2005.

70 FR 52488: National Marine Fisheries Service. Final critical habitat designations for 19 West Coast salmon and steelhead ESUs. Federal Register 70:52488–52627. September 2, 2005.

71 FR 834: National Marine Fisheries Service. Final Listing Determinations for Ten Distinct Population Segments of West Coast Steelhead; Final Rule. Federal Register 71:834-862. January 5, 2006.

71 FR 17557: National Marine Fisheries Service. Final Rule: Endangered and Threatened Wildlife and Plants: Threatened Status for Southern Distinct Population Segment of North American Green Sturgeon. Federal Register 73:17757-17766. April 7, 2006.

71 FR 52084: National Marine Fisheries Service. Endangered and Threatened Wildlife and Plants: Proposed Rulemaking to Designate Critical Habitat for the Threatened Southern Distinct Population Segment of North American Green Sturgeon. Federal Register 73:52084-52109. September 8, 2008.

71 FR 17386: National Marine Fisheries Service. Proposed Rule: Endangered and Threatened Wildlife and Plants: Proposed Threatened Status for Southern Distinct Population Segment of North American Green Sturgeon. Federal Register 70:1738617401. April 6, 2005.

74 FR 52300: National Marine Fisheries Service. Endangered and Threatened Wildlife and Plants: Final rulemaking to designate critical habitat for the threatened southern distinct population segment of north American green sturgeon. Federal Register 74: 52300-52351. October 2009.

76 FR 50447: National Marine Fisheries Service. Endangered and Threatened Species; 5-Year Reviews for 5 Evolutionarily Significant Units of Pacific Salmon and 1 Distinct Population Segment of Steelhead in California. Federal Register 76: 50447-50448. August 2011.

B. Personal Communications

Mark D'Avignon, Dredged Material Management Office, U.S. Army Corps of Engineers, Fisheries Biologist, Personal communications with Jacqueline Pearson Meyer, NMFS January 2012.

Jeffrey Jahn, National Marine Fisheries Service (NMFS) Biologist, Personal communications with Jacqueline Pearson Meyer, NMFS, January 2012.

Melinda Molnar, Caltrans, Senior Fisheries Biologist and Hydroacoustic Lead. Personal communications with Jacqueline Pearson Meyer, NMFS, regarding the Mad River, Ten Mile River and Van Duzen River Bridge Projects. 2011-2012.

David Woodbury, National Marine Fisheries Service. Personal communications with Jacqueline Pearson Meyer, NMFS. 2012.

Enclosure 2

Bridge Demolition and Dredging Activities for the San Francisco-Oakland Bay Bridge East Span Seismic Project.

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

Statutory and Regulatory Information

The Magnuson-Stevens Fishery Conservation and Management Act (MSA), as amended by the Sustainable Fisheries Act of 1996, establishes a national program to manage and conserve the fisheries of the United States through the development of federal Fishery Management Plans (FMPs), and federal regulation of domestic fisheries under those FMPs, within the 200-mile U.S. Exclusive Economic Zone ("EEZ") 16 U.S.C. §1801 *et seq*. To ensure habitat considerations receive increased attention for the conservation and management of fishery resources, the amended MSA required each existing, and any new, FMP to "describe and identify essential fish habitat for the fishery based on the guidelines established by the Secretary under section 1855(b)(1)(A) of this title, minimize to the extent practicable adverse effects on such habitat caused by fishing, and identify other actions to encourage the conservation and enhancement of such habitat." 16 U.S.C. §1853(a)(7). Essential Fish Habitat (EFH) is defined in the MSA as "those waters and substrate necessary to fish for spawning, breeding, feeding, or growth to maturity" 16 U.S.C. §1802(10). The components of this definition are interpreted at 50 C.F.R. §600.10 as follows: "Waters" include aquatic areas and their associated physical, chemical, and biological properties that are used by fish and may include aquatic areas historically used by fish where appropriate; "substrate" includes sediment, hard bottom, structures underlying the waters, and associated biological communities; "necessary" means the habitat required to support a sustainable fishery and the managed species' contribution to a healthy ecosystem; and "spawning, breeding, feeding, or growth to maturity" covers a species' full life cycle.

