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

OCT 30 2001

In reply please refer to
151422-SWR99-SR-190:GRS

Michael G. Ritchie, Division Administrator
U.S. Department of Transportation
Federal Highway Administration, California Division
980 Ninth St., Suite 400
Sacramento, California 95814-2724

Dear Mr. Ritchie:

This document transmits the National Marine Fisheries Service's (NMFS) biological opinion regarding the San Francisco-Oakland Bay Bridge East Span Seismic Safety Project (East Span Project). In response to your September 12, 2001, letter requesting reinitiation of Section 7 consultation and Essential Fish Habitat consultation, NMFS has examined the effects of the East Span Project on threatened Central California Coast steelhead, threatened Central Valley steelhead, threatened Central Valley spring-run chinook, endangered Sacramento River winter-run chinook, threatened Central California Coast coho salmon and on designated critical habitat for these species, in accordance with section 7 of the Endangered Species Act of 1973, as amended (16 U.S.C. 1531 et seq.) (ESA). This document also transmits NMFS' Essential Fish Habitat (EFH) Conservation Recommendations for Pacific Coast Salmon as required by the Magnunson-Stevens Fishery Conservation and Management Act (MSFCMA) as amended (16 U.S.C. 1801 et seq.).

It is our finding in the enclosed biological opinion that the East Span Project is not likely to jeopardize the continued existence of listed anadromous salmonids, or result in the destruction or adverse modification of designated critical habitat for these species. However, NMFS has determined that some adult and juvenile listed anadromous salmonids are likely to be killed and injured during construction activities. Sound pressure waves generated by the driving of large diameter steel piles are expected to result in the immediate mortality of fish in close proximity to the pile being driven. Application of a bubble curtain to attenuate sound is expected to restrict this area of direct mortality to a radius of approximately 69 meters and the proposed monitoring program will allow for confirmation of the bubble curtain's effectiveness. Additional adverse effects associated with project construction include injury, stress, and displacement during construction activities.

The enclosed biological opinion evaluates these potential impacts. Because NMFS anticipates that incidental take will occur, an Incidental Take Statement is attached to the biological opinion.

The Incidental Take Statement presents several nondiscretionary Reasonable and Prudent Measures necessary to avoid and minimize anticipated incidental take of listed anadromous salmonids.

Regarding EFH for Federally managed fish species, NMFS provided Federal Highways Administration (FHWA) with EFH Conservation Recommendations for the East Span Project on September 23, 1999. FHWA provided NMFS with a preliminary response to these Conservation Recommendations on October 13, 1999, and final response was provided on June 12, 2001. Based on FHWA's responses, NMFS continues to believe the project will have an adverse habitat impact. Therefore, this document transmits several revised EFH Conservation Recommendations. FHWA has a statutory requirement under section 305(b)(4)(B) of the MSFCMA to submit a detailed response in writing to NMFS that includes a description of measures proposed for avoiding, mitigating, or offsetting the impact of the activity on EFH, as required by section 305(b)(4)(B) of the MSFCMA and 50 CFR 600.920(j) within 30 days. If unable to complete a final response within this time limit, an interim written response should be provided to NMFS within 30 days. A detailed response should follow.

In closing, I would like to thank and commend staff with FHWA and the California Department of Transportation for their assistance and prompt response with information during this consultation.

If you have questions regarding this consultation or the enclosed draft biological opinion, please contact Mr. Gary Stern at (707) 575-6060 or Mr. Patrick Rutten at (707) 575-6059.

Sincerely,

James H. Lecky

Rodney R. McInnis
Acting Regional Administrator

cc: Jim Lecky, NMFS Long Beach

With Enclosures:
Biological Opinion
Essential Fish Habitat Conservation Recommendations

Enclosure 1

Endangered Species Act
Section 7 Consultation

BIOLOGICAL OPINION

San Francisco-Oakland Bay Bridge
East Span Seismic Safety Project

Agency:	Federal Highway Administration, California Division – Sacramento
Consultation Conducted By:	National Marine Fisheries Service, Southwest Region, Santa Rosa, California
Date Issued:	
Refer to:	151422-SWR99-SR-190

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I. Consultation History

This document transmits the National Marine Fisheries Service's (NMFS) biological opinion for the San Francisco-Oakland Bay Bridge East Span Seismic Safety Project (East Span Project). The U.S. Department of Transportation, Federal Highways Administration (FHWA) in coordination with the California Department of Transportation (Caltrans) proposes to construct a new bridge approximately 2.18 miles (3.5 kilometers) long, to the north of the existing East Span, because the existing bridge does not 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. NMFS has analyzed the effects of the proposed construction of the East Span 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.*).

This biological opinion is based primarily on information provided in the following documents:

- Natural Environment Study for the San Francisco - Oakland Bay Bridge, East Span Project. September 1998;
- Dredge Material Management Plan for the San Francisco - Oakland Bay Bridge, East Span Project. June 1999;
- Biological Assessment for the San Francisco - Oakland Bay Bridge, East Span Project. June 1999;
- Sediment Sampling and Analysis Report for the San Francisco - Oakland Bay Bridge, East Span Project. June 2000;
- Final Environmental Impact Statement/Statutory Exemption and Final Section 4(f) Evaluation for the San Francisco - Oakland Bay Bridge, East Span Project. May 8, 2001;
- Noise and Vibration Measurements associated with the Pile Installation Demonstration Project for the San Francisco - Oakland Bay Bridge, East Span Project. June 30, 2001;
- Fisheries Assessment, Pile Installation Demonstration Project for the San Francisco -

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[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.

Oakland Bay Bridge, East Span Project. August 2001;

- Updated biological assessment and additional materials to support the NMFS biological opinion provided to NMFS on October 4, 2001;

- US Army Corps of Engineers, Public Notice No. 23013S, dated October 12, 2001.

- FHWA letter of October 18, 2001, to NMFS with additional information regarding the proposed fisheries mitigation measures.

By letter dated August 26, 1997, NMFS provided Caltrans with a list of threatened or endangered species or critical habitat that may be affected by the East Span Project.

A draft biological assessment for the East Span Project was provided to NMFS for review in January 1999, and NMFS provided written comments on this draft by letter dated January 20, 1999.

On July 15, 1999, FHWA transmitted the project's biological assessment and Memorandum of Conceptual Mitigation for the East Span Project to NMFS. Appendix F of the biological assessment contains the Essential Fish Habitat Assessment in compliance with the Magnuson-Stevens Fishery Conservation and Management Act (MSFCMA).

By letter dated July 29, 1999, Caltrans requested NMFS' comments on the proposed Pile Installation Demonstration Project (PIDP) for the East Span Project. The PIDP was a scientific investigation involving the driving of three large piles as part of the geotechnical testing program for the East Span Project. Caltrans specifically requested NMFS comments on the need for section 7 consultation associated with the potential impacts of the PIDP.

On September 23, 1999, NMFS provided FHWA with a written determination that the East Span Project as presented in the biological assessment was not likely to adversely affect threatened or endangered anadromous salmonids or designated critical habitat. This determination was based primarily on the use of noise attenuation devices if pile driving occurs between January 1 and May 31.

On May 26, 2000, FHWA requested informal consultation on the implementation of the PIDP in central San Francisco Bay, east of Yerba Buena Island, in June or July 2000. By letter dated July 26, 2000, NMFS concurred with FHWA that the PIDP was not likely to adversely affect listed anadromous salmonids or their designated critical habitat.

On September 14, 2000, FHWA requested NMFS concurrence with conducting the PIDP during fall of 2000, because the demonstration project was not conducted as planned during the summer of 2000. By letter dated September 25, 2000, NMFS concurred with FHWA that the implementation of the PIDP during the fall of 2000 was not likely to adversely affect listed anadromous salmonids or critical habitat.

On March 21, 2001, Caltrans requested NMFS provide an updated listed of threatened or endangered species that may be affected by the East Span Project. NMFS responded in writing to Caltrans on March 22, 2001 with an updated species list.

On August 8, 2001, NMFS provided written comments to FHWA regarding the draft Fisheries Impact Assessment for the PIDP. Based on the study results presented in the draft PIDP document and the companion report on noise and vibration measurements, NMFS questioned some of the document's findings and requested additional information in several areas.

On September 12, 2001, FHWA requested reinitiation of section 7 consultation for the East Span Project. Reinitiation was requested to address the elimination of seasonal restrictions on pile driving activities and the new information gathered during the PIDP regarding potential fisheries impacts.

An updated biological assessment and materials in support of the NMFS biological opinion were provided by FHWA and Caltrans on October 4, 2001.

Additional information regarding the proposed fisheries mitigation measures was provided by FHWA to NMFS by letter dated October 18, 2001.

Several meetings, telephone conference calls, and electronic mail communications were exchanged during September and October 2001 regarding the proposed fisheries mitigation measures, off-site mitigation opportunities, and assessment of potential impacts associated with sound pressure waves during pile installations.

A complete administrative record of this consultation is on file in the NMFS Santa Rosa Area Office, Santa Rosa, California (Administrative Record #151422SWR99SR190).

II. Description of the Proposed Action

The San Francisco-Oakland Bay Bridge is an important transportation component of the Bay Area that provides regional access between the San Francisco Peninsula and the East Bay. An average of 272,000 vehicles currently use the bridge each day. As part of Interstate 80, it is also a critical link in the interstate highway network. The existing East Span is not expected to withstand a maximum credible earthquake (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.

The East Span 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 Yerba Buena Island (YBI) and Oakland. The project limits, as defined by Caltrans, is the eastern portal of the YBI tunnel located in San Francisco as the western project limit and the eastern project limit is located approximately 400 meters (m) west of the Bay Bridge toll plaza on a spit of land referred to as the Oakland Touchdown area in the City of Oakland. The new bridge will be constructed north of the existing East Span and will be approximately 2.18 miles (3.5 kilometers) in length and 70 meters in width, including a 15.3-meter minimum space between the eastbound and westbound bridge decks.

A. Project Overview

Construction of the new bridge is to be divided among four separate contracts: (1) Self-Anchored Suspension/Yerba Buena Island (SAS/YBI) Main Span; (2) Skyway, (3) Oakland Approach Structures, and (4) Geofill at the Oakland Touchdown. A separate demolition contract will be used to remove the existing bridge. The East Span Project is expect to be completed within seven years. Construction is scheduled to begin in early 2002 and end in early 2009. The specific construction schedule will be determined by the contractor.

The project description presented below focuses on construction activities at or below the water line. Additional information can be found in the May 8, 2001 Final Environmental Impact Statement, Replacement Alternative N-6.

1. <u>Self-Anchored Suspension Main Span</u>

The main span between YBI and the Skyway will be a self-anchored suspension design. The main tower would be set offshore from YBI at a water depth of 18 meters. Bay bottom sediments at the main tower foundation will be removed by dredging to expose the sloping bedrock. Holes would be drilled into bedrock, hollow steel pipe piles 2.5 m in diameter inserted, and a pre-fabricated steel box with concrete cover will be sunk onto the piles. A large hammer at low energy would likely be used for socketing of the large piles. The piles would be filled with concrete and welded to the pile cap. Because the bedrock at the main tower location is sloping, the contractor may choose to create a bench by mechanically breaking or excavating rock to create a level surface. The contractor may use a cofferdam for construction of the main tower foundation, but this is unlikely due to water depths and the geology at this location.

A temporary pile-supported dock for barges would be constructed at YBI for construction-related activities such as delivery of materials. Piles for the dock would likely be 18, 24, or 36 inches (46, 61, or 91 centimeters) in diameter and fabricated of steel, concrete, or timber.
Pier E2 of the main span will be constructed with hollow steel pipes driven into the bay strata with a pre-fabricated steel box and concrete cover sunk onto the piles. The piles will be filled halfway with concrete and welded to the pile cap. All sediments within the piles resulting from pile driving would be removed, placed on a barge for transport, and disposed of.

2. <u>Skyway</u>

The skyway will be a segmentally constructed, prestressed concrete box-girder. A temporary access trestle may be utilized to build portions of the skyway and allow for the delivery of materials, equipment, and work crews. The trestle for the skyway would be approximately 7,000 square meters. Barges may support the heavier equipment. Steel, concrete, or timber piles of 18, 24, or 36 inches (46, 61, or 91 centimeters) in diameter will be used to support the trestle.

Construction of the permanent skyway piles and the pile caps would be similar to construction of Pier E2 on the main span. All sediments within the piles resulting from pile driving would be removed, placed on a barge for transport, and disposed of. Cofferdams may or may not be used by the contractor. If cofferdams are installed, sediment will be excavated and the cofferdam dewatered. The steel pipe piles would be driven, either before or after dewatering, to the Alameda geologic formation. A steel box pile cap would be lowered onto the piles and welded to them. If necessary, the piles would be emptied of bay sediments, then the piles and pile caps would be filled with reinforced concrete.

The pier forms would be placed, filled with reinforcing steel and concrete, then removed once the concrete is cured. The pier caps would be constructed similarly. Once the pier is complete, the cofferdams would be removed to at least 1.5 feet (0.46 meters) below the mudline.

3. Oakland Approach Structures

The Oakland approach structures would include a cast-in-place, prestressed, concrete box-girder supported by a cast-in-place, reinforced, concrete substructure. Falsework for the structures would be supported by temporary piles. A temporary access trestle would be utilized to facilitate construction and would be approximately 14,000 square meters. Piles would support the trestle. Piles would likely be 18, 24, or 36 inches (46, 61, or 91 centimeters) in diameter and fabricated of steel, concrete, or timber.

Construction in-bay would include dredging for barge access, building a temporary access trestle, driving piles, and placing cofferdams in areas of shallow water near the Oakland Touchdown. The cofferdam method would involve driving sheet piles into Bay mud to isolate a working area that would be dredged and dewatered to create access for construction of footings. All sediments resulting from pile driving and dredging would be removed, placed on a barge for transport, and disposed of.

4. Geofill at Oakland Touchdown

At the Oakland Touchdown area, a portion of the new westbound roadway and the relocated maintenance road would encroach into the Bay. Engineered fill and surcharge in the Bay and upland areas are proposed for this location. For construction of the westbound roadway, 1,970 linear feet of geotube (approximately 0.5 acre) would be placed in the tidal area north of the Oakland touchdown. A geotube is large diameter tube of permeable geotextile fabric in to which sand and water would be pumped. When the tube is filled, it will act as a tidal barrier to protect the work area. Within the area protected by the geotube (approximately 2.63 acres) the existing soils will be excavated to an elevation of approximately 0.8 m below mean sea level (MSL). Wick drains and vertical drains will be installed to facilitate consolidation of the underlying Bay mud and prevent liquefaction of the overlying sand. The drains will be covered with a layer of gravel upon which clean fill material will be placed.

B. Pile Driving

Current plans anticipate driving a total of 259 in-bay large diameter steel pipe piles. Of these, 189 piles will be 2.5 meters in diameter and 70 piles will be 1.8 meters in diameter. A template, founded on temporary piles fabricated of steel, concrete, or timber approximately 18 to 24 inches (46 to 61 centimeters) in diameter, may be used by the contractor to assist in accurate driving of the large piles.

Each large diameter pile is expected to consist of two or more segments; the first segment will be driven to the water line, then the next segment(s) will be welded on and driven in succession until the pile is driven to its final or "tip" elevation. However, the contractor could choose to drive the piles in one piece. Some piles will be battered, meaning that they will be driven in at an angle, essentially splaying out from the pier to provide additional stability. The rest would be vertical piles. The larger piles which support the skyway and main span sections of the replacement bridge will be driven to depths ranging from about 66 to 108 meters below MSL. The smaller diameter piles which support the Oakland Touchdown structures will be driven to tip elevations ranging from about 41 to 65 meters below MSL.

The three large steel piles used in the November 2000 PIDP each required approximately five hours total driving time to reach the specified tip elevation. Based on this experience, it is expected that the 259 in-bay piles could require about 1,300 hours of total pile driving time. However, the contractor will be allowed to drive simultaneously at multiple locations. Furthermore, it is possible that all three contractors (the contractor for the SAS-YBI portion, the contractor for the skyway, and the contractor for the Oakland approach structures) would drive piles simultaneously. Pile driving will be allowed from 7:00 AM to 8:00 PM, seven days a week. Pile driving that is underway at 8:00 PM will continue until driving of that pile segment is complete.

In a typical pile driving scenario, the first pile segment would require about 1 hour of driving time. The next segment would then be welded to the driven segment. This process takes 2 to 3 days. After welding is complete, 3 to 4 hours would be required to drive the pile to tip elevation. The actual time will depend on local substrate conditions.

To construct all permanent structures, contractors will install piles to found temporary structures, supports, falsework, docks and construction trestles. These temporary structures, designed by the contractor, are required to facilitate construction and support the permanent structures until they are self-supporting. Since the temporary structures will be contractor designed, their exact nature (size, type, number of piles, etc.) will not be known until construction begins. Conservative estimates have been developed by Caltrans, where it is possible to estimate the size of contractor-designed structural and support elements. While the number of piles placed to found the structures will be large, it is expected that they will be of a considerably smaller size than the permanent structures, since they are temporary and are not designed for traffic or seismic loading. When they are no longer needed, temporary piles will be retrieved or cut off 1.5 feet (0.46 meters) below the mudline. An estimate of the likely maximum, median, and minimum number of piles for each temporary project structure is presented below.

Location	Maximum no. of piles	Median no. of piles	Minimum no. of piles
Skyway Trestle	600	400	300
Oakland Trestle	1200	800	600
YBI Dock	180	120	90
SAS Trestle	80	60	40

In-bay pile driving of the large diameter steel piles may require hammer energy levels up to 1,700 kJ. Placement of smaller piles for support of trestles, falsework and pile driving templates is expected to require less hammer energy, probably on the order of 100 kJ or less. However, depending on the size of the pile, the equipment available at the time of construction, and the geology, up to 200 kJ may be required. This is an order of magnitude of energy less than that necessary to drive the large diameter piles. Hammers delivering up to 200 kJ of energy are commonly used for marine and near-shore construction around the bay.

To attenuate the effects of sound pressure waves on fish, a bubble curtain system will be required for driving of all permanent in-water piles. A continuous stream of air bubbles will enclose all permanent in-water piles/pile groups during the pile driving process.[2] Contractor specifications will stipulate the positioning, configuration, operation and removal of the bubble curtain system. The bubble curtain system will consist of air compressors, air supply lines, distribution manifolds, and aeration pipelines.

The aeration pipe will be perforated pipe configured into concentric rings spaced no more than five (5) vertical meters (m) apart at all tide conditions. The lowest aeration pipeline layer will be designed to ensure contact with the mud line without sinking into bay mud. The bubble curtain system will be constructed on a frame designed to keep the aeration pipelines stable (horizontal) and to provide enough ballast to counteract any inherent buoyancy of the system during operation. When installed, the bubble curtain system must be configured such that the aeration pipelines completely enclose the pile/pile group at a minimum distance of two (2) meters.