Pursuant to the MSA, each federal agency is mandated to consult with NMFS (as delegated by the Secretary of Commerce) with respect to any action authorized, funded, or undertaken, or proposed to be, by such agency that may adversely affect any EFH under this Act 16 U.S.C. §1855(b)(2). The MSA further mandates that where NMFS receives information from a Fishery Management Council or federal or state agency or determines from other sources that an action authorized, funded, or undertaken, or proposed to be, by any federal or state agency would adversely affect any EFH identified under this Act, NMFS has an obligation to recommend to such agency measures that can be taken by such agency to conserve EFH. 16 U.S.C. §1855(4)(A). The term "adverse effect" is interpreted at 50 C.F.R. §600.810(a) as any impact that reduces quality and/or quantity of EFH and may include direct or indirect physical, chemical, or biological alterations of the waters or substrate and loss of, or injury to, benthic organisms, prey species and their habitat, and other ecosystem components, if such modifications reduce quantity and/or quality of EFH. In addition, adverse effects to EFH may result from actions occurring within EFH or outside EFH and may include site-specific or habitat-wide impacts, including individual, cumulative, or synergistic consequences of actions.

If NMFS determines that an action would adversely affect EFH and subsequently recommends measures to conserve such habitat, the MSA proscribes that the Federal action agency that receives the conservation recommendation must provide a detailed response in writing to NMFS within 30 days after receiving EFH conservation recommendations. The response must include a description of measures proposed by the agency for avoiding, mitigating, or offsetting the impact of the activity on EFH. In the case of a response that is inconsistent with NMFS EFH conservation recommendations, the Federal agency must explain its reasons for not following the recommendations. 16 U.S.C. §1855(b)(4)(B).

I. BACKGROUND AND CONSULTATION HISTORY

On August 5, 2011, NMFS received the California Department of Transportation's (Caltrans) letter requesting re-initiation of EFH consultation for the seismic retrofit of San Francisco-Oakland Bay Bridge (SFOBB) for additional details, project updates, and activities related to dismantling of the old structure between San Francisco and Alameda Counties, California.

Caltrans originally initiated consultation on construction of the new bridge and dismantling of the existing bridge in 2001. The original 2001 Biological Opinion (BO) includes EFH conservation recommendations, primarily for turbidity and impacts to eelgrass associated with dredging. In response to EFH and other recommendations, terms, and conditions, Caltrans developed a $15.5 million package that included $1 million dollars to be used in partnership with NMFS for bay-wide eelgrass research, and $2.5 million for eelgrass and sand flat restoration. Approximately $1 million of the $2.5 million for eelgrass and sand flat restoration was spent on a pilot project in Berkeley. The remaining funds, which with accrued interest now total approximately $1.9 million, will be used for further eelgrass mitigation/restoration in San Francisco Bay. Caltrans eelgrass mitigation was based on 3.6 acres of predicted impacts, and only 1.5 acres were actually impacted.

Supplemental consultations and reinitiations have occurred since the 2001 BO as outlined in the preceding BO (see Section I. Consultation History).

II. PROPOSED ACTION

Dismantling of the original SFOBB is proposed and the project is described in the preceding BO. The activities and avoidance/minimization measures specifically relevant to EFH are described here in additional detail. Sections of the bridge would be dismantled in phases occurring from west to east starting at the Yerba Buena Island (YBI) Cantilever section, followed by 504' and then 288' spans, and finally the Oakland Shore spans. To facilitate dismantling of the original bridge, four sets of temporary structures (2 trestles, and 2 sets of falsework) would be constructed in four phases, with approximately one set estimated to be constructed per year. The estimated number of piles required for the temporary structures is based the maximum number potentially needed.

Construction of the YBI Access Trestle is proposed for summer or fall of 2012, would be in place an estimated 2-4 years, and would require a maximum of 100 H-piles, driven by impact hammer. YBI Trestle would result in temporary fill of 1.6 cubic yards and temporary shading of 7,000 square feet.

Construction of the Oakland Access Trestle is dependent on the contractor and whether they prefer to do the work by barge[18]. If constructed (between 2014 and 2017), the trestle would be in place an estimated 1-4 years, and would require a maximum of 700 18" to 36" pipe piles, driven by vibratory hammer with an estimated 10% of those piles proofed by impact hammer. The trestle would be constructed parallel to the southern side of the existing east span. The Oakland Access Trestle would result in temporary fill of 1800 cubic yards and temporary shading of 96,000 square feet (maximum).

Additional falsework for bridge dismantling may require installation of a maximum of 2,540 pilings below the bridge. Falsework would be installed beneath the existing structure. Construction of the falsework for dismantling of the cantilever section is proposed for 2013-2014, would be in place an estimated 1-2 years, and would require a maximum of 440 piles, driven by vibratory hammer with an estimated 10% of those piles proofed by impact hammer. Cantilever falsework would result in temporary fill of 2924 cubic yards. Construction of the falsework for dismantling of the 504' and 288' spans is proposed for 2014-2016 and would be in place an estimated 1-3 years. Falsework for the removal of the 504' spans would require a maximum of 450 24' to 36' pipe piles. Falsework for the removal of the 288' spans would require a maximum of 700 18" to 36" pipe piles. Piles would be driven by vibratory hammer with an estimated 10%

[18] Construction of the Oakland Access Trestle is dependent on the contractor and whether they prefer to do the work by barge. If work by barge is included by the contractor, the Oakland Trestle may not be built, or may only be partially built, along with dredging of the access channel. Impacts and conservation recommendations for dredging the access channel were addressed in the 2001 Biological Opinion.

of those piles proofed by impact hammer. Falsework for the removal of the 504' and 288' spans would result in temporary fill of 3947 cubic yards. A maximum of 150 other pilings (18" to 36" pipe piles) may be required for coffer dams, spuds, fenders, or other temporary structures, as needed. Other pilings may result in temporary fill of up to 1030 cubic yards of fill.

Dismantling of each section would most likely begin with installation of falsework, removal of concrete decks, followed by dismantling and removal of the steel structures at and above the bridge deck, and finally the dismantling and removal of steel towers that supported the superstructure. Upon completion of bridge dismantling, all falsework would be removed and, whenever possible, temporary pilings would be fully extracted by rocking or vibrating out. If pilings cannot be fully extracted, they will be cut off below the mudline. Dismantling would also eventually include removal of marine foundations, but at this time there is insufficient information on means and methods to determine potential impacts to EFH. Removal of marine foundations will be addressed in a supplemental consultation when the process has been further developed.

Dredging may also occur but was covered under previous consultations in 2001 and 2009, and the current Corps of Engineers permit includes additional dredge episodes and sufficient cubic yardage to cover the dismantling activities described herein. Caltrans was originally permitted for four dredging episodes. They have dredged twice already under the current permit and have 2 episodes left - one for the barge access channel along the south side of the bridge from E11 to E21 and one for around the pier foundations. They currently do not anticipate any increases in volume, area, or depth. Dredging will go through DMMO process for sediment characterization and disposal.

BMPs and conservation measures include the following:

- Debris from bridge dismantling, including lead paint and asbestos, will be contained with netting and tenting and will not be allowed to enter the water (Caltrans 2011).

- Temporary structures and pilings in the Bay will be fully removed upon completion of the project (Caltrans 2011).

- Caltrans will continue to perform turbidity monitoring during activities with the potential to produce turbidity and suspended sediment. Monitoring will be conducted in accordance with methods and standards outlined in the Water Quality Self-Monitoring Program required by RWQCB Order No. R2-2002-0011. The Department will ensure, to the extent practical, that turbidity generated by construction activities do not exceed 50 NTU or result in incremental increase greater than 10% of the background NTU at a distance greater than 30 meters (100 feet) from the activity, when the activity occurs within 1,000 meters (3,200 feet) of an eelgrass bed or sand flat, or as required by the RWQCB (Galvez-Abadia 2011).

- Caltrans proposes project-wide eelgrass surveys conducted annually at both YBI and Oakland, during the growing season, during all years which have in-water work. Surveys

will be consistent with prior eelgrass surveys performed for this project from 1999 to 2007 (Galvez-Abadia 2011).

The BMPs described as part of the proposed action in the consultation initiation package, in Caltrans' email outlining proposed turbidity monitoring and eelgrass surveys (Galvez-Abadia 2011), and at the Interagency Meetings (June 23 & October 27, 2011) are effective to reduce or avoid some adverse effects to EFH. NMFS regards these conservation measures as integral components of the proposed action and expects that all proposed activities will be completed consistent with those measures. We have completed our effects analysis accordingly. Any deviation from these conservation measures will be beyond the scope of this consultation and may require supplemental consultation to determine what effect the modified action is likely to have on EFH.