Each aeration pipeline will have four adjacent rows of approximately 1.6 mm diameter air holes

[2]Unless other equally effective methods such as cofferdams are used, or as otherwise directed by Caltrans for the purpose of collecting performance data.

spaced approximately 20 mm apart. The bubble curtain system will provide a bubble flux of three (3.0) cubic meters per minute, per linear meter (32 cubic feet per minute, per linear foot) of pipeline in each concentric ring. Valves and gauges to measure air pressure and flow rates will be installed in the main air supply lines and at critical branch locations and shall be accurate to +/- 2 percent. All gauges shall be installed to be accessible to Caltrans inspectors. The contractor will keep a log and graphic plot of all gauge readings, with data logged during every 30 minutes of operation. If the reading of any gauge drops below 10 percent of normal operation, pile driving will stop until the defect is repaired to the satisfaction of Caltrans' Engineer.

The contractor must submit a bubble curtain system design and supporting calculations for Caltrans' review within two (2) months of receiving notice to proceed on the project. Caltrans will comment on the system within one (1) month and the contractor shall respond within two (2) weeks of Caltrans comments. The contractor will be required to demonstrate the operation of the bubble curtain system during the re-strike of the PIDP piles. The contractor will ensure that bubble "drift" at maximum tidal flux or current does not compromise the integrity of the continuous bubble curtain. The pile-driving barge will also be isolated so that noise from the pile installation is not transmitted through the barge into the water-column.

To monitor the performance of the bubble curtain and assess the level of impact to fisheries, a number of investigations will be performed in the vicinity of pile driving operations. It is anticipated the fisheries monitoring program will be similar to the PIDP including (1) observations on predation by gulls and other birds, (2) examination of injured fish collected from the water, and (3) experiments using fish in cages at different distances. This fisheries program will be designed to document near-term fish mortalities and the likelihood of delayed mortality of differing sizes and species of fish that have swim bladders. In addition to the biological monitoring, measurements of sound pressure and other parameters will be monitored. The specific monitoring plan will be developed by FHWA and Caltrans for review and approval by NMFS and California Department of Fish and Game (DFG). It is estimated that fisheries monitoring will cost approximately $500,000.

C. Dredging

Near the Oakland shore, dredging is required for barge access, foundation construction, and pile cap construction. The barge access channel would be on the north side of the replacement bridge. The anticipated maximum draft for the barges is 10 feet (3 meters), but to ensure adequate clearance over potential irregularities in channel depth, barge listing during heavy lifting, and to allow for some potential resettlement of materials in the channel after dredging, the channels would be dredged to a depth of 12 feet (3.6 meters) adjacent to the Oakland Touchdown and 14 feet (4.3 meters) for the rest of the channel. Barge anchor lines would be moved into position from smaller boats as opposed to the primary barge(s) to prevent the dragging of anchors into position, and barge anchor lines would be kept taut as the tide and levels change in order to minimize contact between the lines and the bay bottom. It is anticipated that 216,230 cubic yards of material will be dredged to create the barge access channel. This material will be disposed of at the deep ocean disposal site (SF-DODS), approximately 50 nautical miles west of the Golden Gate Bridge.

Additional dredging and excavation will be required for the installation of piers, footings and foundation for the new bridge. A hydraulic or mechanical dredge may be used. It is anticipated that 187,087 cubic yards of material will be dredged to construct new piers and footings. This material will be disposed of at the Alcatraz Island site (SF-11).

Dredging will also be required to create a barge access channel to dismantle the existing bridge and to remove piers from the existing bridge. It is anticipated 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 the deep ocean disposal site (SF-DODS), at an upland wetland reuse site, or at a landfill reuse site. 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).

Additional information on East Span Project 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, areas to be dredged and material classifications are contained in letters from Caltrans (June 19, 2001 and August 15, 2001) to the Dredge Materials Management Office (DMMO) and from FHWA (June 12, 2001) to NMFS.

D. Dismantling of the Existing Bridge

Once the construction of the East Span is completed and put into service, the dismantling of the existing bridge structure would begin. An access channel will be constructed just south of the existing structure through dredging. Dismantling activities would consist of seven major stages, which represent major components of the existing bridge and construction-related structures.

Removal of decks could be performed by cutting them into pieces or by disassembling them panel-by-panel. Truss spans near the Oakland shore may be removed by conventional barge and crane methods due to the shallow water and low clearance under the deck. Options include constructing temporary supports under the span and disassembling the truss segment-by-segment, dredging for barge clearance, constructing temporary embankments of engineered fill within the bay for access, or using special shallow-draft barges or rigging devices for lowering sections onto barges from the bridge deck. Protective measures would be taken to prevent materials or debris from falling into the bay. Depending on location, materials could be removed by barge or truck to a predetermined site for reuse, recycling, or disposal.

Substructure elements could be lifted from their bases in one piece or piece-by-piece. Dismantling of concrete foundations would require reducing the reinforced concrete to pieces small enough to be hauled away, which could be done by mechanical means such as saw cutting, flame cutting, mechanical splitting, or pulverizing and hydro-cutting. The hollow interiors of the piles remaining below the mudline could also be used as receptacles for pieces of concrete as the pier above is dismantled. This method would substantially reduce the quantity of material requiring transport and disposal and would lower dismantling costs. The piles remaining below the mudline could be capped or would gradually fill in through siltation. Any reinforcing steel would be cut off to be flush with the face of the concrete that remains below the mudline. Removal of the piles to 1.5 feet (0.46 meter) below the mudline could be completed by an underwater dismantling method or by constructing cofferdams at each pier. The use of cofferdams at YBI would depend on methods selected by the contractor; however, their use is assumed for purposes of estimating dredged quantities generated by existing bridge removal.

E. Mitigation

To mitigate impacts to special aquatic sites in the intertidal areas just to the north of the Oakland Touchdown, both on-site and off-site mitigation is proposed. Caltrans initially proposed on-site mitigation through the creation of new eelgrass beds at the Oakland Touchdown area and at Clipper Cover on Yerba Buena Island. This would have been accomplished by placing sand-filled plateaus to raise elevations of the Bay bottom to a level suitable to support eelgrass and then planting the area with eelgrass from a donor site. However, the policies of some resource and bay planning agencies prevent the creation of new habitat in the Bay using fill material. Caltrans has dropped this proposal for the creation of new eelgrass beds at the Oakland Touchdown site.

Caltrans' current proposal for on-site mitigation is the restoration of eelgrass habitat. This 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. The proposed restoration would maximize the potential for planting success by incorporating site manipulation, monitoring and data collection. The proposed on-site mitigation includes:

- Harvesting approximately 0.55 acres (0.22 hectares) of eelgrass from the footprint of the barge access channel prior to dredging, planting test plots in adjacent eelgrass beds and monitoring to evaluate performance;
- Restoring up to 1.73 acres (0.70 hectares) of the barge access channel to its pre-construction bathymetry. Dredged material and excavated sand would be used to facilitate eelgrass colonization and the area would be replanted with eelgrass from an adjacent donor site;
- Restoring approximately 1.70 acres (0.69 hectares) of sand flats that are temporarily affected by the placement of a geotube or mud boils from engineered fill;
- Constructing rock slope protection to allow sand to accrete over the rock areas subject to tidal action. Slope gradients would be 1(V):3(H) at the toe of the slope and transition to a 1(V):2(H) gradient at mid-slope; and
- Capping rock slope protection areas with soil above the limits of tidal action to provide a medium to support growth of native upland plants and provide a more natural upland transition than the existing abrupt slope provides.

Caltrans will provide additional mitigation for the Project's direct impacts at off-site locations. Caltrans will provide $10.5 million in funds to be divided between the following:

a. Provide 2.5 million in funding to the East Bay Regional Park District (EBRPD) to restore, enhance or create new aquatic habitat and transitional uplands at the Eastshore State Park and within Central San Francisco Bay. Potential mitigation sites include:

   - Radio Beach Area-potential shoreline restoration including intertidal habitat and upland transition zones;
   - Brickyard Cove Area-potential shoreline restoration including intertidal habitat, the removal of riprap and upland transition zones;
   - Albany Beach Area-potential beach restoration/nourishment including the removal of parking areas; and,
   - Hoffman Marsh Area – potential tidal marsh restoration including the removal of fill and improving tidal action and water circulation.

b. Provide 8 million in funding to the United States Fish and Wildlife Service (USFWS) to acquire, cleanup contaminants, and initiate restoration of approximately 3,000 acres of diked historic baylands at Skaggs Island, Sonoma County, to tidal wetlands.

When specific information become available for these off-site mitigation actions, project-level environmental review and permitting will occur. It is anticipated that separate section 7 consultations will occur with the appropriate Federal action agency concurrent with the project-level environmental review.

An additional fund of $4 million will be established by Caltrans for the restoration of federal- and State-listed salmonid habitat in the central and south Bay. This restoration fund will be utilized for off-site, out-of-kind mitigation to offset construction related injury and mortality of listed salmonids associated with the East Span Project. The restoration fund will be used solely for anadromous salmonid restoration projects in San Francisco Bay tributaries, and is expected to provide a positive benefit to steelhead. Prior to December 31, 2003, funds totaling $4 million will be placed into an escrow account by Caltrans and expenditures from the account will be made at the discretion of NMFS and DFG, in consultation with Caltrans and FHWA. A portion of this fund, not to exceed $500,000, will be made available by Caltrans prior to the initiation of construction activities on the East Span Project for monitoring fisheries impacts, sound pressure levels and other environmental conditions associated with pile driving. Funds not used for monitoring will be applied to the steelhead habitat restoration fund.

III. Status of the Species and Critical Habitat

This biological opinion analyzes the effects of the East Span Project on Central California Coast coho salmon, Central Valley spring-run chinook salmon, Sacramento River winter-run chinook salmon, Central Valley steelhead, Central California Coast steelhead and their designated critical habitats.

A. Listing Status

Central California Coast coho salmon (*Oncorhynchus kisutch*) are listed as threatened under the ESA (October 31, 1996, 61 FR 56138). This Evolutionarily Significant Unit[3] (ESU) consists of populations from Punta Gorda in northern California south to the San Lorenzo River in central California, as well as populations in tributaries to San Francisco Bay, excluding the Sacramento-San Joaquin River system. Designated critical habitat for Central California Coast coho salmon encompasses accessible reaches of all rivers (including estuarine areas and tributaries) between Punta Gorda and the San Lorenzo River (inclusive) in California, including two streams entering San Francisco Bay: Arroyo Corte Madera del Presidio and Corte Madera Creek. This critical habitat designation includes all waterways, substrate, and adjacent riparian zones. Excluded are: (1) areas above specific dams identified in the Federal Register notice; (2) areas above longstanding, natural impassable barriers (i.e., natural waterfalls in existence for at least several hundred years); and (3) Indian tribal lands (May 5, 1999, 64 FR 24049).

Central Valley spring-run chinook salmon (*O. tshawytscha*) are listed as threatened under the ESA (September 16, 1999, 64 FR 50394). This ESU consists of spring-run chinook salmon occurring in the Sacramento River Basin. Designated critical habitat for Central Valley spring-run chinook salmon includes all river reaches accessible to listed chinook salmon in the Sacramento River and its tributaries in California, except for reaches on tribal lands. Also included are river reaches and estuarine areas 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 San Francisco/Oakland Bay Bridge) from San Pablo Bay to the Golden Gate Bridge. This critical habitat designation includes all waterways, substrate, and adjacent riparian zones. Excluded are: (1) areas above specific dams identified in the Federal Register notice; (2) areas above longstanding, natural impassable barriers (i.e., natural waterfalls in existence for at least several hundred years); and (3) Indian tribal lands (February 16, 2000, 65 FR 7764).

Sacramento River winter-run chinook salmon (*O. tshawytscha*) are listed as endangered under the ESA (January 4, 1994, 59 FR 440). This ESU consists of the Sacramento River population in

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[3] For purposes of conservation under the Endangered Species Act, an Evolutionarily Significant Unit (ESU) is a distinct population segment that is substantially reproductively isolated from other conspecific population units and represents an important component in the evolutionary legacy of the species (Waples 1991).

California's Central Valley. Designated critical habitat includes the Sacramento River from Keswick Dam in Shasta County (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 San Francisco/Oakland Bay Bridge) from San Pablo Bay to the Golden Gate Bridge. This critical habitat designation includes the river water, river bottom, and the adjacent riparian zone. In areas westward from Chipps Island, including San Francisco Bay to the Golden Gate Bridge, it includes the estuarine water column, essential foraging habitat, and food resources used by the winter-run chinook salmon as part of their juvenile out-migration or adult spawning migration (June 16, 1993, 58 FR 33212).

Central Valley steelhead (*O. mykiss*) are listed as threatened under the ESA (March 19, 1998, 63 FR 13347). This ESU consists of steelhead populations in the Sacramento and San Joaquin River basins in California's Central Valley. Designated critical habitat for Central Valley steelhead includes all river reaches accessible to listed steelhead in the Sacramento and San Joaquin rivers and their tributaries in California, except for reaches on tribal lands. Also included are river reaches and estuarine areas 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 San Francisco/Oakland Bay Bridge) from San Pablo Bay to the Golden Gate Bridge. Excluded are: (1) areas above specific dams identified in the Federal Register notice; (2) areas above longstanding, natural impassable barriers (i.e., natural waterfalls in existence for at least several hundred years); (3) Indian tribal lands; and (4) areas of the San Joaquin River upstream of the Merced River confluence (February 16, 2000, 65 FR 7764). Central California Coast steelhead (*O. mykiss*) are listed as threatened under the ESA (August 18, 1997, 62 FR 43937). This ESU includes steelhead in coastal California streams from the Russian River to Aptos Creek, and the drainages of San Pablo and San Francisco Bays. Designated critical habitat for this species includes all river reaches and estuarine areas accessible to listed steelhead in coastal river basins from the Russian River to Aptos Creek, California (inclusive), and the drainages of San Francisco and San Pablo Bays. Also included are all waters of San Pablo Bay westward of the Carquinez Bridge and all waters of San Francisco Bay to the Golden Gate Bridge. Excluded are: (1) areas above specific dams identified in the Federal Register notice; (2) areas above longstanding, natural impassable barriers (i.e., natural waterfalls in existence for at least several hundred years); and (3) Indian tribal lands (February 16, 2000, 65 FR 7764).

Following are descriptions of the general life histories and population trends of listed species that may be directly or indirectly affected by the proposed action.

B. Coho Salmon

Coho salmon is a widespread species of Pacific salmon occurring in most major river basins around the Pacific Rim from central California to Korea and northern Hokkaido, Japan. Recently published investigations have reported that a number of local populations of coho salmon in Washington, Oregon, Idaho and California have become extinct, and the abundance of many others is depressed (e.g. Brown and Moyle 1991, Nehlsen et al. 1991, Frissell 1993). There is a general geographic trend in the health of West Coast coho salmon stocks, with the southernmost and easternmost stocks in the worst condition. During this century, naturally-reproducing populations of coho salmon are believed to have been extirpated in nearly all Columbia River tributaries. These declines led to the listing of three of six West Coast ESUs by NMFS since 1996, and two others are candidates for listing.

1. General Life History

In contrast to the life history patterns of other Pacific salmonids, coho salmon exhibit a relatively simple three-year life cycle. Coho salmon are typically associated with small to moderately-sized coastal streams characterized by heavily forested watersheds; perennially-flowing reaches of cool, high-quality water; dense riparian canopy; deep pools with abundant overhead cover; instream cover consisting of large, stable woody debris and undercut banks; and gravel or cobble substrates. Most coho salmon enter rivers between September and January and spawn from November to January (Weitkamp *et al.* 1995; Hassler 1987). Coho salmon river entry timing is influenced by many factors, one of which appears to be river flow. In addition, many small California stream systems have their mouths blocked by sandbars for most of the year except winter. In these systems, coho salmon and other Pacific salmonid species are unable to enter the rivers until sufficiently strong freshets open passages through the bars (Weitkamp *et al.* 1995). Spawning is concentrated in riffles or in gravel deposits at the downstream end of pools with suitable water depth and velocity.

Coho salmon eggs incubate for approximately 35 to 50 days, and start emerging from the gravel two to three weeks after hatching (Hassler 1987). Following emergence, fry move into shallow areas near the stream banks. As coho salmon fry grow, they disperse upstream and downstream and establish and defend territories (Hassler 1987). During the summer, coho salmon fry prefer pools and riffles featuring adequate cover such as large woody debris, undercut banks, and overhanging vegetation. Juvenile coho salmon prefer to over-winter in large mainstem pools, backwater areas and secondary pools with large woody debris, and undercut bank areas (Hassler 1987; Heifetz *et al.* 1986). Juveniles primarily eat aquatic and terrestrial insects (Sandercock 1991). Coho salmon rear in fresh water for up to 15 months, then migrate to the sea as smolts between March and June (Weitkamp *et al.* 1995). During this migration, juvenile coho salmon undergo a physiological process, smoltification, which prepares them for living in the marine environment. After entering the ocean, the immature salmon initially remain in nearshore waters close to their parent stream. While living in the ocean, coho salmon remain closer to their river of origin than do chinook salmon (Weitkamp *et al.* 1995). Nevertheless, coho salmon have been captured several hundred to several thousand kilometers away from their natal stream (Hassler 1987). Coho salmon typically spend two growing seasons in the ocean before returning to their natal streams to spawn as three year-olds. Some precocious males, called "jacks," return to spawn after only six months at sea.

2. Population Trends - Central California Coast Coho Salmon

A comprehensive review of estimates of historic abundance, decline and present status of coho salmon in California is provided by Brown *et al.* (1994). They estimated that coho salmon annual spawning population in California ranged between 200,000 and 500,000 fish in the 1940s, which declined to about 100,000 fish by the 1960s, followed by a further decline to about 31,000 fish by 1991, of which 57 percent were artificially propagated. The other 43 percent (13,240) were natural spawners, which included naturally produced, wild fish and naturalized (hatchery-influenced) fish. Brown *et al.* (1994) cautioned that this estimate could be overstated by 50 percent or more. Of the 13,240 natural spawners, only about 5,000 were naturally-produced, wild coho salmon without hatchery influence, and many of these were part of individual stream populations of less than 100 fish each. In summary, Brown *et al.* (1994) concluded that the California coho salmon population had declined more than 94 percent since the 1940s, with the greatest decline occurring since the 1960s.

NMFS' status review (Weitkamp *et al.* 1995) concluded that abundance data for the Central California Coast coho salmon ESU were very limited. Recent population estimates vary from approximately 600 to 5,500 adults (Brown *et al.* 1994). Brown *et al.* (1994) estimated average annual coho salmon spawning escapement for the period from the early 1980s through 1991 was 6,160 naturally spawning fish and 332 artificially propagated fish. Of the naturally-spawning coho salmon, 3,880 were from the tributaries in which supplementation occurs (Noyo River and several coastal streams south of San Francisco).

Of 186 streams in the range of the Central California Coast coho salmon ESU identified as having historic accounts of adult coho salmon, recent data exist for 133 streams. Of these 133 streams, 62 streams have recent records of occurrence of adult coho salmon and 71 streams no longer maintain coho salmon spawning runs (61 FR 56138). Adams *et al.* (1999) looked at historical presence-absence data drawn from four principle sources, in addition to their own data, and found that for the three-year period between 1995 to 1997 coho salmon were present in 51 percent (98 of 191) of the streams where they were historically present, and documented an additional 23 streams within the Central California Coast coho salmon ESU in which coho salmon were found for which there were no historical records.

Weitkamp *et al.* (1995) concluded that all coho salmon stocks south of Punta Gorda were depressed relative to past abundance, but that there were limited data to assess population numbers or trends. The main stocks in this region have been heavily influenced by hatcheries, and there are apparently few native coho salmon left. The apparent low escapements in these rivers and streams, in conjunction with heavy historical hatchery production, suggest that natural populations are not self-sustaining.

Designated critical habitat for Central California Coast coho salmon includes two streams that are tributary to San Francisco Bay. Those streams are Arroyo Corte Madera Del Presidio and Corte Madera Creek, both in Marin County. Leidy (1984) collected several juvenile coho salmon specimens in the lowermost reaches of both these streams in 1981.

C. Chinook Salmon

Chinook salmon historically ranged from the Ventura River in southern California north to Point Hope, Alaska, and in northeastern Asia from Hokkaido, Japan to the Anadyr River in Russia (Healey 1991). Based on the results of a comprehensive scientific review of chinook salmon on the entire West Coast, NMFS identified 17 ESUs of chinook salmon, from southern California to the Canadian border and east to the Rocky Mountains. Out of these 17 ESUs, nine have been listed by NMFS as threatened or endangered since 1990, and one remains a candidate for listing.

1. General Life History

Of the Pacific salmon, chinook salmon exhibit arguably the most diverse and complex life history strategies. Healey (1986) described 16 age categories for chinook salmon, consisting of seven total ages with three possible freshwater ages. Two generalized freshwater life-history types were described by Healey (1991): "stream-type" chinook salmon reside in freshwater for a year or more following emergence, whereas "ocean-type" chinook salmon migrate to the ocean within their first year.

Chinook salmon mature between two and six-plus years of age (Myers *et al.* 1998). Freshwater entry and spawning timing are generally thought to be related to local water temperature and flow regimes (Miller and Brannon 1982). 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). Spring-run chinook salmon tend to enter freshwater as immature fish, migrate far upriver, and finally spawn in the late summer and early autumn. 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 the rivers, and spawn within a few days or weeks of freshwater entry (Healey 1991).

Central Valley spring-run chinook salmon adults are estimated to leave the ocean and enter the Sacramento River from March to July (Myers *et al.* 1998). Spring-run chinook spawning typically occurs between late-August and early October with a peak in September. Spawning typically occurs 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 takes place. The upper preferred water temperature for spawning adult chinook salmon is 55° F (Chambers 1956) to 57° F (Reiser and Bjornn 1979). Length of time required for eggs to develop and hatch is dependent on water temperature and is quite variable. In Butte and Big Chico creeks, emergence of spring-run chinook typically occurs from November through

January. In Mill and Deer creeks, colder water temperatures delay emergence to January through March (CDFG 1998).

Post-emergent fry seek out shallow, nearshore areas with slow current and good cover, and begin feeding on small terrestrial and aquatic insects and aquatic crustaceans. In Deer and Mill creeks, juvenile spring-run chinook usually spend nine to10 months in their natal streams, although some may spend as long as 18 months in freshwater. Most "yearling" spring-run chinook move downstream in the first high flows of the winter from November through January (USFWS 1995; CDFG 1998). In Butte and Big Chico creeks, spring-run chinook juveniles typically exit their natal tributaries soon after emergence during December and January, while some remain throughout the summer and exit the following fall as yearlings. 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, *et al.* 1989; Vogel and Marine 1991). 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.

Chinook salmon spend between one and four years in the ocean before returning to their natal streams to spawn (Myers *et al.* 1998). Fisher (1994) reported that 87 percent of returning spring-run adults are three year-olds based on observations of adult chinook trapped and examined at Red Bluff Diversion Dam between 1985 and 1991.

Adult Sacramento River winter-run chinook salmon leave the ocean and migrate through the Sacramento-San Joaquin Delta to the upper Sacramento River from December through June. Spawning generally occurs between mid-April and July, and occasionally into early August. The majority of winter-run chinook salmon spawning occurs upstream of Red Bluff Diversion Dam in the vicinity of Redding, California. The eggs are fertilized and buried in the river gravel where they incubate and hatch in approximately a two-month period. Emergence of the fry from the gravel begins during early July and continues through September. Fall and winter emigration behavior by juveniles varies with streamflow and hydrologic conditions. Most juveniles distribute themselves to rear in the Sacramento River through the fall and winter months. Some winter-run chinook salmon juveniles move downstream to rear in the lower Sacramento River and Delta during the late fall and winter. Smolting and ocean entry typically occurs between January and April.

2. Population Trends - Central Valley Spring-run Chinook Salmon

Historically, spring-run chinook salmon were predominant throughout the Central Valley, occupying the upper and middle reaches of the San Joaquin, American, Yuba, Feather, Sacramento, McCloud, and Pit rivers, with smaller populations in most other tributaries with sufficient habitat for over-summering adults (Stone 1874; Rutter 1904; Clark 1929). The Central Valley drainage as a whole is estimated to have supported spring-run chinook salmon runs as large as 600,000 fish between the late 1880s and 1940s (CDFG 1998). Before the construction of Friant Dam, nearly 50,000 adults were counted in the San Joaquin River (Fry 1961). Following the completion of Friant Dam, the native population from the San Joaquin River and its tributaries was extirpated. Spring-run chinook salmon no longer exist in the American River due to the existence and operation of Folsom Dam.

Natural spawning populations of Central Valley spring-run chinook salmon are currently restricted to accessible reaches in the upper Sacramento River, Antelope Creek, Battle Creek, Beegum Creek, Big Chico Creek, Butte Creek, Clear Creek, Deer Creek, Feather River, Mill Creek, and Yuba River (CDFG 1998; USFWS, unpublished data). With the exception of Butte Creek and the Feather River, these populations are relatively small ranging from a few fish to several hundred. Butte Creek returns in 1998 and 1999 numbered approximately 20,000 and 3,600, respectively (CDFG, unpublished data). On the Feather River, significant numbers of spring-run chinook, as identified by run timing, return to the Feather River Hatchery. However, coded-wire-tag information from these hatchery returns indicates substantial introgression has occurred between fall-run and spring-run chinook populations in the Feather River due to hatchery practices. Additional historical and recent published chinook salmon abundance information are summarized in Myers *et al.* (1998).

3. Population Trends - Sacramento River Winter-run Chinook Salmon

Historically, winter run chinook salmon were abundant in the McCloud, Pit, and Little Sacramento rivers. Construction of Shasta Dam in the 1940s eliminated access to all of the historic spawning habitat for winter-run chinook salmon in the Sacramento River Basin. Since then, the ESU has been reduced to a single spawning population confined to the mainstem Sacramento River below Keswick Dam; although some adult winter-run chinook have been observed in recent years in Battle Creek, a tributary to the upper Sacramento River. The fact that this ESU is generally comprised of a single population with very limited spawning and rearing habitat increases its risk of extinction due to local catastrophe or poor environmental conditions. There are no other natural populations in the ESU to buffer it from natural fluctuations.

Quantitative estimates of run size are not available for the period prior to the completion of Red Bluff Diversion Dam in 1966. CDFG estimated spawning escapement of Sacramento River winter-run chinook salmon at 61,300 (60,000 mainstem, 1,000 in Battle Creek, and 300 in Mill Creek) in the early 1960s, but this estimate was based on "comparisons with better-studied streams" rather than actual surveys. During the first three years of operation of the counting facility at Red Bluff Diversion Dam (1967-1969), the spawning run of winter-run chinook salmon averaged 86,500 fish. From 1967 through the mid-1990's, the population declined at an average rate of 18 percent per year, or roughly 50 percent per generation. The population reached critically low levels during the drought of 1987-1992; the three-year average run size for period of 1989 to 1991 was 388 fish. However, the trend in the past five years indicates that the population may be recovering. The most recent three-year (1997-1999) average run size was 2,220 fish. Additional historical and recent published chinook salmon abundance information is summarized in Myers *et al.* (1998).

D. Steelhead

West coast steelhead are presently distributed across 15 degrees of latitude, from approximately 49°N at the U.S.-Canada border south to 34°N at the mouth of Malibu Creek, California. In some years steelhead may be found as far south as the Santa Margarita River in San Diego County. During the 1900's, over 23 indigenous, naturally-reproducing stocks of steelhead are believed to have been extirpated, and west coast stocks have experienced dramatic declines in abundance throughout their range (Busby *et al* 1996). Forty-three steelhead stocks have been identified by Nehlsen *et al* (1991) as being at moderate or high risk of extinction. Out of 15 ESUs, ten have been listed by NMFS as threatened or endangered since 1997, and one (the Oregon coast ESU) is a candidate for listing.

1. General Life History

Steelhead exhibit perhaps the most complex suite of life history traits of any species of Pacific salmonid. They can be anadromous or freshwater resident. Resident forms are usually called rainbow trout. Winter steelhead generally leave the ocean from August through April, and spawning occurs between December and May (Busby *et al.* 1996). Steelhead using San Francisco Bay tributaries belong to the winter race of steelhead, that are ocean-maturing, and begin their spawning migration in the fall and winter (Leidy 2000). The timing of upstream migration is generally correlated with higher flow events and associated lower water temperatures. Unlike Pacific salmon, steelhead are iteroparous, or capable of spawning more than once before death (Busby *et al.* 1996). However, it is rare for steelhead to spawn more than twice before dying; most that do so are females (Busby *et al.* 1996; Nickelson *et al.* 1992). Iteroparity is more common among southern steelhead populations than northern populations (Busby *et al.* 1996).

Steelhead spawn in cool, clear streams featuring suitable gravel size, depth, and current velocity. Intermittent streams may be used for spawning (Barnhart 1986; Everest 1973). The length of the incubation period for steelhead eggs is dependent on water temperature, dissolved oxygen concentration, and substrate composition. In late spring, following yolk sac absorption, alevins emerge from the gravel as fry and begin actively feeding in shallow water along perennial stream banks (Nickelson *et al.* 1992).

Summer rearing takes place primarily in higher velocity areas in pools, although young-of-the-year are also abundant in glides and riffles. Winter rearing occurs more uniformly at lower densities across a wide range of fast and slow habitat types. Productive steelhead habitat is characterized by complexity, primarily in the form of large and small wood. Some older juveniles move downstream to rear in larger tributaries and mainstem rivers (Nickelson *et al.* 1992). Juveniles feed on a wide variety of aquatic and terrestrial insects (Chapman and Bjornn 1969), and emerging fry are sometimes preyed upon by older juveniles. Juveniles live in freshwater from one to four years (usually two years in California; Barnhart 1986), then smolt and migrate to the sea from February through April. However, some steelhead smolts may outmigrate during the fall and early winter months. While some emigrating juveniles move downstream at all hours of the day and night, the bulk of downstream fish movement in riverine conditions occurs during the night or at least in the early morning or late evening (Shapovalov and Taft 1954). California steelhead typically reside in marine waters for one to two years prior to returning to their natal stream to spawn as three- or four-year olds (Busby *et al.* 1996).

2. Population Trends - Central Valley Steelhead

Central Valley steelhead once ranged throughout most of the tributaries and headwaters of the Sacramento and San Joaquin basins prior to dam construction, water development, and watershed perturbations of the 19th and 20th centuries (McEwan and Jackson 1996; CALFED 2000). In the early 1960s, the California Fish and Wildlife Plan estimated a total run size of about 40,000 adults for the entire Central Valley including San Francisco Bay (CDFG 1965). The annual run size for this ESU in 1991-92 was probably less than 10,000 fish based on dam counts, hatchery returns and past spawning surveys (McEwan and Jackson 1996).

At present, all Central Valley steelhead are considered winter-run steelhead (McEwan and Jackson 1996), although there are indications that summer steelhead were present in the Sacramento River system prior to the commencement of large-scale dam construction in the 1940s (IEP Steelhead Project Work Team 1999). McEwan and Jackson (1996) reported that wild steelhead stocks appear to be mostly confined to upper Sacramento River tributaries such as Antelope, Deer, and Mill creeks and the Yuba River. However, naturally spawning populations are also known to occur in Butte Creek, and the upper Sacramento mainstem, Feather, American, Mokelumne, and Stanislaus rivers (CALFED 2000). It is possible that other small populations of naturally spawning steelhead exist in Central Valley streams, but are undetected due to lack of sufficient monitoring and research programs. The recent implementation of new fisheries monitoring efforts has found steelhead in streams previously thought not to contain a population, such as Auburn Ravine, Dry Creek, and the Stanislaus River (IEP Steelhead Project Work Team 1999).

3. Population Trends - Central California Coast Steelhead

Only two estimates of historic (pre-1960s) abundance specific to this ESU are available: an average of about 500 adults in Waddell Creek in the 1930s and early 1940s (Shapovalov and Taft 1954), and 20,000 steelhead in the San Lorenzo River before 1965 (Johnson 1964). In the mid-1960s, 94,000 adult steelhead were estimated to spawn in the rivers of this ESU, including 50,000 fish in the Russian River and 19,000 fish in the San Lorenzo River (CDFG 1965). Recent estimates indicate an abundance of about 7,000 fish in the Russian River (including naturally-produced steelhead) and about 500 fish in the San Lorenzo River. These estimates suggest that recent total abundance of steelhead in these two rivers is less than 15 percent of their abundance in the mid 1960s. Recent estimates for several other streams (Lagunitas Creek, Waddell Creek, Scott Creek, San Vincente Creek, Soquel Creek, and Aptos Creek) indicate individual run sizes of 500 fish or less. Steelhead in most tributaries to San Francisco and San

Pablo bays have been virtually extirpated (McEwan and Jackson 1996). Fair to good runs of steelhead still apparently occur in coastal Marin County tributaries. In a 1994 to 1997 survey of 30 San Francisco Bay watersheds, steelhead occurred in small numbers at 41 percent of the sites, including the Guadalupe River, San Lorenzo Creek, Corte Madera Creek, and Walnut Creek (Leidy 1997). Presence/absence data available since the proposed listing show that in a subset of streams sampled in the central California coast region, most contain steelhead (Adams *et al.* 1999). While there are several concerns with these data (e.g., uncertainty regarding origin of juveniles), NMFS believes it is generally a positive indicator that there is a relatively broad distribution of steelhead in smaller streams throughout the region.

Little information is available regarding the contribution of hatchery-produced fish to natural spawning of steelhead, and little information on present run sizes or trends for this ESU exists. However, given the substantial rates of declines for stocks where data do exist, the majority of natural production in this ESU is likely not self-sustaining (62 FR 43937).

Generally, life history characteristics and habitat requirements for Central California Coast steelhead are similar to those described for Central Valley steelhead. However, Central California Coast steelhead typically migrate shorter distances and spawn in smaller, rainfall-fed streams compared to the larger, snowmelt-fed spawning streams and rivers occupied by Central Valley steelhead. Adult Central California Coast steelhead spawn in tributaries to San Francisco, San Pablo, and Suisun Bays. Outmigrants may utilize tidal marsh areas, non-tidal freshwater marshes, and other shallow water areas in the bays as rearing areas for short periods prior to their emigration to the sea. Additional historical and recent published steelhead abundance are summarized in NMFS' west coast steelhead status review (Busby *et al.* 1996).

IV. 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 (50 CFR §402.02). For the purposes of this consultation, the action area is the San Francisco Bay between the Richmond-San Rafael Bridge in the north, the Golden Gate Bridge in the west, and the San Mateo Bridge in the south due to the direct and indirect effects of the project's pile driving and dredging/disposal activities.

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 northern portion of the action area, north of the Bay Bridge, is 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 Bay Bridge, includes part 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 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.

B. Status of Steelhead, Chinook Salmon, and Coho Salmon in the Action Area

Examination of the migratory pathways of the various ESUs can provide some information regarding the occurrence and abundance of listed anadromous salmonids within the action area. Adult salmon and steelhead from all five listed ESUs travel through the action area in San Francisco Bay from the ocean to their natal streams to spawn. Juvenile salmon and steelhead use the action area in San Francisco Bay as a migration corridor to the ocean. Unlike salmon, some adult steelhead return to the ocean after spawning and these fish migrate seaward as adults through San Francisco Bay.

For Central Valley ESUs (Sacramento River winter-run chinook salmon, Central Valley spring-run chinook, Central Valley steelhead), the Golden Gate is the site of freshwater entry for all returning adults and the site of ocean entrance for all outmigrating smolts. However, fisheries studies conducted by NMFS (B. MacFarlane, pers. comm) and DFG (Baxter *et al.*, 1999) indicate that the primary migration corridor for these Central Valley fish is within the northern portion of the action area. Thus, the majority of Central Valley anadromous salmonids are unlikely to wander south into the immediate construction area of the East Span Project. The population status of Central Valley ESUs is discussed above under Status of Listed Species.

For coho salmon, the two tributaries to San Francisco Bay that currently support Central California Coast coho salmon are Arroyo Corte Madera del Presidio and Corte Madera creeks in Marin County. These two creeks flow to northern central San Francisco Bay on either side of the Tiburon Peninsula. Central California Coast coho salmon would most likely migrate to and from these creeks along the north side of the central Bay and their presence in the immediate East Span Project construction area is unlikely. Information regarding the population status of Central California Coast coho salmon is discussed above under Status of Listed Species.

Several tributary streams to San Francisco Bay currently support populations of Central California Coast steelhead. Within central San Francisco Bay, steelhead runs are believed to occur in Corte Madera Creek and its tributaries, Miller Creek, Novato Creek, and possibly Arroyo Corte Madera del Presidio Creek in Marin County. Within San Pablo Bay, steelhead are present in the Napa River, Petaluma River, and Sonoma Creek. Tributaries to Suisun Bay and adjacent drainages that support steelhead runs of unknown size include Green Valley and Suisun creeks in Solano County; and Walnut Creek and possibly Alhambra, Pinole, Wildcat, and San Pablo creeks in Contra Costa County. As with the Central Valley ESUs, the primary migration corridor for these fish is likely on the northern side of action area and the majority of fish are unlikely to wander south into the immediate construction area of the East Span Project. However, there are several streams in South San Francisco Bay which presently support steelhead including the Guadalupe River, Stevens Creek, San Francisquito Creek, Coyote and Upper Penitencia creeks, Alameda Creek, and possibly San Leandro Creek (Leidy 2000). Information regarding the population status of Central California Coast steelhead is discussed above under Status of Listed Species.

All adult and juvenile steelhead originating from south San Francisco Bay streams migrate under the Bay Bridge. Although no data is available to determine the migration routes of steelhead through central and south San Francisco Bay, some inferences can be made from the Bay's bathymetry and tidal current patterns, and chinook salmon distribution data. Of particular importance to the East Span Project is the proportion of the population that migrates to the west or east of YBI.