III. ACTION AREA

For purposes of this EFH consultation, the action area occurs between Yerba Buena Island and Oakland along the length of the original San Francisco-Oakland Bay Bridge eastern spans. The length of the bridge to be dismantled extends approximately 2.3 miles from west to east over Yerba Buena Island, a deep water ship channel, sand and mudflats, and the Oakland Touch Down (OTD) area**.** The YBI Trestle would be constructed extending out from the southeastern shoreline of Yerba Buena Island in an area less than 10 feet deep and characterized by relatively light sediment deposits over bedrock. Eelgrass has been documented in Coast Guard Cove near the proposed YBI Trestle. Surveys performed annually 1999-2005 and in 2007 show variability in the spatial extent of the beds. The closest documented eelgrass to the YBI Trestle varied in distance from 30 - 130 meters when present; no eelgrass was documented in four out of nine years surveyed. The Oakland Trestle and the falsework for dismantling the 288' spans are proposed in a shallow area characterized by mudflats. The trestle would extend westward from the Oakland shoreline along the south edge of the existing bridge. The closest eelgrass to the Oakland Trestle documented in previous surveys ranged from 20 – 150 meters and was present every year surveys were conducted.

IV. EFFECTS OF THE ACTION

Based on information provided in the Biological Assessment and developed during consultation, NMFS concludes that the proposed action would adversely affect EFH for various federally managed species within the Pacific Groundfish FMP, Coastal Pelagics FMP, and the Pacific Salmon FMP. The proposed bridge superstructure and support dismantling could adversely affect EFH, including estuary HAPC due to: (1) temporary turbidity/suspended sediment effects, (2) temporary elevated levels of underwater sound, (3) temporary loss of subtidal habitat, (4) temporary disturbance of benthic habitat, and (5) temporary increase of shaded areas.

Installation and pulling of temporary piles will result in short-term localized increases in turbidity. Considerable resuspension of bottom sediments is expected to occur with piling removals. If sediment loads remain high for an extended period of time, the primary productivity of an aquatic area may be reduced (Cloern 1987). Turbidity would generally be expected to dissipate quickly due to strong currents in the project area. However, the cumulative impact may be significant as large numbers of pilings are proposed for installation and removal over an extended period of time. Fish may suffer reduced feeding ability (Benfield and Minello 1996) and be prone to fish gill injury (Nightingale and C.A. Simenstad 2001) if exposed to excessive high levels of turbidity However, turbidity impacts to fish are expected to be temporary and minor as fish tend to move out of areas with persistently high levels of suspended sediment.

Increased turbidity from sediment resuspension in the water column can reduce light penetration and lower the rate of photosynthesis for submerged aquatic vegetation (SAV) (Dennison 1987). SAV in the form of eelgrass (*Zostera* sp.) has been documented near the project area, and is designated as an EFH Habitat Area of Particular Concern (HAPC). Eelgrass is an ecologically important SAV, providing structure and refuge for estuarine fish. Eelgrass beds serve as a refuge from predation, food source, and nursery for many commercially and recreational important finfish and shellfish species. In addition, eelgrass beds provide physical benefits in bays and estuaries, dampening wave and current action, trapping suspended particulates, and reducing erosion by stabilizing the sediment. Turbidity generated within 250 meters of eelgrass beds has the potential for indirect impacts due to reduction in light levels. The eelgrass monitoring proposed by Caltrans may detect potential impacts due to turbidity generated by project activities if distribution and densities are compared to a suitable control site. If eelgrass surveys indicate a significant decline in distribution or density due to the dismantling project activities (i.e., compared to control site conditions), NMFS will consider dismantling impacts within the context of the 3.6 acres of originally predicted impacts for which the mitigation package was developed.

Caltrans has included measures to monitor and minimize turbidity in San Francisco Bay to satisfy Regional Water Quality Control Board requirements. However, light monitoring for photosynthetically active radiation (PAR) in nearby eelgrass beds is not proposed. Water column turbidity reduces the amount of light available for photosynthesis and consequently affects the depth distribution, density and productivity of eelgrass (Thayer 1984; Zimmerman 1991; Lee 2007). Eelgrass in San Francisco Bay is adapted to growing in low light environments, but if the period of irradiance-saturated photosynthesis (H_{sat}) falls below 3-5 hours per day, growth is negatively affected (Zimmerman 1991). Light monitoring provides an opportunity to avoid and minimize impacts associated with increased turbidity, which is preferable to mitigation for impacts. Monitoring for turbidity levels does not equate to H_{sat} because it does not take light levels into account.