The DFG's San Francisco Bay study collected fish by beach seine and trawl throughout San Francisco Bay between 1980 and 1995 (Baxter *et al.* 1999). Too few steelhead were collected to draw any conclusions regarding their rearing and migration locations within San Francisco Bay, but juvenile chinook salmon collections do provide some information regarding their presence and periodicity. In or near the project's action area, DFG sampled 20 open water locations by midwater and otter trawls and another 16 stations sampled by beach seine. The results of this study indicate that juvenile chinook salmon are distributed on either side of YBI, although the data is so sparse that is would be difficult to calculate what percent use either side as a migration corridor. The data also shows that chinook salmon juveniles are distributed throughout the action area during the period between February and July, but may also be found as early as January and as late as September in the action area. During February and March, juvenile chinook salmon were primarily captured by beach seine in shallow water areas, and during April, May, and June juvenile chinook salmon were primarily captured by trawl in deep water areas (Baxter *et al.*

1999). Although these juvenile salmon are likely non-listed fall-run chinook salmon, the data do indicate that juvenile salmonids can be found throughout San Francisco Bay and the action area during their outmigration season. Since the migration patterns of chinook salmon smolts is very similar to that of steelhead smolts, the information does infer that juvenile steelhead are also likely to be distributed on both sides of YBI

The bathymetry of San Francisco Bay and the distribution of tidal currents also provides some information relevant to the distribution and migration patterns of steelhead. Based on the bathymetry of San Francisco Bay around YBI, Caltrans estimates that 80 percent or more of the water originating from south Bay tributaries passes to the west of YBI and approximately 20 percent passes under the East Span Project. Examination of the tidal currents indicates that surface water velocities at various tidal stages does not differ significantly from the west to east side of YBI; both sides can experience tidal currents exceeding 3 knots. This information suggests that between 20 and 30 percent of the steelhead run from south San Francisco Bay streams pass to the east of YBI and through the East Span Project construction area.

Preliminary analysis of data collected from juvenile chinook salmon during a 1997 survey conducted by the NMFS' Tiburon Laboratory provides some additional information regarding the life history of juvenile salmonids within San Francisco Bay (B. MacFarlane, NMFS, pers. comm., January 2001). Preliminary findings from this research indicate:

1) Juveniles spent about 40 days migrating through the estuary, with extended rearing in the bay and estuary not observed.
2) Little increase in mean length or weight was found while in the estuary, suggesting that feeding and rearing activities in the estuary replace energy spent reaching the ocean.
3) Juvenile chinook salmon condition declined in the estuary, but improved markedly in ocean fish.
4) Whole body and organ concentrations of metals, PCBs, PAHs, and pesticides 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. These contaminant levels seemed to drop once fish left the bay and spent time in the ocean.
5) Unlike populations in the Pacific Northwest, chinook salmon from California's Central Valley show little estuarine dependency and transit rapidly to the ocean.

Leidy (2000) reported that emigrating adult and juvenile steelhead may forage in the open water of estuarine subtidal and riverine tidal wetland habitats within the San Francisco Bay estuary, though the importance of these areas as rearing habitat for yearlings and sub-yearlings is not well documented. In the DFG San Francisco Bay Study, only two juvenile steelhead were observed during the eight years of data collection and the origin (e.g., Central Valley or Central California Coast ESU) of these juveniles is unknown. No information exists on the length of time juvenile steelhead may use the bay before moving out into the ocean.

C. Factors Affecting Environment Within the Action Area

The factors presenting risks to naturally reproducing listed salmonid populations are numerous and varied. A number of documents have addressed the history of human activities, present environmental conditions, and factors contributing to the decline of salmon and steelhead species listed under the ESA. For example, NMFS has prepared range-wide status reviews for west coast chinook (Myers *et al.* 1998), west coast coho salmon (Weitkamp *et al.* 1995) and west coast steelhead (Busby *et al.* 1996). Additional information is available in Federal Register notices announcing ESA listing proposals and determinations for these species and their critical habitat (chinook salmon: June 16, 1993, 58 FR 33212; January 4, 1994, 59 FR 440; March 9, 1998, 63 FR 11481; September 16, 1999, 64 FR 50394; February 16, 2000, 65 FR 7764), (steelhead: August 9, 1996, 61 FR 41541; August 18, 1997, 62 FR 43937; March 19, 1998, 63 FR 13347; February 9, 1999, 64 FR 5740; February 16, 2000, 65 FR 7764), (coho salmon: July 25, 1995, 60 FR 38011; October 31, 1996, 61 FR 56211; January 9, 1997, 62 FR 1296; November 25, 1997, 62 FR 62741; May 5, 1999, 64 FR 24049). The July 2000 Programmatic Environmental Impact Statement/Report for the CALFED Bay-Delta Program (CALFED 2000) and the October 1999 Programmatic Environmental Impact Statement for the Central Valley Project Improvement Act (DOI 1999) provide excellent summaries of historical and recent environmental conditions for salmon and steelhead in the Central Valley, Delta, and San Francisco Bay. For the purposes of the proposed project, a general description of the environmental baseline for salmon and steelhead listed under the ESA is based on a summary of these documents.

Profound alterations to the estuarine habitat of San Francisco Bay 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 San Francisco Bay into the era of rapid urban development and coincident habitat degradation. In general, the human activities that have affected these fish and their habitats within the action area consist of: (1) dam construction and water development activities that affect water quantity, timing, and quality in San Francisco Bay; (2) land use activities such as urban development and landfill that degrade and transform aquatic habitat; (3) hatchery operation and practices; (4) harvest activities; (5) pollution; (6) introduction of non-native species; and (7) ecosystem restoration.

1. Dam Construction and Water Development

Hydropower, flood control, and water supply dams of the Central Valley Project (CVP), State Water Project (SWP), and other municipal and private entities have affected water quantity, timing, and quality in San Francisco Bay. Altered streamflows and inflow to San Francisco Bay have affected the natural cycles by which juvenile and adult salmonids base their migrations. Depleted inflow to San Francisco Bay has contributed to higher water temperatures, lower dissolved oxygen levels, and decreased recruitment of gravel and large woody debris in streams. Additionally, the seasonal distribution of freshwater inflow differs from historical patterns. The magnitude and duration of peak flows during the winter and spring are significantly reduced by water impoundment in upstream reservoirs. During the summer and early fall, inflow to San

Francisco Bay may be greater than historical levels due to deliveries of municipal and agricultural water supplies.

2. Land-Use Activities

Historically, the tidal marshes 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 utilize the estuary for seasonal rearing, and as a migration corridor to the sea. Returning adult salmon and steelhead navigate their way through San Francisco Bay as they seek the upstream spawning grounds of their natal streams. Land use activities since the 1850s associated with urban development, mining, and agriculture have significantly altered fish habitat quantity and quality in San Francisco Bay, and contributed to salmonid stock declines.

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. 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.

3. Hatchery Operation and Practices

Hatchery production of chinook salmon and steelhead salmon occurs in Central Valley hatcheries and some outplanting of juveniles occurs in the vicinity of San Francisco Bay. The United Anglers Casa Grande High School Salmon Hatchery has released 1,000 to 7,000 chinook salmon smolts annually into the Petaluma River or San Pablo Bay since 1984 and an unknown number of steelhead yearlings have been released periodically to Adobe Creek or the Petaluma River since 1984. The egg source for both chinook and steelhead at Casa Grande Hatchery has frequently been Central Valley stocks from the Feather River and Nimbus (American River) hatcheries. Competition may occur between hatchery and native salmonid juveniles, and may lead to decreased survival and production of listed salmonids. Outplanting of smolts in San Pablo and San Francisco bays contributes to elevated straying levels for returning adult spawners. The effects of straying hatchery spawners have differing effects on listed salmonids depending on the size of the wild population.

4. Harvest

Historically, salmon and steelhead were abundant in many western coastal and interior streams of the United States and have supported substantial tribal, sport and commercial fisheries, contributing millions of dollars to numerous local economies. Overfishing in the early days of the European settlement led to the depletion of many stocks of salmon and steelhead even before extensive habitat degradation. More recently, overfishing in non-tribal fisheries is believed to have been a significant factor in the decline of salmon and steelhead. This included significant overfishing that occurred from the time marine survival turned poor for many stocks (ca. 1976) until the mid-1990s, when harvest was substantially curtailed. Since 1994, the retention of coho salmon has been prohibited in marine fisheries south of Cape Falcon, Oregon. Coho salmon are still impacted, however, as a result of hook-and-release mortality in chinook salmon-directed fisheries. Sport and commercial fishing restrictions ranging from severe curtailment to complete closures in recent years may be providing an increase in adult salmon and steelhead spawners in some streams, but trends cannot be established from the existing data.

5. Pollution

Industrial, municipal, and agricultural wastes have been discharged into the waters of San Francisco Bay with major historical point sources including wastes from fish, fruit and vegetable canneries, and municipal sewage. The 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. Non-point sources of pollution, such as urban and agricultural runoff, continue to degrade water quality today.

6. Introduction of Non-native Species

As native fishes became depleted in the late 19th century, non-native species were brought in to the bay and delta: 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 invertebrates through ballast water of ships. 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 in San Francisco Bay has affected native species, including listed salmonids, through competition for food and habitat, and predation on native species.

7. Ecosystem Restoration

Preliminary, significant steps towards the largest ecological restoration project yet undertaken in the United States have occurred during the past five years and continue to proceed in California's Central Valley. The CALFED Program and the Central Valley Project Improvement Act's (CVPIA) Anadromous Fish Restoration Program (AFRP), in coordination with other Central

Valley and Bay Area efforts, have implemented numerous habitat restoration actions that benefit Central Valley steelhead, Central Valley spring-run chinook salmon, Sacramento River winter-run chinook, and their designated critical habitat. A few of these restoration projects include restoration actions within the San Francisco Bay. These restoration actions are primarily land acquisition, wetland restoration, and restoration of fish passage. Restoration of wetland areas typically involves flooding lands previously used for agriculture, thereby creating additional wetland areas and rearing habitat for juvenile salmonids, other fish species, and birds.

On two important steelhead streams in south San Francisco Bay, the recent construction and operation of two new fish ladders have improved environmental baseline conditions for Central California Coast steelhead. On Coyote Creek a fish ladder was installed in 1999 on Coyote Steel Dam, approximately 10 miles downstream of Anderson Dam. Prior to the construction of this ladder, adult steelhead had very limited access to the reach upstream with the highest quality spawning and juvenile rearing habitat in Coyote Creek. On Guadalupe River a fish ladder was constructed at the Alamitos Drop Structure in 1999. The Alamitos fish ladder provides upstream passage over a 13-foot drop structure and allows steelhead access to high quality spawning and rearing habitat in the upper watershed. These fish ladders on both Coyote Creek and Guadalupe River provide returning adult steelhead with suitable passage conditions at structures where no fish passage facilities existed prior to 1999. Full access to significantly better habitat conditions upstream for spawning (i.e. clean gravels) and rearing (i.e. suitable flows and temperatures) is expected to improve reproductive success and survival of juvenile steelhead in south San Francisco Bay.

V. Effects of the Action

A. Evaluating Proposed Actions

The standards for determining jeopardy and destruction or adverse modification of critical habitat are set forth in section 7(a)(2) of the ESA and 50 CFR Part 402 (the consultation regulations). This analysis involves the following steps: (1) define the biological requirements of listed anadromous salmonids within the action area; (2) evaluate of the effects of past and ongoing human and natural factors leading to the current status of the species; (3) determine the effects of the proposed or continuing action on listed salmonids and designated critical habitat; and (4) determine whether the proposed action, in conjunction with the status of the species, environmental baseline, and cumulative effects, can be expected to reduce appreciably the likelihood of survival and recovery of the species or destroy or adversely modify their critical habitat.

B. Effects of Proposed Action

The East Span Project is expected to result in short-term adverse effects to listed species during construction. Specifically, pile driving activities and dredging/disposal are likely to adversely affect listed anadromous salmonids and their designated critical habitat.

1. Pile Driving

The underwater sound pressure waves that have the potential to adversely affect listed anadromous salmonids originate with the contact of the hammer with the top of the steel pile. The impact of the hammer on the top of the 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 wall by a fraction of an inch sends an underwater pressure wave propagating outward from the pile in all directions. The molecular elasticity of the steel pipe pulls the pile walls back inward with the water following the inward movement of the pipe wall, resulting in the propagation of an under-pressure wave. The steel pipe pile resonates sending out a succession of waves even as it is pushed several inches deeper into the bay bottom.

a. Literature Review

There is very little literature on the effects of underwater shock waves generated by pile driving on aquatic life. There are a few refereed publications, but most of the information is contained in "gray literature" publications produced for government agencies that are project specific. The monitoring methods have not been standardized and measurements tend to be sporadic (Keevin *et al.* 1999). The following is a brief discussion on the effects of underwater shock waves on fish and the available literature on this subject.

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. Bubble expansion in blood vessels can cause hemorrhaging. 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.

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 of 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.

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.

Loud sounds can have detrimental effects on fish by causing 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 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.

Pile driving may result in "agitation" of salmonids indicated by a change in swimming behavior (Shin 1995). Salmon and steelhead 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 is not in any way injured, but it is exhibiting behavior that suggests it perceives a stimulus indicating potential danger in its immediate environment. Fish do not exhibit a startle response every time they experience a strong hydro-acoustic stimulus. The startle response is likely to extinguish after a few pile strikes.

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.

b. Case Studies - Pile Driving Projects

The following examples of specific pile driving projects provide additional insight to the potential effects of the East Span Project on listed salmonids:

At the Hong Kong Airport Fuel Transfer Facility project an air bubble ring with a diameter of 50 m was placed around the pile-driving operation. The pile driver was a six metric ton diesel hammer at 90 kilojoules (kJ). Hammer strikes resulted in underwater pulses of sound about 40 milliseconds in duration. The effective source level (inferred by extrapolating from the longer-distance measurements) was 238 dB re: 1 μPa at one meter without bubbles and 234 dB with bubbles. On average, the bubble screen diminished the sound pressures by 4 dB. The contractor did not measure peak pressures. It was also observed that low and high frequency sounds were not attenuated by the air bubble curtain. The peak pressure of sound anticipated to occur during the proposed East Span project (268 dB re: 1 μPa at one meter) far exceeds the level observed for the Hong Kong project.

At the Canada Place Cruise Ship Terminal in Vancouver, B.C., open-ended steel pipe piles 36 inches in diameter with 0.75-inch wall thickness were driven, as were 24-inch diameter closed-ended steel pipe piles with 0.75-inch wall thickness (Longmuir and Lively 2001). An air bubble curtain was developed to protect fish. It was kept as close to the pile as practical, allowing for battered (slanted) piles to be driven. The authors stated that a proper bubble curtain can reduce underwater sound overpressures from pile driving by at least 85 percent (16.5 dB) and that their bubble curtain in Vancouver reduced underwater overpressures during pile driving from more than 22 psi to less than 3 psi (a reduction of more than 17 dB). They referred to the Canada Department of Fisheries and Oceans' criterion for fish safety of not exceeding an explosion blast peak pressure of 14.5 psi (220 dB re: 1 μPa). The Canada Department of Fisheries and Oceans standard for fish safety is based on mortalities immediately after the explosion. The Vancouver study found that, perhaps due to the repetitive nature of pile driving, the peak pressure should be less than 4.5 psi (210 dB re: 1 μPa) to protect small fish. This standard is supported by Rasmussen (1967), who found that 3 to 6 month old salmon were killed by underwater explosions at levels exceeding 2.7 psi (204 dB re: 1 μPa).

To assess the environmental and technical factors involved in driving the very large piles proposed for the East Span Project, a Pile Installation Demonstration Project (PIDP) was undertaken in late 2000 in which three eight-foot diameter steel pipe pilings were driven into the San Francisco Bay (Illingworth and Rodkin 2001). The underwater sound measurements were not comprehensive, but important data came from two measurements at hydrophone depths of 1 and 6 m, without a sound attenuation system in place. Using a pile-driver energy of 900 kJ, peak pressure of 207 dB (re: 1 μPa) at a distance of 103 m and 191 dB at distance of 358 m were measured. Correcting for hammer size, excess attenuation of approximately 30 dB per tenfold increase in distance and applying the spreading loss formula (1), it was estimated that the pile driving source level (1 meter) was 268.5 dB (re 1 μPa) for the 1,700 kJ hammer (Greene 2001). Applying the spreading-loss model for received levels, the corresponding equation is:

$RL\ (dB\ re{:}\ 1\ \mu Pa) = 266.5 - 29.6 \bullet \log(R)\ for\ R\ in\ m.$ (Greene 2001)

The attenuation loss rate was almost 30 dB per tenfold change in distance, close to the 28 dB per tenfold change in distance observed at the Hong Kong refueling facility discussed above.
The maximum pile-driver energy available for the proposed project is 1,700 kJ. Applying the scaling suggested above, the peak pressure would be expected to have been

20●log(1,700/900)0.33 = 1.8 dB more at the higher energy level, or almost 209 dB at distance of 103 m. Thus, when the energy is 1,700 kJ, the constant term will be 268.5 dB in the equation for received level.

At the Baldwin Bridge piers in Connecticut, underwater acoustic measurements from the demolition pounding of a "hoe ram" were recorded by Dolat (1997). The ram struck the pier approximately four times per second creating loud pulsed sine waves with each blow. Four strikes per second was equivalent to a continuous 170 dB (re: 1μPa). Based on these estimates of the peak sound pressure levels, the report concluded that fish less than 30 m away could experience permanent auditory system damage, temporary and possibly permanent loss of equilibrium or complete incapacitation. The report included a brief discussion of previously unreported studies that show that beyond a brief startle response associated with the first few acoustic exposures, fish do not move away from areas of very loud noises and can be expected to remain in the area unless they are carried away by the river currents.

c. East Span Project

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 the East Span Project, but considerable uncertainty remains. Effects on an individual fish during pile driving at the East Span 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 sound/pressure attenuation technology

The discussion below elaborates upon several of these areas of uncertainty and the potential range of effects to listed salmonids associated with pile driving at the East Span Project.

Uncertainty associated with the effectiveness of the proposed air bubble curtain is related to several factors. The size of the impact hammers proposed for use on the East Span Project is larger than any of the hammers used in the projects discussed above. The resulting sound pressure levels generated are also expected to significantly exceed those measured in the examples above. Although the project's bubble curtain design was effective at the Canada Place Cruise Ship Terminal project, the sound pressure levels expected on the East Span Project are orders of magnitude greater and the performance of the bubble curtain under these conditions is unknown. The East Span Project is also located in an area of strong tidal currents. Experience has shown that bubble curtains work best in areas not influenced by currents, because moving water will carry the upward-traveling air bubbles away from the pile. If the pile is not completely encapsulated by air bubbles, high sound pressure waves are likely to travel further out into San Francisco Bay through areas thin or devoid of air bubbles.

Water depth at the pile driving site will influence the rate of sound attenuation and performance of the air bubble curtain. In 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. Approximately two-thirds of the large piles in the East Span Project are located in water depths less than 5 m. Sound attenuation is expected to occur at higher rates in the shallow water portion (< 5 m) of the East Span Project.

The specific construction schedule determined by the contractor will also greatly influence the level of potential impact on listed anadromous salmonids. If the contractor drives the deep water piles along the western third of the East Span (piers 2-7) during the summer and fall months, the expected impact on listed salmonids is likely to be significantly reduced. In deep water areas, sound pressure levels are expected to travel greater distances and these deeper channel areas are the likely migration corridors for both adult and juvenile Central California Coast steelhead traveling between natal streams in south San Francisco Bay and the Golden Gate. However, few juvenile or adult Central California Coast steelhead are likely be present in the action area between June 1 and November 30. Since the specific construction schedule and sequence of pile driving activities has not been established at this time, the vulnerability of listed salmonids to deep water pile driving is uncertain.

The actual number of impact hammers used will influence the extent of area affected by high sound pressure levels. It is possible that all three contractors (the contractor for Self-Anchored Suspension Main Span, the contractor for the Skyway, and the contractor for the Oakland approach structures) will drive piles simultaneously. Pile driving will be allowed from 7:00 AM to 8:00 PM, seven days a week and a pile that is underway at 8:00 PM will continue until driving of that pile segment is complete. During the winter months, pile driving conducted after dusk 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. 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 pressure levels.

Although little information is available to determine how and where listed anadromous salmonids migrate through and utilize San Francisco Bay, general inferences can be made based on geography, bathymetry, and known behavior patterns of salmon and steelhead. For the three listed ESUs originating from the Central Valley (Central Valley steelhead, Central Valley spring-run chinook salmon, Sacramento River winter-run chinook salmon), it is believed 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 adult salmon have been recorded feeding near YBI in the summer, these numbers are probably small. For juvenile 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. It is also the consensus of California salmon researchers that juvenile salmonids migrate relatively quickly through San Francisco Bay en route to productive feeding areas off the Pacific coast. Therefore, it is anticipated that only a small percentage of fish from the three Central Valley ESU's will be present in the East Span Project construction area and vulnerable to the adverse effects of high sound pressure levels.

Central California Coast coho salmon utilize two streams in Marin County (one empties into Richardson Bay, the other into north San Francisco Bay) and neither adults nor juveniles (emigrating as one year-olds) are expected to be near the East Span Project pile driving area during their migration between the ocean and natal streams.

The listed anadromous salmonids that are most likely to be present in the immediate construction area and exposed to harmful sound levels during pile driving are Central California Coast steelhead, which spawn in tributaries flowing into San Francisco Bay. Central California Coast steelhead traveling to and from south Bay streams must pass under the Bay Bridge. Considering the bathymetry of San Francisco Bay and the distribution of tidal currents, NMFS believes that it is likely that between 20 and 30 percent of the steelhead run from south San Francisco Bay streams pass to the east of YBI and through the East Span Project construction area, based on the division of flow around YBI. Caltrans estimates that only 5 percent of south San Francisco Bay's adult and juvenile steelhead migrate to the east of YBI. Caltrans' estimate is based on an estimate that 20 percent of the water originating from the south bay passes east of YBI and other factors related to smolt outmigration behavior (Deborah McKee, Caltrans; pers. comm; October, 2001).

Adult and juvenile salmonids 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 East Span Project construction site is expected to assist with the transport of listed salmonids 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 are influenced by tidal currents, which is currently unknown.

The extent of area of impacted by high sound pressure levels during pile driving is strongly dependant upon the effectiveness of the proposed air bubble curtain. Based on the performance of the bubble curtain used at the Canada Place project in Vancouver and results from the PIDP, Greene (2001) estimates that fish beyond 44 m from the pile driving operation in the East Span Project will generally survive, assuming a 10 dB reduction in sound pressure levels from the bubble curtain. However, Greene (2001) assumes that immediate mortality of fish is limited to levels of 210 dB and greater. Rassmusen (1967) suggests immediate mortality of juvenile salmonids may occur at sound pressure levels exceeding 204 dB. In consideration of this uncertainty, NMFS estimates fish beyond 69 m (204 dB re: 1 μPa) will generally survive during the large hammer pile driving in the East Span Project, assuming a 10 dB reduction in sound pressure levels from the bubble curtain.

Assuming the bubble curtain reduces sound pressure levels by 10 dB, juvenile steelhead and salmon within 69 m (204 dB re: 1 μPa) of an active pile driving operation are likely to be killed instantaneously. A strong shock wave or high pressure/low pressure cycle in this zone is expected to rupture the fish's swim bladder and result in other trauma to many internal organs. If the bubble curtain does not reduce sound pressure levels by 10 dB, this zone of immediate mortality may extend up to 100 m from an active pile driving operation. Due to their size, adult salmon and steelhead can tolerate higher pressure levels (40-50 psi) (Hubbs and Rechnitzer 1952) and immediate mortality rates or adults are expected to be less than that experienced by juveniles.

Beyond 69 m (204 dB re: 1 μPa) and up to a distance of 440 m (180 dB re: 1 μPa) from an active pile driving operation, listed salmonids are likely to experience trauma in many organs including the inner ear, eyes, blood, nervous system, kidney, and liver. These injuries are expected to result in the delayed mortality of many of these fish. As the underwater sound pressure wave generated by a pile strike passes through a fish, the swim bladder will be rapidly squeezed due to the high pressure and then rapidly expand as the underpressure component of the wave passes through the fish. At relatively low sound pressure levels, only a fraction of 1 psi above the ambient sound pressure level in the environment, the swim bladder will rhythmically expand and contract with no adverse effect. The swim bladder routinely expands and contracts as salmonids swim near the surface or swim in deeper water near the bottom. At high sound pressure levels of pile driving, the swim bladder may 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).

Damage to the inner ear of fish is also expected to occur within a distance of 440 m from an active pile driving operation. Based on the sound pressures and exposure times for sensory hair cell damage reported by Hastings (1995) and Hastings *et al.* (1996), and an assumption of deposition of equivalent acoustic energy in the inner ear over time, damage to the inner ear will occur to individual fish that remain within the vicinity of high sound pressure levels (180 dB re: 1 μPa at 440 m) for more than a few minutes.

Between 440 m and 4,440 m from an active pile driving operation, sound pressure levels are predicted to attenuate from 180 dB (re: 1 :Pa) to approximately 150 dB (re: 1 :Pa), respectively. Within this area, listed salmonids may exhibit temporary abnormal behavior indicative of stress or exhibit a startle response, but not sustain permanent harm or injury. However, there is some uncertainty about the potential for injury to fish from sound pressure levels in this range, because Hastings has information that suggests damage to the inner ear may occur at levels greater than 150 dB (re: 1 :Pa) (M. Hastings pers. comm., October 2001). Hastings concludes that 150 dB (re: 1 FPa) is a safe upper limit for relatively short exposures (M. Hastings pers. comm., October 2001).

Determining the number of threatened Central California Coast steelhead that may be injured or killed by the East Span Project is difficult at best. The size of the steelhead run in south San Francisco Bay tributaries is not known, but has been estimated as 300 adult steelhead returning to spawn in Guadalupe River, Coyote Creek, and San Franciscquito Creek (J. Smith, pers. comm.) In lieu of estimating the number of individual 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 can be calculated. For the purposes of this analysis, the zone of potential impact is defined as the area where there may be injury or mortality to listed anadromous salmonids. Based on the research discussed above and the recommendations of Hastings (pers. comm., October 2001), the area of injury and mortality of juvenile anadromous salmonids is defined as the area with sound pressure levels exceeding 180 dB (re: 1 μPa). During the Baldwin Bridge project in 1997, NMFS established 180 dB s the threshold for harm to fish during pile driving operations (M. Ludwig, pers. comm., October 2001). For adult salmonids, the area of injury and mortality is defined as the area exceeding 200 dB (re 1 μPa), because adult fish can tolerate higher pressure levels (40-50 psi) (Hubbs and Rechnitzer 1952) than can juvenile fish. This represents an order of magnitude (20 dB) increase over levels that produce lethal effects for juveniles.

Using Greene's calculations (Greene 2001) the area of potential impact to juvenile anadromous salmonids with 10 dB of reduction at the air bubble curtain is expected to extend 440 meters from the pile (180 dB). For adult salmonids, the area of potential impact with a 10 dB reduction by the bubble curtain is expected to extend approximately 100 meters from the pile (200 dB). Taking into account tidal currents at the project site ranging from 3 knots in deep water to low velocities along shoreline areas, an average velocity of 1 knot (1,852 m/s) was selected. A one hour impact volume for each pile was summed based on the depth of water and then multiplied by the estimated total driving time of 5 hours per pile.

To calculate the percentage of the south San Francisco Bay steelhead population that would be impacted by sound levels greater than 180 dB (re: 1 μPa), the following assumptions were made: (1) twenty five percent of the fish migrate to the east side of YBI en route to and from the Golden

Gate; (2) pile driving will occur in areas greater than 5 m deep during the period between December and May; (3) pile driving will occur on average 3 hours per day; and (4) only one impact hammer will be operating. The 880 m diameter of the impact area corresponding to the 180 dB level is roughly one-third the distance between from YBI to the Oakland shoreline. With these assumptions, roughly 1 percent of the outmigrating juvenile population of steelhead originating from south San Francisco Bay tributaries will be injured or killed by sound pressure levels exceeding 180 dB (re: 1 μPa) during pile driving. If two impact hammers are used simultaneously during this period, this percentage could increase up to 2 percent. Additional uncertainties that could increase this percentage of injured and killed juvenile steelhead include: (1) more than 25% of the juvenile fish migrate along the east side of YBI; (2) the air bubble curtain does not achieve full 10 dB level of sound reduction; (3) tidal currents and swimming behavior of the fish result in multiple passes through the construction area; and (4) pile driving in deep water areas extends beyond one year into a second steelhead migration season. On the other hand, the level of impact upon the south San Francisco Bay steelhead could be significantly reduced if pile driving activities are limited to shallow water areas during the winter and spring migration season, the bubble curtain performs better than expected, or fewer than 25 percent of the run migrate along the east side of YBI.

A similar calculation for adult steelhead based on an impact area diameter of 200 m indicates less than 0.5 percent of the run in south San Francisco Bay tributaries will be killed or injured by high sound pressure levels during pile driving. As with the calculation for juvenile fish, several factors could increase this percentage including: (1) multiple hammers are used; (2) more than 25 percent of the adults migrate along the east side of YBI; (3) the air bubble curtain is less effective; (4) tidal currents and swimming behavior of the fish result in multiple passes through the construction area; and (5) pile driving in deep water areas extends beyond one year into a second steelhead migration season. Impacts would be reduced if pile driving activities are limited to shallow water areas during the winter migration season, the bubble curtain performs better than expected, or fewer than 25 percent of the run migrate along the east side of YBI.

It has been suggested that salmon and steelhead may avoid areas of high sound pressure levels and impacts may be reduced by their own behavioral response to the pile driving noise. Shin (1995) suggests that noise may result in "agitation" of salmonids indicated by a change in swimming behavior. However, observations to date suggest salmon and steelhead may exhibit a startle response to the first few strikes of a pile, but the fish do not exhibit a startle response every time they experience a strong hydro-acoustic stimulus. The startle response is likely to extinguish after a few pile strikes. Therefore, the noise associated with pile driving is not expected to delay or block adult or juvenile salmonids in the course of their migrations.

Coffer dams may be used by the contractors to dewater some pile installation sites. If cofferdams are installed, sediment will be excavated and the cofferdam dewatered. The steel pipe piles would be driven after dewatering into the Alameda geologic formation. It is anticipated that the layer of air and the coffer dam itself surrounding the pile will effectively attenuate sound pressure waves to safe levels for aquatic organisms in the Bay including listed salmonids. Coffer dams are likely to be used in shallowest areas at the Oakland Touchdown which will avoid adverse effects during the driving of these piles. In a riverine environment, the installation of cofferdams can trap fish inside. Fish within an enclosed cofferdam will be stranded and likely killed during dewatering. Although remote in a large estuarine environment such as San Francisco Bay, there is a slight risk for stranding of juvenile listed anadromous salmonids inside a cofferdam at the East Span Project.

2. Dredging

The potential impacts of dredging associated with the East Span Project include both direct and indirect adverse effects. Potential direct 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).

a. Entrainment

Dredging techniques expected to be employed for this project can be categorized as either hydraulic or mechanical. Both methods may be used. Entrainment of listed salmonids (primarily juveniles) can occur when hydraulic dredging is used; mechanical dredging is unlikely to entrain fish. If the dredging draghead is in operation while 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).

Dredging for barge access channels at the Oakland Touchdown and to dismantle the existing bridge could take four to six months each to complete. Water depths are expected to be approximately 4.3 m in depth or less adjacent to the Oakland Touchdown, where rearing and foraging juvenile chinook salmon may occur during the months of January through May (Baxter *et al.* 1999). However, NMFS expects that juvenile Central California Coast steelhead are less likely to be rearing or foraging in this shallow water habitat due to their age and size.

b. Turbidity

There is little direct information available to assess the effects of turbidity in San Francisco Bay on juvenile or adult salmonids. 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. Barges for holding, transport, and disposal of dredged material will be selected by the contractor, so their size and characteristics cannot be accurately estimated.

LaSalle (1988) described the physical characteristics of sediment dispersal during hopper dredging activities. 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.

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.

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 East Span Project, turbidity levels that may induce mortality are not expected to occur due to the open environment at both the dredge and disposal sites. However, turbidity may alter the behavior of both adult and juvenile fish. 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 juvenile feeding, increase the susceptibility of juveniles to predation, and interfere with migratory behavior.

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.

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). 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; polynuclear aromatic hydrocarbons (PAHs); pesticides; polychlorinated biphenyls (PCBs); mono-, di-, tri- and tetrabutyltin and total organic carbon (TOC). Biological analyses were conducted for 96-hour L/SP 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 (USACOE letter dated October 31, 2000).

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* 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 an upland location.

Although the DMMO determined that the majority of dredged material from the project is suitable for unconfined aquatic disposal, contaminants are present. They include oil and grease, TRPH, chlorinated pesticides (DDD, DDE, and DDT[4]), metals (arsenic, cadmium, chromium, copper, lead, mercury, nickel, selenium, silver, and zinc), organotins, and 12 PAHs. Concentrations appear unlikely to result in any acute toxicity to listed anadromous salmonids as a result of the re-suspension of contaminated sediments during project dredging. However, there remains a concern for chronic effects that may occur as a result of the uptake of contaminants by juvenile salmonids during their migration through the Bay.

d. Ammonia and Dissolved Oxygen

Two common by-products produced in anaerobic sediments containing adequate concentrations of organic matter are ammonia and hydrogen sulfide, which are highly toxic and produced by anaerobic aquatic microorganisms. Dillon and Moore (1990) report that ammonia can exert toxicity at relatively low concentrations on fish and other aquatic organisms. The release of ammonia during dredging and the disposal of dredged material could affect aquatic species as it is

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[4]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).

re-suspended in the water column.

For the East Span Project it appears unlikely that acute, short-term effects due to increased levels of ammonia at either the dredge site or the disposal site will occur due to the open environment at the disposal site, and to a slightly lesser extent at the dredge site. Un-ionized form of ammonia has great potential for adversely affecting listed salmonids, but the concentrations anticipated at the dredge and disposal sites are unlikely to directly affect juvenile or adult listed anadromous salmonids. Indirect effects, in a similar pattern as is described for turbidity, may occur through behavior modification resulting from avoidance of the increased concentration levels of ammonia near both sites.

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. There will be some short-term impact to invertebrate colonies as a result of dredging, however, rapid recolonization rates indicate that this would be of minimal impact to salmonids.

Although benthic invertebrates in subtidal and intertidal habitats have been shown to be key food sources for juvenile salmonids during the outmigration (McCabe and Hinton 1998), it is unlikely a significant loss of prey species will occur from these activities on the bottom at either the dredge or disposal site. Within the upper portion of the water column at the disposal site there may be some loss of prey items.

3. Impacts to Critical Habitat

The entire San Francisco Bay is designated critical habitat for Central California Coast steelhead while areas north of the San Francisco-Oakland Bay Bridge are designated critical habitat for Central Valley steelhead, Central Valley spring-run chinook, and Sacramento River winter-run chinook. Permanent impacts to designated critical habitat in San Francisco Bay are expected to occur in intertidal areas just north of the Oakland Touchdown and a small area in Clipper Cove at YBI. Dredging for barge access at the Oakland Touchdown and the placement of fill to construct the westbound roadway are expected to result in the permanent loss of mud flats, sand flats, and eelgrass beds. At Clipper Cove on YBI approximately 0.1 acre of an eelgrass bed will be impacted from the construction of a temporary barge dock. In total an estimated 3.24 acres of eelgrass beds will be permanently impacted.

The use of the eelgrass beds in San Francisco Bay by juvenile salmonids is unknown, but the areas are likely to provide some habitat value for foraging and rearing juvenile salmonids. Eelgrass can provide cover, and general habitat diversity and complexity for salmonids in the shallow water portions of San Francisco Bay.

Temporary impacts to the designated critical habitat of anadromous salmonids are expected during construction of the East Span Project. Pile driving and dredging will adversely affect the water column of San Francisco Bay. Impacts to the water column from high sound pressure levels are discussed above, as are impacts to water quality associated with dredging. Temporary loss of mud flats and sand flats in the vicinity of the Oakland Touchdown are expected due to the installation of geotube. The geotube will serve as a temporary tidal barrier during construction to protect the work area. Fish and other aquatic species will not have free access to approximately 2.63 acres of tidal sand and mud flats within the geotube protected area during construction.

Proposed on-site mitigation includes restoring the bathymetry of 1.73 acres of the barge access channel to facilitate the re-colonization of eelgrass and restoring 1.70 acres of sand flats. This on-site restoration is expected to restore some of the habitat value lost during project construction. Because the use of intertidal areas and eelgrass in San Francisco Bay by juvenile salmonids is thought to be low, these restoration actions are expected to provide minimal benefits to listed anadromous salmonids.

Off-site mitigation at Skaggs Island will allow for USFWS to acquire and restore approximately 3,000 acres of wetland and aquatic habitat. The USFWS would be responsible for designing, constructing, monitoring, and managing the habitat creation and/or restoration. The inclusion of eelgrass and sand flat habitat could provide some habitat benefits to juvenile anadromous salmonids, but the location in the north bay would primarily benefit Central Valley ESUs and not steelhead from south San Francisco Bay streams. It is anticipated that USFWS will work together with NMFS through an ESA Section 7 consultation on the acquisition and restoration of Skaggs Island when sufficient project-level information becomes available.

Caltrans will establish a $4 million fund for the restoration of federal- and State-listed salmonid habitat in the central and south Bay. These projects will be 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 to steelhead and designated critical habitat in central and south San Francisco Bay tributaries. It is anticipated that the individual restoration projects funded by this Caltrans account will undergo section 7 consultation with the Corps of Engineers, NMFS, or another appropriate Federal action agency when sufficient project-level information becomes available.