Pile driving for this project will create elevated underwater sound pressure waves in EFH with potential impacts to fish species managed under the MSA. Fish can be injured or killed when exposed to elevated underwater sound pressure waves generated from pile driving. Elevated sound levels will temporarily adversely affect EFH. In most cases fish will likely leave the area in

response to sound transmitted through water and sediment. In some situations they may be injured or killed. Noise impacts to fish are described in detail in the preceding BO (see Section VI. Effects of the Action).

A maximum of approximately 0.24 acres of estuarine benthic EFH in San Francisco Bay will be impacted by temporary fill associated with pilings. These areas will also experience additional disturbance upon piling removal. The fine grain sediment associated with mudflats within the project area is considered foraging habitat for some species of fish managed under the Pacific Groundfish FMP, providing a substrate for infaunal and bottom-dwelling organisms, such as polychaete worms, crustaceans, and other EFH prey types (NMFS 2007). Rates of recovery listed in the literature range from several months to several years for estuarine muds (McCauley 1976; Oliver 1977; Currie 1996; Tuck 1998; Watling 2001). Thus, EFH forage resources for fish that feed on the benthos may be substantially reduced for several years during and after construction before recovery is achieved. Temporary falsework will be installed and removed in phases and the locations will be shifted as bridge dismantling work progresses from west to east. As a result, the maximum number of 2,450 temporary pilings will be distributed over a large area and will not be installed simultaneously. Some permanent fill below the mudline may result if individual pilings cannot be fully extracted by rocking or vibrating out. These piling fragments would be cut off below the potential scour zone and below what is typically considered the biologically active surface zone of benthic mud.

Trestles will result in approximately 2.4 acres of temporary overwater shading. Shading is known to decrease primary productivity, alter predator-prey interactions, change invertebrate assemblages, and reduce the density of benthic invertebrates (Helfman 1981; Glasby 1999; Struck, Craft et al. 2004; Stutes, Cebrian et al. 2006); all of which lead to an overall reduction in the quality of EFH. Effects of shading from trestles will be temporary and will, for the most part, occur in areas where overwater structures already exist. Falsework will be installed beneath the existing structure and will not result in increased shading. Temporary structures, including trestles, will not be directly located where eelgrass beds have been documented and are not expected to pose impacts to eelgrass from shading. Removal of the old structure will ultimately reduce shading in the project area.

V. CONSERVATION RECOMMENDATIONS

To adequately avoid and minimize the potential direct and indirect adverse impacts to eelgrass HAPC from construction activities and turbidity, NMFS recommends the following:

1. Light monitoring (as described in the Light Monitoring Protocol provided by NMFS) for photosynthetically active radiation (PAR) should be conducted in nearby eelgrass beds during construction activities occurring within 250 meters of the Oakland and Yerba Buena Island eelgrass beds. This includes activities that may produce turbidity and suspended sediment such as trestle installation and removal, and piling removals. If daily light levels fall below 5 hour H_{sat} at sampling sites but not at reference locations, turbidity-

producing activities should be paused and modified, and /or turbidity control measures should be put in place. Results of the light monitoring should be provided to NMFS monthly.

2. Eelgrass surveys should include a suitable control site in an adjacent or comparable area to monitor natural variability, changes in shoot density, or decline/increase in eelgrass beds that may not be associated with project activities.

VI. EFH CONCLUSION

As described in the above effects analysis, NMFS has determined that the proposed project would adversely affect EFH for various federally-managed species within the Pacific Groundfish, Coastal Pelagic, and Pacific Salmonid FMPs. As described above, the adverse effects are expected to be temporary and may be offset long-term by benefits from removing the existing bridge. The proposed action contains measures to avoid, minimize, mitigate, or otherwise offset some potential adverse effects to EFH. With the additional EFH Conservation Recommendations provided here, potential adverse effects to EFH are expected to be adequately minimized or compensated.

This concludes EFH consultation for the proposed dismantling of the superstructure and supports for the San Francisco-Oakland Bay Bridge Project between San Francisco and Alameda Counties, California.