4. Integration and Synthesis of Effects on the ESUs

As discussed above, pile driving and dredging/disposal activities associated with the East Span Project are expected to result in adverse effects to listed anadromous salmonids during construction. For the three listed Central Valley ESUs (Central Valley steelhead, Central Valley spring-run chinook salmon, Sacramento River winter-run chinook salmon), the East Span Project is expected to result in minimal adverse effects, because few individuals are likely to be present within the area of direct construction impacts. High sound levels from pile driving are predicted to extend several hundred meters from the pile, but the geography and bathymetry of San Francisco Bay combined with the known behavior patterns of salmon and steelhead suggest 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. This portion of San Francisco Bay is several kilometers from the area that will be subject to high sound pressure levels. The dredging areas are also relatively distant from the primary migration routes of Central Valley ESUs, but the disposal site at SF-11 near Alcatraz Island could subject many Central Valley salmonids to degraded water quality during a disposal event. Therefore, it is expected the East Span Project will result in minimal adverse effects to threatened Central Valley salmon and steelhead ESUs or their designated critical habitat.

Central California Coast coho salmon utilize two streams in Marin County (one empties into Richardson Bay, the other into north San Francisco Bay) and neither adults nor juveniles (emigrating as one year-olds) are expected to be near the East Span Project pile driving area during their migration between the ocean and natal streams. Therefore, it is expected the East Span Project will result in minimal adverse effects to threatened Central California Coast coho salmon ESU or their designated critical habitat.

For Central California Coast steelhead, up to 2 percent of the juvenile population originating from south San Francisco Bay tributary streams may be adversely affected by pile driving during the construction of the East Span Project. Up to 0.5 percent of the steelhead adults returning to south San Francisco Bay streams may be adversely affected by pile driving. These construction-related impacts are expected to be limited to one year, but could extend partially into a second year depending upon the actual construction schedule determined by the contractor. Numerically south San Francisco Bay steelhead represent a very small portion of the entire Central California Coast steelhead ESU, but these south Bay tributaries represent a significant and unique portion of the geographic distribution of this ESU. Loss of 2 percent of the juvenile steelhead in south Bay streams is likely to reduce the number of adults returning by a similar percentage in the first and second years subsequent to the East Span Project's in-water construction. Loss of those adults and the 0.5 percent of returning adult steelhead during construction activities is likely to reduce juvenile production in south Bay streams in the years immediately following construction. These combined losses of adult and juvenile steelhead associated with the East Span Project are expected to manifest as a slight reduction (< 2 percent) in the number of adult returns in future years.

Under former baseline conditions, these reduced levels of juvenile steelhead production and adult returns would likely have resulted in long-term effects on the south Bay steelhead population's survival and potential for recovery. However, recent improvements to baseline conditions in two of the most important south San Francisco Bay steelhead streams are expected to significantly improve reproductive success and survival of juvenile steelhead. On Coyote Creek a fish ladder was installed in 1999 on Coyote Steel Dam, approximately 10 miles downstream of Anderson Dam. Prior to the construction of this ladder, adult steelhead had very limited access to the reach upstream with the highest quality spawning and juvenile rearing habitat in all of Coyote Creek. On Guadalupe River a fish ladder was constructed at the Alamitos Drop Structure in 1999. The Alamitos fish ladder provides upstream passage over a 13-foot drop structure and allows steelhead access to high quality spawning and rearing habitat in the upper watershed. These fish ladders on both Coyote Creek and Guadalupe River provide returning adult steelhead with suitable passage conditions at structures where no fish passage facilities existed prior to 1999.

Improved access to significantly better habitat conditions upstream for spawning (i.e. clean gravels) and rearing (i.e. suitable flows and temperatures) are expected to result in long-term benefits towards the survival and recovery of steelhead in south San Francisco Bay. Additional restoration actions implemented by the $4 million fund established by Caltrans are also expected to improve the environmental baseline in central and south San Francisco Bay steelhead streams. Therefore, the number of adult steelhead returning to south Bay streams is expected to improve and will provide the south San Francisco Bay steelhead populations additional resilience to contend with the potential adverse effects of the East Span Project. In consideration of the above, the East Span Project is not anticipated to reduce the likelihood of the survival and recovery of the local Central California Coast steelhead populations or the Central California Coast ESU.

Permanent loss of eelgrass beds, mud flats and sand flats in the vicinity of the Oakland Touchdown will diminish the value of designated critical habitat in San Francisco Bay for listed anadromous salmonids. However, observations to date suggest the use of these habitat types by juvenile salmonids is primarily limited to young fall-run chinook salmon prior to smolt migration (Baxter *et al.* 1999). Therefore, these habitat losses are expected to have minimal adverse effect on the function of this component of designated critical habitat for listed salmon and steelhead.

VI. Cumulative Effects

Cumulative effects are defined in 50 CFR 402.02 as "those effects of future State or private activities, not involving Federal activities, that are reasonably certain to occur within the action area of the Federal action subject to consultation." For the purposes of this consultation, the action area is the San Francisco Bay between the Richmond-San Rafael Bridge in the north, the Golden Gate Bridge in the west, and the San Mateo Bridge in the south. Non-Federal actions that may affect the action area include State angling regulation changes, voluntary State or private sponsored habitat restoration activities, State hatchery practices, discharge of stormwater and agricultural runoff, increased population growth, mining activities, and urbanization. State angling regulations are generally moving towards greater restrictions on sport fishing to protect listed fish species. Habitat restoration projects may have short-term negative effects associated with in-water construction work, but these effects are temporary, localized, and the outcome is typically a benefit to these listed species. State hatchery practices may have negative effects on naturally produced salmonids through genetic introgression, competition, and disease transmission resulting from hatchery introductions. 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 and mining operations in the action area may adversely affect water quality and estuarine productivity.

VII. Conclusion

After reviewing the best available commercial and scientific information regarding the current status of effected listed anadromous salmonids, 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 East Span Project is not likely to jeopardize the continued existence of endangered Sacramento River winter-run chinook salmon, threatened Central Valley spring-run chinook salmon, threatened Central California Coast steelhead, threatened Central Valley steelhead, or threatened Central California Coast coho salmon or result in the destruction or adverse modification of their designated critical habitats.

VIII. Incidental Take Statement

"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 to include significant habitat modification or degradation that results in death or injury to listed species 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 intended as part 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 incidental take statement.

The measures described below are nondiscretionary, and must be undertaken by FHWA so that they become binding conditions of any grant or permit issued to Caltrans, as appropriate, for the exemption in section 7(o)(2) to apply. The FHWA has a continuing duty to regulate the activity covered by this Incidental Take Statement. If the FHWA (1) fails to assume and implement the terms and conditions or (2) fails to require Caltrans or Caltrans' contractors to adhere to the terms and conditions of the incidental take statement through enforceable terms that are added to the permit or grant document, the protective coverage of section 7(o)(2) may lapse. In order to monitor the impact of incidental take, the FHWA or Caltrans must report the progress of the action and its impact on the species to NMFS as specified in the incidental take statement (50 CFR §402.14(I)(3)).

A. Amount or Extent of Take Anticipated

It is anticipated that take associated with the East Span Project will be in the form of mortality, injury, harassment, and disturbance through temporary impacts from construction activities associated with pile driving and dredging.

1. Pile Driving

Underwater sound pressure waves generated by pile driving activities are expected to expose both adult and juvenile listed salmonids to lethal and injurious conditions. Most juvenile anadromous salmonids within a 69 m (204 dB re: 1 μPa) radius of the pile during the operation of large hammers will be killed instantaneously. Beyond this 69 m radius, up to a distance of 440 m (180 dB re: 1 μPa) from a pile driving operation, fish are expected to experience trauma in many organs including the inner ear, eyes, blood, nervous system, kidney, and liver. These injured fish are expected to have some difficulty in maneuvering or maintaining orientation in the water column, and many will be subject to delayed mortality. Still further out from the pile driving activity, up to possibly 4,400 m (150 dB re: 1 μPa) during the driving of large piles, fish may exhibit temporary abnormal behavior indicative of stress or exhibit a startle response, but not sustain permanent harm or injury.

The number of adult and juvenile Sacramento River winter-run chinook salmon, Central Valley spring-run chinook salmon, and Central Valley steelhead that will be harassed, injured or killed from pile driving cannot be accurately estimated, but is expected to be a very small number of individuals given their main migration corridor is the north side of central San Francisco Bay. Since Central California Coast coho salmon are limited to two streams in Marin County, neither adult nor juvenile coho salmon are expected to be near the pile driving area and no take is expected from pile driving. For Central California Coast steelhead originating from the south San Francisco Bay streams lethal and non-lethal take are likely to occur as described above. Based on the bathymetry of San Francisco Bay and the distribution of tidal currents, NMFS anticipates up to 2 percent of the juvenile steelhead steelhead originating from south San Francisco Bay streams will be adversely affected by pile driving and up to 0.5 percent of the steelhead adults returning to south San Francisco Bay streams will be adversely affected. The actual number of affected steelhead is dependent upon a number of factors including the pile driving schedule and sequence established by the contractor. Pile driving in deep water areas (greater than 5 m) during the period of December through May is expected to result in the greatest level of lethal and non-lethal take (2 percent of juveniles and 0.5 percent of adults). If this operation is repeated in the subsequent year, a second year class of steelhead will be similarly subjected to this level of take. However, these percentages would be significantly reduced if pile driving activities occur in shallow water areas during the winter and spring migration season, the bubble curtain performs better than expected, or fewer than 25 percent of the run migrate along the east side of YBI.

During the installation of cofferdams and geotubes, an unknown number of juvenile salmon and steelhead may be stranded and killed during sediment removal and dewatering. The number of fish lost to stranding in this manner is expected to be very few due to the low density of juvenile salmonids within a large estuarine environment such as San Francisco Bay.

2. Dredging and Disposal

Dredging and disposal activities are expected to result in "take" in the form of harassment and disturbance through temporary habitat impacts at and near the dredging and disposal sites. Habitat within several hundred meters at both the dredge and aquatic disposal sites will be temporarily degraded due to localized turbidity produced by dredge and disposal activities. Migration behavior and foraging of juvenile and adult salmon and steelhead are likely to be disrupted by the plume of turbid water occurring during and immediately following dredging and disposal events. An unknown amount of turbidity may also result from the air bubble attenuation system around each pile driving activity as it causes an upwelling area while operating. Impacts from turbidity are not expected to result in lethal take of any listed anadromous salmonid. Mortality of juvenile salmonids due to entrainment in a hydraulic dredge is expected to be very low.

B. Effect of the Take

In the accompanying biological opinion, NMFS has determined that the anticipated take is not likely to result in jeopardy to Central California Coast coho salmon, Central California Coast steelhead, Sacramento River winter-run chinook salmon, Central Valley spring-run chinook salmon, or Central Valley steelhead.

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 Central California Coast coho salmon, Central California Coast steelhead, Sacramento River winter-run chinook salmon, Central Valley spring-run chinook salmon, and Central Valley steelhead.

The FWHA shall:

1. Utilize measures to reduce the impacts from pile driving.
2. Utilize measures to reduce the impacts from dredging.
3. Utilize measures to reduce the impacts from dismantling the existing bridge.
4. Ensure the fisheries and hydroacoustic monitoring program is properly implemented.
5. Ensure the $4 million restoration fund for off-site steelhead restoration and enhancement projects is properly administered.

D. Terms and Conditions

FHWA must comply with the following terms and conditions, which implement the reasonable and prudent measure described above. These terms and conditions are non-discretionary.

1. Utilize measures to reduce the impacts from pile driving.

    1a. To avoid attracting fish with lights during nighttime pile driving operations, pile driving shall be limited to daylight hours to the extent practicable and the use of artificial lights shall be minimized. If needed, illumination for any pile driving operations shall be directed away from the water.

    1b. To maintain the integrity of the air bubble curtain, no barges, boat traffic, or other structure or equipment will be allowed to penetrate the curtain during pile driving activities.

    1c. Piles containing creosote for in-water construction will not be used.

    1d. Installation of the geotube shall occur during low tide to minimize the potential for entrapment and stranding of fish within the enclosed area.

2. Utilize measures to reduce the impacts from dredging.

    2a. 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 dredge be operated at a level higher than three feet above the bed.

3. Utilize measures to reduce the impacts from dismantling the existing bridge.

    3a. Dredging/disposal associated with barge access for the dismantling the existing bridge will be restricted to the period between June 1 and November 30.

    3b. All activities that will generate high sound pressure levels (>150 dB re: 1 μPa) associated with the dismantling of the existing bridge will be restricted to the period between June 1 and November 30.

4. Ensure the fisheries and hydroacoustic monitoring program is properly implemented.

    4a. A fisheries and hydroacoustics monitoring plan will be developed that includes the following:

        (1) underwater sound measurements at various distances and depths from pile driving operations

(2) evaluation of fish mortality and injury rates through the use of caged fish at various distances and depths from pile driving operations;
(3) observations of bird predation and behavior.

4b. The draft fisheries and hydroacoustic monitoring plan will provided to the NMFS for review and approval 90 days prior to initiation of pile driving.

4c. Data from the monitoring program will be made available to NMFS on a real-time basis.

4d. An interim report will be provided to NMFS prior to December 31, 2002, and a final report will be provided by June 1, 2004.

4e. All salmonids killed and collected by this project must be transferred to the NMFS Southwest Fisheries Science Center Santa Cruz Laboratory Tissue Repository within thirty days of collection.

5. Ensure the $4 million restoration fund for off-site steelhead restoration and enhancement projects is properly administered.

5a. Quarterly reports regarding the status of the steelhead restoration and enhancement fund shall be provided to NMFS beginning in June 2002 and continue until all funds have been spent.

5b. All proposed expenditures from the account shall be provided to NMFS 30 days in advance of the proposed withdrawal date. Proposed expenditures shall be fully described and tied to a proposed steelhead restoration and enhancement project in central or south San Francisco Bay tributaries. NMFS must provide written approval in advance of each withdrawal from the escrow account.

REPORTING REQUIREMENTS

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

San Francisco Bay Team Leader
National Marine Fisheries Service
777 Sonoma Ave., Room 325
Santa Rosa, California 95404
Phone (707) 575-6050
Fax (707) 578-3435

IX. 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. The FHWA, in conjunction with 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 of salmonids and their habitats.

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.

X. Reinitiation Notice

This concludes formal consultation on the proposed San Francisco - Oakland Bay Bridge East Span 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.

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XII. Personal Communications

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Enclosure 2

San Francisco-Oakland Bay Bridge
East Span Seismic Safety Project

ESSENTIAL FISH HABITAT CONSERVATION RECOMMENDATIONS
(Magnuson-Stevens Fishery Conservation and Management Act - EFH Consultation)

San Francisco-Oakland Bay Bridge
East Span Seismic Safety Project

ESSENTIAL FISH HABITAT CONSERVATION RECOMMENDATIONS
(Magnuson-Stevens Fishery Conservation and Management Act - EFH Consultation)

The 1996 amendments to the Magnuson-Stevens Fishery Conservation and Management Act (MSFCMA) set forth mandates for the National Marine Fisheries Service (NMFS), regional fishery management councils, and federal action agencies to identify and protect important marine and anadromous fish habitat. The Councils, with assistance from NMFS, are required to delineate "essential fish habitat" (EFH) in fishery management plans (FMPs) or FMP amendments for all managed species. Federal action agencies which fund, permit, or carry out activities that may adversely impact EFH are required to consult with NMFS regarding potential adverse effects of their actions on EFH, and respond in writing to NMFS' conservation recommendations. In addition, NMFS is required to comment on any state agency activities that would impact EFH. Although the concept of EFH is similar to that of "Critical Habitat" under the Endangered Species Act, measures recommended to protect EFH are advisory, not proscriptive.

The Pacific Fisheries Management Council has delineated EFH for west coast groundfish (PFMC 1998a), coastal pelagic species (PFMC 1998b) and Pacific Coast Salmon (PFMC 1999). Species from each of the above Fisheries Management Plans (FMP) occur within the action area of the preceding biological opinion and require EFH consultation.

I. IDENTIFICATION OF ESSENTIAL FISH HABITAT

Essential fish habitat (EFH) is defined in the MSFCMA as "...those waters and substrate necessary to fish for spawning, breeding, feeding, or growth to maturity...". NMFS regulations further define "waters" to 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" to include sediment, hard bottom, structures underlying the waters, and associated biological communities; "necessary" to mean 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" to cover a species' full life cycle.

The geographic extent of EFH for coastal pelagic species and west coast groundfish includes waters, substrates and biological communities within bays and estuaries of the Pacific coast seaward from the high tide line (Mean Higher-High Water) or extent of upriver saltwater intrusion. This includes waters of San Francisco Bay which are within the action area of the preceding biological opinion.

For Pacific coast salmon, the geographic extent of EFH currently being considered includes both marine and freshwater habitat. For purposes of this consultation, Pacific coast salmon EFH corresponds to "Critical Habitat" designated under the Endangered Species Act for Sacramento River winter-run chinook (58 FR 33212), Central Valley Spring-run chinook salmon, and Central California Coast coho salmon (64 FR 24049).

II. PROPOSED ACTION.

The San Francisco-Oakland Bay Bridge East Span Seismic Safety Project (East Span Project) is described in the preceding biological opinion for the endangered Sacramento River winter-run chinook salmon, threatened Central Valley spring-run chinook salmon, threatened Central California Coast coho salmon, threatened Central California Coast steelhead, and threatened Cental Valley steelhead.

III. EFFECTS OF THE PROJECT ACTION

The following is a general description of the non-fishing related activities that directly or cumulatively, temporarily or permanently may threaten the physical, chemical and biological properties of the habitat utilized by west coast groundfish species, coastal pelagic species or Pacific coast salmon and their prey within the proposed project area. The direct result of these threats is that the function of EFH may be eliminated, diminished or disrupted.

Potential impacts to Pacific coast salmon EFH, specifically Sacramento River winter-run chinook salmon, Central Valley spring-run chinook salmon, and Central California Coast coho salmon, due to the proposed action have been described in the preceding biological opinion. These potential impacts would also apply to Central Valley fall and late-fall run chinook salmon.

Adverse effects of the proposed action on west coast groundfish (e.g. starry flounder, leopard shark, brown rockfish, English sole) EFH, coastal pelagic species (e.g. northern anchovy, Pacific sardine) EFH, and biological prey organisms (e.g., pacific herring, shiner perch) for EFH species may occur through direct mortality and injury during pile driving operations, and entrainment, turbidity, resuspension of contaminants, and degraded water quality during dredging and disposal activities. Additionally, the proposed project will destroy at least 3.24 acres of eelgrass habitat which functions as an important habitat type used by EFH species (e.g., Northern anchovy, English sole, and starry flounder) and their prey for foraging and shelter.

IV. CONCLUSION

Upon review of the anticipated effects of the proposed project, NMFS believes that San Francisco-Oakland Bay Bridge East Span Seismic Safety Project will adversely affect Pacific coast salmon EFH, coastal pelagic species EFH and west coast groundfish EFH.

V. EFH CONSERVATION RECOMMENDATIONS

Pursuant to Section 305(b)(4)(A) of the Magnuson-Stevens Act, NMFS recommends that the terms and conditions of the preceding biological opinion's Incidental Take Statement be adopted as EFH Conservation Recommendations for Pacific coast salmon, coastal pelagic species, and west coast groundfish. Additionally, NMFS recommends the following conservation recommendations be adopted:

1. A mitigation (compensation) plan for permanent and temporary losses of eelgrass habitat will be provided to the NMFS prior to beginning construction. This plan must be approved by NMFS before construction begins. The plan must include, but not be limited to the following mandatory components, with each mitigation component fully described in the plan.

a. Replace in-kind, permanently impacted eelgrass beds (currently estimated at 3.24 acres) at or near the project site through the creation of new eelgrass beds at the Oakland Touchdown area and at Clipper Cove on Yerba Buena Island. This would be accomplished by placing sand-filled plateaus to raise elevations of the Bay bottom to a level suitable to support eelgrass, and then planting the area with eelgrass from a donor site. The actual areas to be directly or indirectly impacted by dredging, by bridge installation, and by other actions are not clearly defined, and appropriate replacement ratios are yet to be determined by NMFS.

b. A mitigation fund will be established to finance an Adaptive Management Plan for providing mitigation for the balance of project impacts to eelgrass, replacing failed mitigation attempts, and other actions determined appropriate for eelgrass habitat restoration and enhancement. The amount and management of this fund will be negotiated with NMFS prior to construction. NMFS determines that eelgrass mitigation success in San Francisco Bay is speculative and that additional information, including habitat surveys and limiting factors analyses, is crucial and should be included in this Adaptive Management Plan. NMFS further determines that using the mitigation fund for this purpose is appropriate and sets no precedent for future similar mitigation actions in the bay.

2. ***Disposal of fine-grained sediments at disposal sites in San Francisco Bay will contribute to increased of turbidity levels. One of the disposal sites, SF-11, is dispersive, and any fine-grained sediments deposited at this site will resuspend and get transported to other areas, both inside and outside of the Bay. The resultant increased turbidity can inhibit foraging by fish and reduce production of eelgrass. Another result can be an overlying layer of fine-grained sediments over sand shoals or rocky areas, thereby reducing the quality of those types of habitats. These habitats are utilized by many groundfish species including flatfish and rockfish. To reduce impacts on EFH , the disposal of dredged materials shall only occur at upland disposal sites, when available. When upland disposal sites are not available in San***

Francisco Bay, then dredged materials shall be transported to the San Francisco Deep Ocean Disposal Site (SF-DODS) for disposal.

VI. FEDERAL AGENCY STATUTORY REQUIREMENTS

The Magnuson-Stevens Act (Section 305(b)(4)(B)) and federal regulations (50 CFR Section 600.920(j)) to implement the EFH provisions of the MSFCMA require federal action agencies to provide a written response to EFH Conservation Recommendations within 30 days of its receipt. The Federal action agency included in this consultation is the U.S. Department of Transportation. A preliminary response is acceptable if final action cannot be completed within 30 days. The final response must include a description of measures proposed to avoid, mitigate, or offset the adverse impacts of the activity on designated EFH. If the response is inconsistent with our EFH Conservation Recommendations, it must provide justification for not implementing them.

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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

APR 10 2009

In response refer to:
F/SWR/2008/08829

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:

This document transmits NOAA's National Marine Fisheries Service's (NMFS) supplemental biological opinion and conference opinion for the San Francisco-Oakland Bay Bridge East Span Seismic Project (enclosure). The supplemental biological and conference opinions analyze the effects of the project's remaining activities on the following listed species (Evolutionary Significant Units [ESU]) or Distinct Population Segment (DPS), designated critical habitat, and proposed critical habitat in accordance with section 7 of the Endangered Species Act of 1973, as amended (16 U.S.C. 1531 *et seq.*).

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)
proposed critical habitat (September 8, 2008, 73 FR 52084)

In the supplemental biological and conference opinions, 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 designated critical habitat, or proposed critical habitat for green sturgeon. 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.

Caltrans may ask NMFS to confirm the conference opinion as a biological opinion issued through formal consultation once critical habitat is designated for the southern DPS of green sturgeon. The request must be in writing. If NMFS reviews the proposed action and finds there have been no significant changes in the action as planned or in the information used during the conference, NMFS will confirm the conference opinion as part of the biological opinion for this project.

You may refer any questions concerning this consultation to Jacqueline Pearson Meyer of my Santa Rosa office staff by telephone at (707) 575-6057, or by e-mail at Jacqueline.Pearson-Meyer@noaa.gov.

Sincerely,

Rodney R. McInnis
Regional Administrator

cc: Russ Strach, NMFS, Sacramento
Jeff Jensen, Caltrans District 4, Oakland
Hal Durio, US Army Corps of Engineers, San Francisco
Copy to file: ARN# 151422SWR99SR190

Enclosure

SUPPLEMENTAL BIOLOGICAL OPINION AND CONFERENCE OPINION

ACTION AGENCY:	California Department of Transportation
ACTION:	Completion of Pile Driving and Other Remaining Activities for the San Francisco-Oakland Bay Bridge East Span Seismic Project.
CONSULTATION CONDUCTED BY:	National Marine Fisheries Service, Southwest Region
TRACKING NUMBER:	F/SWR/2008/08829
DATE ISSUED:	April 10, 2009

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 NMFS and 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.*).

[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.

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 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 eel grass 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 eight times[2] with NMFS to address proposed changes to the project, and to address impacts of the project to recently Federally-listed species.

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).

The majority of work for the construction of the new bridge has already been completed. However, in the October 2001 BO impacts from the installation of temporary piles were not analyzed for impacts to salmonids, analysis was only conducted for sound impacts associated with the installation of the permanent piles. The decision to exclude analyses on impacts associated with temporary pile installation was based generally upon the lack of information at the time on pile driving impacts and sound attenuation technology, and because Caltrans and NMFS anticipated the temporary piles required to build falsework would be substantially smaller than the permanent piles (18 to 24-inch diameter piles), and therefore sound impacts would not be at levels injurious to fish. However, changes to the project during the course of various planning phases resulted in plans consisting of temporary piles twice as large as what was originally proposed (42 to 48-inch diameter piles); and more information regarding the effects of pile driving on fish is available today. Thus, the anticipated effects from pile driving for temporary piles will be considered in this opinion for salmonids. All other remaining components (dredging/disposal and bridge dismantling) for the project remain the same as what were analyzed in the 2001 BO, and are not expected to vary from what was originally considered in prior consultations. Therefore, impacts on salmonids from dredging and disposal, and bridge dismantling that were originally analyzed in the October 2001 BO, are incorporated here by reference, and updated with additional information if warranted.

Additionally, since the signing of the October 2001 BO, green sturgeon were Federally-listed (71 FR 17757). Impacts on green sturgeon from construction activities were not considered in the 2001 BO, therefore all remaining project activities and associated impacts to green sturgeon will be included in this supplemental consultation.

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[2] This BO represents the eighth 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 North American southern DPS green sturgeon (*Acipenser medirostris*), and effects associated with temporary pile installation and impacts to salmonids.

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.

Several meetings, telephone conference calls, and electronic mail communications were exchanged between January 2008 and January 2009 regarding the remaining activities and revisions for the project, and assessment of potential impacts to the southern DPS green sturgeon associated with pile installation, placing of temporary fill, dredging, and bridge dismantling activities.

A complete administrative record of this consultation is on file in the NMFS Santa Rosa Area Office, Santa Rosa, California (Administrative Record #151422SWR99SR190).

II. DESCRIPTION OF THE PROPOSED ACTION

Caltrans is reinitiating consultation on the SFOBB East Span Seismic Project in order to address the remaining project activities’ impacts on the North American southern DPS green sturgeon, and the effects of temporary pile installation on salmonids. 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. 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 2013.

A. Proposed Actions

Construction of the bridge has been ongoing since 2001, therefore much of the project activities have been completed. 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 primary remaining and ongoing projects include 1) Yerba Buena Island Transition Structure (YBIT); 2) Self-Anchored Suspension Span (SAS); and 9) Dismantling of the existing East Span of the bridge. Construction activities for the remaining projects will include: installation of temporary piles and placement of temporary fill for falsework, and dredging for a barge access channel for dismantling the bridge. The project description presented below focuses on the remaining construction activities for the SFOBB East Span Seismic Project, including the contractor's temporary work, and will be the only actions analyzed as effects of the action in this BO.

1. <u>YBIT</u>

The YBIT is the portion of the new bridge that will extend northward from the SAS onto YBI. All construction of the YBIT will occur on YBI once demolition of the existing bridge is complete. The construction of the YBIT is expected to occur in three phases, however, as of the date of this BO, the construction contract for the YBIT has not been awarded and final designs are not confirmed for this component of the project. Caltrans does not anticipate any portion of the YBIT construction will require in-water work. For this reason, NMFS does not anticipate any impacts to Federally-listed anadromous species; therefore, the YBIT will not be discussed further in this document.

2. <u>SAS</u>

The main span between YBI and the Skyway Structure will be a self-anchored suspension design. The main tower will be set offshore from YBI at a water depth of 18 meters (m). Bay bottom sediments at the main tower foundation will be removed by dredging to expose the sloping bedrock. Holes will be drilled into bedrock, hollow steel pipe piles 2.5 m in diameter inserted, and a pre-fabricated steel box with concrete cover will be sunk onto the piles. A large hammer at low energy would likely be used for socketing of the large piles. The piles would be filled with concrete and welded to the pile cap. Because the bedrock at the main tower location is sloping, the contractor may choose to create a bench by mechanically breaking or excavating rock to create a level surface. The contractor may use a cofferdam for construction of the main tower foundation, but this is unlikely due to water depths and the geology at this location.

a. Pile Driving for Temporary Falsework

Temporary pile-supported falsework will be constructed at YBI for construction-related activities such as delivery of materials, and structural support of the SAS. Part of the falsework requires the construction of seven temporary towers. Of the seven temporary towers, three require marine installation of piles (Temporary Towers D, F, and G). Of these, only Temporary Tower G remains to be completed. The temporary piles are cast-in-steel-shell (CISS) piles ranging in size from 42-48 inches in diameter. For Temporary Tower G, the structure will consist of a northern and southern component. Each component will be comprised of 18 piles each, for a total of 36 piles for the tower. The piles will consist of sixteen 48-inch piles, and twenty 42-inch piles. The piles each have a top and bottom segment. The top segment of the piles will be welded to the bottom segment. Whenever feasible, piles will be installed with a vibratory hammer. For Temporary Tower G, it will be possible for Caltrans to install the top segment of each pile to within five meters of their tip elevation with a vibratory hammer. An impact hammer will then be used to drive the piles the final five meters after an approximate fifteen day settling period has passed.

Pile driving will be conducted within the navigation channel, where water depths are estimated to be 15 to 25 m deep. Caltrans will use vibratory hammers and diesel impact hammers (Delmag D100-13, or Menck MHU 500T) to install the piles. Pile driving has already begun on this project since it was originally covered under the 2001 BO. The expected completion date for the remaining pile driving of the temporary piles is in 2009. The expected duration for the remaining pile driving will be approximately 3 months. Pile driving will be intermittent and non-continuous through this period. Caltrans estimates that approximately two to three piles will be installed per day. Pile driving will be allowed from 7:00 AM to 8:00 PM, seven days a week. Pile driving that is underway at 8:00 PM will continue until driving of that pile segment is complete. Upon completion of the SFOBB East Span Seismic Project, temporary fill, temporary piles, barges and other falsework will be removed from the area.

To assess the level of impact to fisheries, monitoring will be implemented within the vicinity of pile driving operations. The fisheries monitoring program will include: 1) observations on predation by gulls and other birds; 2) examination of injured fish collected from the water; and 3) the implementation of a hydroacoustic monitoring program. The biological monitoring program will be designed to document near-term fish mortalities and the likelihood of delayed mortality of differing sizes and species of fish that have swim bladders. In addition to the biological monitoring, measurements of sound pressure and other parameters will be monitored via the hydroacoustic monitoring plan.

3. Dismantling of the Existing Bridge

a. Dredging

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. It is anticipated 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. The proposed disposal of a portion of the dredged material at SF-DODS is not expected 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. Therefore, 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 not likely 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).

b. Dismantling

Once the construction of the new East Span for the SFOBB is completed and put into service, the dismantling of the existing bridge structure will begin. The dismantling of the existing East Span is expected to occur in seven major stages, anticipated to be completed by 2013. An access channel will be constructed just south of the existing structure through dredging. Decks will be cut into pieces or disassembled panel-by-panel. Truss spans near the Oakland shore may be removed by conventional barge and crane methods because of the shallow water conditions and low clearance under the deck. Substructure elements may be lifted from their bases in one piece, or piece-by-piece. Options include constructing temporary supports under the span and disassembling the truss segment-by-segment, dredging for barge clearance, constructing temporary embankments of engineered fill within the bay for access, or using special shallow-draft barges or rigging devices for lowering sections onto barges from the bridge deck. Protective measures will be taken to prevent materials or debris from falling into the bay. Depending on location, materials could be removed by barge or truck to a predetermined site for reuse, recycling, or disposal.

Dismantling concrete foundations will require reducing the concrete into pieces small enough for transport; and may be accomplished either by saw-cutting, flame-cutting, mechanical splitting, pulverizing or hydro-cutting. The hollow interiors of piles remaining below the mud line could also be used as receptacles for concrete debris as the pier above is being dismantled. The piles remaining below the mudline could be capped or would gradually fill in through siltation. Any remaining steel would be cut flush with the remaining concrete face that remains below the mud line. Removal of the piles to 1.5 feet (0.46 m) below the mudline could be completed by an underwater dismantling method or by constructing cofferdams at each pier. The use of cofferdams at YBI would depend on methods selected by the contractor; however, since the final plans for bridge dismantling are not yet available, the use of cofferdams is not yet known.

All activities that will generate high sound pressure levels (>150 decibels [dB] re: 1 μPa) associated with the dismantling of the existing East Span of the SFOBB will be restricted to the period between June 1st and November 30th in order to avoid the peak migration period for salmonids, and spawning adult green sturgeon.

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 the central and south San Francisco Bay, extending for a diameter of approximately 4982 m around the SFOBB (Figure 1), and 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. This action area has been determined due to the direct and indirect effects of the project's pile driving and dredging/disposal activities.

Figure 1. Action area indicating the 4982 meter diameter around SFOBB project site.

III. STATUS OF THE SPECIES AND CRITICAL HABITAT

The following Federally-listed species (Distinct Population Segments [DPS]) and designated critical habitat, and proposed critical habitat occur in the action area and may be affected by bridge construction, dismantling, and dredging activities:

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)
proposed critical habitat (September 8, 2008, 73 FR 52084)

For the above salmonid species, only Central California Coast steelhead has designated critical habitat in south San Francisco Bay. There is no designated critical habitat for salmonids in the marine waters west of the Golden Gate Bridge. A proposed critical habitat designation for North American green sturgeon southern DPS was completed September 8, 2008 (73 FR 52084). As of the signing of this opinion, the take prohibitions under section 4(d) of the ESA, as well as final critical habitat designations have yet to be determined for green sturgeon.

A. Species and Critical Habitat Listing Status

1. Salmonids

NMFS completed an updated status review of 16 salmon ESUs, including Sacramento River winter-run Chinook salmon and Central Valley spring-run Chinook salmon; and concluded the species' status should remain as previously listed (70 FR 37160). NMFS also completed an updated review for ten steelhead ESUs, including Central California Coast steelhead and Central Valley steelhead. The new listing determination concludes that Central California Coast steelhead and Central Valley steelhead will remain listed as threatened and all ten steelhead populations will be newly classified as DPS, rather than as ESUs (71 FR 834).

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 the most recent status review, NMFS reconfirmed the endangered status of Sacramento River winter-run Chinook salmon on June 28, 2005 (70 FR 37160). As part of the new listing determinations, NMFS made several changes involving West Coast hatchery populations. For Sacramento winter-run Chinook salmon, two artificial propagation programs are considered to be part of the ESU: the Livingston Stone National Fish Hatchery (LSNFH) Conservation Program and the Captive Broodstock Program (LSNFH and Bodega Marine Laboratory) (70 FR 37160).

Designated critical habitat 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. The action area for this project includes designated critical habitat north of the SFOBB for Sacramento River winter-run Chinook salmon. Primary constituent elements (PCEs) of designated critical habitat in the action area include the estuarine water column, foraging habitat, and natural cover including large substrate and aquatic vegetation.

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. Critical habitat has recently 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). The action area north of the SFOBB is within designated critical habitat for threatened Central Valley spring-run Chinook salmon. Primary constituent elements of designated critical habitat in the action area include the estuarine water column, foraging habitat, and natural cover including large substrate and aquatic vegetation.

After completing the most recent status review, NMFS reconfirmed the threatened status of Central Valley spring-run Chinook salmon on June 28, 2005 (70 FR 37160). As part of the new 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 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 new listing determination, NMFS included Central Valley steelhead

produced at the Coleman and FRH hatcheries as part of the DPS. Critical habitat has been designated for Central Valley steelhead, including 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). The action area north of the SFOBB is within designated critical habitat for threatened Central Valley steelhead. Primary constituent elements of designated critical habitat in the action area include the estuarine water column, foraging habitat, and natural cover including large substrate and aquatic vegetation.
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, and 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. 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 action area containing central and south San Francisco Bay is located within designated critical habitat for Central California Coast steelhead. Primary constituent elements of designated critical habitat in the action area include the estuarine water column, foraging habitat, and natural cover including large substrate and aquatic vegetation.

2. Green Sturgeon

Two sub-populations, or DPS of North American green sturgeon have been identified along the Pacific Coast, and qualify as species under the ESA. 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.

Because of 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, the southern DPS green sturgeon was listed as threatened on April 7, 2006 (71 FR 17757). Adult green sturgeon migrate through the action area, and juvenile and subadult green sturgeon utilize the action area as rearing and migration habitat. The action area is within proposed designated critical habitat for southern DPS green sturgeon. Proposed designated critical habitat for North American green sturgeon southern DPS was completed September 8, 2008 (73 FR 52084). Critical habitat has includes approximately 325 miles of freshwater river habitat, 1,058 square miles of estuarine habitat, including 270 square miles in the San Francisco Bay, and 11,927 square miles of marine habitat (73 FR 52084). The action area within central and south San Francisco Bay is located within designated critical habitat for southern DPS green sturgeon. Primary constituent elements of designated critical habitat in the action area include adequate food resources and foraging habitat, the estuarine water column including suitable water quality and depths, sediment quality, and an unimpeded migratory corridor.