VII. FEDERAL AGENCY STATUTORY REQUIREMENTS

Please be advised that regulations (50 CFR 600.920(k)) to implement the EFH provisions of the MSA require your office to provide a written response to this letter within 30 days of its receipt and prior to the final action. A preliminary response is acceptable if final response cannot be completed within 30 days. Your final response must include a description of how the EFH Conservation Recommendations will be implemented and any other measures that will be required to avoid, mitigate, or offset the adverse impacts of the activity. If your response is inconsistent with our EFH Conservation Recommendations, you must provide an explanation for not implementing this recommendation at least 10 days prior to final approval of the action.

Pursuant to 50 CFR 600.920(l), Caltrans must reinitiate EFH consultation with NMFS if the proposed action is substantially revised in a way that may adversely affect EFH, or if new information becomes available that affects the basis for NMFS' EFH Conclusion or Conservation Recommendations. NMFS also expects that further consultation will be required on the marine foundation removals, for which there is currently insufficient information on means and methods.

VII. LITERATURE CITED

Benfield, M. C. and T. J. Minello (1996). "Relative effects of turbidity and light intensity on reactive distance and feeding of an estuarine fish." Environmental Biology of Fish **46**(2): 211-216.

Caltrans (2011). Interagency Work Group Meeting June 23, 2011.

Cloern, J. E. (1987). "Turbidity as a control on phytoplankton biomass and productivity in estuaries." Continental Shelf Research 7(11/12):1367-1381.

Currie, D. G. P. (1996). "Effects of scallop dredging on soft sediment community: a large-scale experimental study." Marine Ecology Progress Series 134: 131-150.

Galvez-Abadia, S. (2011). Email Subject: SFOBB dismantling eelgrass recommendations. M. Goff.

Glasby, T. M. (1999). "Effects of shading on subtidal epibiotic assemblages." Journal of Experimental Marine Biology and Ecology **234**: 275-290.

Helfman, G. S. (1981). "The advantage to fishes of hovering in shade." Copeia **2**: 392-400.

Lee, K.-S., S. R. Park, and Y. K. Kim. (2007). Effects of irradiance, temperature, and nutrients on growth dynamics of seagrasses: A review. *Journal of Experimental Marine Biology and Ecology 350:144-175*.

McCauley, J. E., R.A. Parr, & D.T. Hancock (1976). "Benthic infauna and maintenance dredging: a case study." Water Research 11:233-242.

Nightingale, B. and J. C.A. Simenstad (2001). Dredging activities: marine issues. Seattle, WA 98105, University of Washington.

NMFS (2007). "Report on the subtidal habitats and associated biological taxa in San Francisco Bay." National Marine Fisheries Service, Santa Rosa, CA. p 86.

Oliver, J. S., P.N. Slattery, L.W. Hulberg, and J.W. Nybakken (1977). "Patterns of succession in benthic infaunal communities following dredging and dredged material disposal in Monterey Bay." U.S. Army Corps of Engineers, Technical Report D-77-27.

Struck, S. D., C. B. Craft, et al. (2004). "Effects of bridge shading on estuarine marsh benthic invertebrate community structure and function." Environmental Management **34**(1): 99-111.

Stutes, A. L., J. Cebrian, et al. (2006). "Effects of nutrient enrichment and shading on sediment primary production and metabolism in eutrophic estuaries." Marine Ecology Progress Series **312**: 29-43.

Thayer, G. W., W. J. Kenworthy, and M. S. Fonseca. (1984). Ecology of eelgrass meadows of the Atlantic Coast: a community profile. *National Marine Fisheries Service, Beaufort, NC (USA). Beaufort Lab.; Virginia Univ., Charlottesville (USA). Dept. of Environmental Sciences*, 165.

Tuck, I. D., S.J. Hall, M.R. Robertson (1998). "Effects of physical trawling disturbance in a previously unfished sheltered sheltered Scottish sea loch." Marine Ecology-Progress Series162: 227-242. .

Watling, L., R.H. Findlay, L.M. Lawrence, and D.F. Schick (2001). "Impact of a scallop drag on the sediment chemistry, microbiota, and faunal assemblages of a shallow subtidal marine benthic community." Journal of Sea Research 46 (3-4): 309-324.

Zimmerman, R. C., J. L. Reguzzoni, S. Wyllie-Echeverria, M. Josselyn, and R. S. Alberte. (1991). Assessment of environmental suitability for growth of Zostera-Marina L (eelgrass) in San-Francisco Bay. *Aquatic Botany 39:353-366*.