B. Species Life History and Population Dynamics

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 enter the Sacramento Delta beginning in January and enter natal streams from March to July (Myers *et al.* 1998). 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*. (1981) reported that juvenile Chinook salmon demonstrated a diel migration pattern, orienting themselves to nearshore cover and structure during the day, but moving into more open, offshore waters at night. The fish also distributed themselves vertically in relation to ambient light. 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). Most Central Valley spring-run Chinook salmon smolts are present in the delta from mid-March through mid-May depending on flow conditions (CDFG 2000).

b. Population Trend - Sacramento River winter-run Chinook Salmon

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; however, returns of several West Coast Chinook salmon and coho salmon stocks were lower than expected in 2007 (Southwest Fisheries Science Center 2008) and preliminary data for 2008 indicates similar declines in returns (Jeffrey Jahn, NMFS personal communication).

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).

c. Population Trend - Central Valley spring-run Chinook Salmon

Historically, the predominant salmon run in the Central Valley was the spring-run Chinook salmon. Extensive construction of dams throughout the Sacramento-San Joaquin basin has reduced the Central Valley spring-run Chinook salmon run to only a small portion of its historical distribution. The Central Valley drainage as a whole is estimated to have supported Central Valley spring-run Chinook salmon runs as large as 600,000 fish between the late 1880s and 1940s (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[3]. 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,

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

and populations sizes have shown continued increases over the abundance levels of the 1980s.

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 FRH population is closely related genetically to the natural Feather River population. The FRH's goal is to release five million spring-run Chinook salmon per year. Recent releases have ranged from about one-and-a-half to five million fish, with most releases below five million fish (Good *et al.* 2005).

Several actions have been taken to improve habitat conditions for Central Valley spring-run Chinook salmon, including: 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) concluded that the ESU is likely to become endangered within the foreseeable future.

Data from the 2007 adult CVSR Chinook salmon return counts and estimates indicates a decline in returning adults across the range of CVSR Chinook salmon within the Central Valley of California. Ocean conditions are suspected as the principal short term cause because of the wide geographic range of declines (Southwest Fisheries Science Center 2008). Preliminary data from the 2008 adult CVSR Chinook salmon returns also indicate a decline in returning adults across their range compared to recent returns (Jeffrey Jahn, personal communication).

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. 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. Barnhart (1986) reported that steelhead smolts in California range in size from 140 to 210 millimeter (mm) fork length. Juvenile steelhead in the Sacramento River Basin migrate downstream during most months of the year, but the peak period of emigration occurrs in the spring, with a much smaller peak in the fall.

b. Population Trend - Central Valley steelhead

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 are estimated at 1 to 2 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 most recent 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.

c. Population Trend - Central California Coast steelhead

Historically, approximately 48 populations[4] of steelhead existed in the CCC steelhead DPS (Bjorkstedt *et al*. 2005). Many of these populations (about 20) were independent, or potentially independent, meaning they had a high likelihood of surviving for 100 years absent anthropogenic impacts. The remaining populations were dependent upon immigration from nearby CCC steelhead DPS populations to ensure their viability (Bjorkstedt *et al*. 2005, McElhaney *et al*. 2000).

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). Although there were average returns of adult CCC steelhead during 2007/08, preliminary data from the 2008/09 adult CCC steelhead returns indicate a decline in returning adults across their range compared to recent returns (Jeffrey Jahn, personal communication). For more detailed

[4] 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).

information on long term trends in CCC steelhead abundance, see: Busby *et al*. 1996, NMFS 1997, and Good *et al*. 2005.

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). Reduced population sizes and fragmentation of habitat in San Francisco streams has likely also led to loss of genetic diversity in these populations.

CCC steelhead have experienced serious declines in abundance, and long-term population trends suggest a negative growth rate. This indicates the DPS's 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. The most 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

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).

As mentioned previously, two DPS of green strugeon have been identified along the western coast of North America, and 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. 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). 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).

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. Recent analysis by Israel (2006a) indicates a substantial population of southern DPS green sturgeon to be present in the Columbia estuary (50-80 percent). This information also agrees with the results of green sturgeon tagging studies completed by the California Department of Fish and Game (CDFG) where they tagged a total of 233 green sturgeon in the San Pablo Estuary between 1954 and 2001. A total of 17 tagged fish were recovered, 12 from commercial fisheries off of Oregon and Washington, with eight of the 12 recoveries in the Columbia estuary, three in the Sacramento-San Joaquin estuary, and two in the Pacific Ocean off of California (CDFG 2002).

Kelley *et al.* (2007) studied the movement of six green sturgeon (one adult and five sub-adults) in the San Francisco Estuary (tagged in San Pablo Bay) and discovered while adults and subadults occupied shallow water depths, there were distinct directional movements. In contrast, when the fish exhibited non-directional movements, they remained close to the bottom. The movements were not found to be related to salinity, current, or temperature and the authors surmised they are related to resource availability. Although Heublein (2006) thought that all adult green sturgeon left the Sacramento River prior to September 1, recent monitoring data reveals that post-spawned green sturgeon can remain in the river for several additional months. Accoustical 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 freshwater. They were found to inhabit deep (> 5m), low gradient reaches or off-channel sloughs or coves of the river during summer and autumn months when water temperatures were between 59 and 73 degrees Farenheit (^{o}F). The authors presumed that holding in deep pools was to conserve energy and utilize abundant food resources. When ambient temperatures in the river dropped in autumn and early winter (< 50 ^{o}F) and flows increased, the majority of fish emigrated from freshwater into the ocean (Erickson *et al*. 2002). Recent evidence of similar behavior has been noted for post-spawned green sturgeon in the Sacramento River (Vogel 2008). Based on several tagged adult green sturgeon detected in the Sacramento River during their spawning migration in 2007, it appears that they spend several months in holding pools on the Sacramento River above the Glenn-Colusa Irrigation District (GCID) diversion (RM 205).

The life cycle of southern DPS green sturgeon can be broken into four distinct phases based on developmental stage and habitat use[5]: (1) larvae and post-larvae less than 10 months of age; (2) juveniles less than or equal to three or four years of age; (3) coastal migrant females between three or four and thirteen, and males between three or four and nine years of age; and (4) adult females greater than or equal to thirteen years of age and males greater than or equal to nine years

5 It was suggested by Nakamoto *et al*. 1995, to break them into three parts.

of age (Nakamoto *et al*. 1995). The largest fish have been aged at 42 years, but this is probably an under estimate and maximum ages of 60-70 years or more are likely (Emmett *et al.* 1991). Adult green sturgeon can reach lengths up to 270 centimeters (cm) and weigh up to 175 kilograms (kg) (Moyle 2002); although adult sturgeon longer than 2 m and over 90 kg in weight are uncommon (Skinner 1962). Males reach maturity at younger ages than females, thus females tend to be larger and older than males (Nakamoto *et al*. 1995).

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).

Recent data regarding adult southern DPS green sturgeon has been collected from monitors located from the Golden Gate Bridge to the upper Sacramento River. Some fish that entered the estuary continued to the Sacramento River to spawn. Spawning has been documented on the mainstem over 240 miles upstream, both upstream and downstream of the Red Bluff Diversion Dam (RBDD) (Brown, 2007 cited in 73 FR 52084, September 8, 2008). Based on the distribution of sturgeon eggs, larvae, and juveniles in the Sacramento River, CDFG (2002) indicated that southern DPS green sturgeon spawn in late spring and early summer above Hamilton City possibly to Keswick Dam.

Adult female green sturgeon produce between 59,000 and 242,000 eggs, depending on body size, with a mean egg diameter of 4.3 millimeters (mm) (Moyle *et al.* 1992, Van Eenennaam *et al*. 2001, 2006). Eggs are broadcast spawned, and either adhere to substrate or settle into crevices between river substrate, which ranges from clean sand to bedrock (Deng 2000, Van Eenennaam *et al*. 2001). Like salmonids, green sturgeon require cool water temperatures for egg and larval development, with optimal temperatures ranging from 11 to 17-18 degrees ˚C. Laboratory studies have shown 15˚C to be optimal for larval growth, whereas temperatures below 11˚C and above 19˚C may be detrimental. Higher temperatures may cause cellular stress and decreased swimming performance (Cech, Jr. *et al.* 2000, Mayfield and Cech 2004, Allen *et al.* 2006), and temperatures ≥ 23˚C have been found lethal for embryos (Van Eenennaam *et al*. 2005). Larvae supplemented with live food in lab conditions exhibited significantly higher survival rates (Van Eenennaam *et al*. 2001). The type of substrate may also affect larval growth and foraging behavior. Nguyen and Crocker (2007) found that larvae reared on flat-surfaced substrates (*e.g*., glass or slate-rock) had higher specific growth rates than larvae reared on cobble or sand. The authors surmised that this was likely due to lower foraging effectiveness and greater activity level in cobble and sand substrates.

Newly hatched green sturgeon are approximately 12.5 to 14.5 mm in length. Metamorphosis from larvae to juvenile stage (62.5mm – 94.4mm) is completed by 45 days post hatch (dph). Exogenous feeding starts at approximately 10 dph (23-25 mm)(Deng *et al*. 2002), and at this time larvae are believed to initiate downstream migration from spawning areas staying close to the bottom, with downstream migration periodically interrupted by foraging bouts upstream (Kynard *et al*. 2005). Green sturgeon larvae do not exhibit the initial pelagic swim-up behavior characteristic of other members of the Acipenseridae family. As mentioned previously, they are strongly oriented to the bottom and exhibit nocturnal activity patterns. Under laboratory conditions, green sturgeon larvae cling to the bottom during the day, and move into the water column at night (Van Eenennaam *et al*. 2001). After five to six dph, the larvae exhibit nocturnal swim-up activity (Van Eenennaam *et al*. 2001, Deng *et al*. 2002) and nocturnal downstream migrational movements (Kynard *et al.* 2005). Juvenile green sturgeon continue to exhibit nocturnal behavioral beyond the metamorphosis from larvae to juvenile stages. Green sturgeon larvae grow rapidly, reaching 300 mm in one year, and over 600 mm within 2-3 years. Laboratory studies by Kynard *et al*. (2005) indicated that juvenile fish continued to migrate downstream at night for the first six months of life. When ambient water temperatures reached 46 ^{o}F, downstream migrational behavior diminished and holding behavior increased. These data suggests that nine to ten-month-old fish would hold over in their natal rivers during the ensuing winter following hatching, but at a location downstream of their spawning grounds.

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).

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 1 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 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.

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), and designated critical habitat was proposed on September 8, 2008 (73 FR 52084).

IV. 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 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 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 (greater 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.

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, Central Valley spring-run Chinook salmon, and Central Valley steelhead. Both central and south San Francisco Bay are designated critical habitat for Central California Coast steelhead. Essential features of critical habitat in the action area include the estuarine water column, foraging habitat, and food resources used by these salmonids as part of their juvenile downstream migration or adult spawning upstream migration (58 FR 33212). Primary constituent elements 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 with: 1) water quality, water quantity and salinity conditions supporting juvenile and adult physiological transitions between freshwater and saltwater; 2) natural cover such as submerged and overhanging large wood, aquatic vegetation, large rocks and boulders, and side channels; and 3) juvenile and adult forage, including aquatic invertebrates and fishes, supporting growth and maturation (69 FR 71880).

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 and Upper Penitencia creeks, 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. 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, it is assumed 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 Biological Opinion 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. Green Sturgeon

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, trawls 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 proposed 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 (D. Woodbury, pers. comm. 2008). 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 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; and 6) ecosystem restoration.

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 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.

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 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 large species, they are likely to bioacumulate 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).

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 and Upper Penitencia creeks, 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.

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. <u>Ecosystem Restoration</u>

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 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. 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. <u>Impacts of construction from the SFOBB East Span Seismic Project to Date</u>

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 2004. 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[6] (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 swimbladders and kidneys after exposure to unattenuated peak sound pressure levels (SPL) between 207 and 209 decibels (dB) 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 SPL from pile driving. The report also noted that several hundred more fish were taken by gulls. However, the study did show use 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 occurrences resulting from high SPL during unattenuated sound 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 one micropascal and 191 dB sound exposure level (SEL) at 20 meters north, and 206 dB peak re one micropascal and 179 dB SEL 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 SPL levels would be smaller and not at levels injurious to fish. However, changes to the project during the course of various planning phases resulted in plans consisting of temporary piles twice as large as what was originally proposed (42 to 48-inch diameter piles). Unfortunately this increase in size did not result in any sound attenuation methods being developed for the piles. Therefore, sound attenuation has not been 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 and F) for the SAS. Fish kills have been documented as occurring as a result of pile driving within the action area (Garcia and Associates 2008). 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 degrade 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 current monitoring of pile driving activities occurs at most, 10 percent of the time, the possibility exists

6 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 unrecorded impacts to listed anadromous fish. Some temporary piles were driven during peak salmonid migration periods (December through January).

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 was likely from dredge disposal. However, as discussed in the previous dredging and disposal section, 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, along 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.

V. EFFECTS OF THE ACTION

The remaining construction 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 during construction. For the three listed salmonids ESUs originating from the Central Valley (Central Valley steelhead, Central Valley spring-run Chinook salmon, Sacramento River winter-run Chinook salmon), it is believed 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 adult salmon have been recorded feeding near YBI in the summer, the number of adults is probably small. For juvenile 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). Thus it is anticipated that only a very small percentage of fish from the three Central Valley ESU's will be present in the SFOBB East Span Seismic Project action area and vulnerable to the adverse effects of high sound pressure levels.

The remaining pile driving activities may affect the species and critical habitat for all the ESUs described above, however, most of the impacts are likely to be on CCC steelhead (, and their designated critical habitat. The analysis of impacts on salmonids from bridge dismantling and dredging/disposal activities was described in the October 2001 biological opinion and is included below in our integration and synthesis of effects. Pile driving, bridge dismantling and dredging/disposal activities are likely to adversely affect listed southern DPS green sturgeon and their proposed designated critical habitat.

A. Pile Driving

1. 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.

NMFS has evaluated the remaining activities of the proposed project for potential adverse effects to ESA-listed salmonids, green sturgeon and their designated and proposed critical habitat. These activities, especially the SAS component, may affect listed salmonids and green sturgeon through exposure to high underwater sound levels produced during pile driving and degradation of water quality during pile driving activities. Available information indicates that fish may be injured or killed when exposed to elevated underwater sound pressure waves generated by steel piles installed with impact hammers. Pathologies 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 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*. a swim bladder).

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. 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 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.

Pile driving may result in "agitation" of salmonids and green sturgeon indicated by a change in swimming behavior detected by Shin (1995) with salmonids. 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 is not in any way injured, but it is exhibiting behavior that suggests it perceives a stimulus indicating potential danger in its immediate environment. Fish do not exhibit a startle response every time they experience a strong hydroacoustic stimulus. The startle response is likely to extinguish after a few pile strikes.

Caltrans proposes to use a vibratory hammer, and either a Delmag D100-13 diesel impact hammer, or Menck MHU 500T diesel impact hammer to install piles. 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 within the San Francisco Bay region are included in the compendium. From this data, a dual metric criteria of 206 dB re one micropascal peak sound pressure level for any single strike and an accumulated SEL of 187 dB re one micropascal squared-second are currently used by NMFS and Caltrans 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 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 an adult green 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. 2008).

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. Project Specific Considerations

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 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 (D. Woodbury, pers. comm. 2008). However, Caltrans specially designed and constructed a pile driving frame (template) that will be used for the installation of the temporary support piles for the SAS. This specific driving frame precludes the use of sound attenuation through the use of a bubble curtain or other available methods. Therefore, an estimation of sound pressure levels derived from current data for pile driving without 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.

As stated above, a dual metric criteria of 206 dB re one micropascal peak SPL for any single strike and an accumulated SEL of 187 dB re one micropascal squared-second 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 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.

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 (< 5 m) and the expected area of adverse effects is expected to be reduced. However, the SFOBB East Span Seismic Project is located in an area of strong tidal currents, and the remaining temporary piles to be installed at Temporary Tower G are expected to occur in waters greater than 5 m deep (15 to 25 m), and therefore may have less sound attenuation resulting in acoustic energy reaching greater distances from the pile driving area. Without sound attenuation, 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, the expected impact on migrating CCC steelhead and spawning adult green sturgeon is likely to be significantly reduced since few CCC steelhead and adult green sturgeon are thought to be present in the action area during this time. Juvenile and subadult green sturgeon however, could be present in the project area year-round, and possibly non-spawning adults. Recent tracking studies from 2007 conducted in the San Francisco Bay by CALFED (NMFS and the University of California at Davis collaboration) recorded three adult green sturgeon within the action area during spring and summer months; two of these were spawning adults, and one was a non-spawning adult considered a summer resident. Since the specific construction schedule and sequence of pile driving activities has not been precisely established at this time, and due to limited information on the percentage of juveniles and subadults likely to be within the action area, the vulnerability of listed southern DPS green sturgeon to deep water pile driving is uncertain.

c. Assessment of Pile Driving Effects

Given the uncertainties described above, and additional uncertainties such as the timing of pile driving, duration of pile driving episodes, the number of piles driven per day, etc., we have developed a reasonable worst case scenario of likely effects 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.

The most recent hydroacoustic reports (see Environmental Baseline section) submitted by Caltrans for the installation of both land and water-based pile driving activities for the construction of the Temporary Towers D and F of the SAS indicate that sound pressure levels are in some instances exceeding the above dual metric criteria and therefore likely resulting in injury to salmonids and green sturgeon. 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 one micropascal and 191 dB SEL at 20 meters north, and 206 dB peak re one micropascal and 179 dB SEL at 135 meters north. Using this data (based upon the maximum peak of 217 dB at 20m north, and SEL of 179 dB at 135m north) to calculate the distance in meters to the threshold for physical injury to fish resulted in a radial distance of 2491 meters (1.55 miles) for 500 strikes. The high decibel levels measured during installation of some of the piles for Temporary Towers D and F were likely to have occurred due to unanticipated difficulties driving piles in the Franciscan Assemblage geologic formation at YBI, as well the methods required for guiding the piles (preventing the use of a vibratory hammer). The sound pressure levels recorded during the driving of piles at Temporary Towers D and F are the maximum levels anticipated to occur. Given that the remaining piles to be installed for Temporary Tower G are the same size and larger (42 to 48-inch diameter), and the large size of the impact hammers proposed for use to install the piles, the resulting sound pressure levels generated without sound attenuation are also capable of exceeding the dual metric criteria for threshold levels that cause injury to fish if piles are installed solely with an impact hammer. The installation of the remaining piles is not expected to exceed the maximum sound pressure levels that were used to base the worst case scenario.

Additionally, the actual number of impact hammers used simultaneously will influence the extent of area affected by high sound pressure levels. If multiple piles are installed concurrently with impact hammers, sound pressure levels are likely to increase and extend across a larger area of bay. Pile driving will be allowed from 7:00 AM to 8:00 PM, seven days a week and a pile that is underway at 8:00 PM will continue until driving of that pile segment is complete. During the winter months (December through February), pile driving conducted after dusk 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. 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 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 would likely increase at night. However, the remaining pile driving activities for the project are not expected to continue beyond April of 2009, and therefore are not expected to occur in future winter months.

Although 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 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 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; and therefore most likely to be exposed to harmful sound levels during pile driving. Considering the bathymetry of San Francisco Bay and the distribution of tidal currents, NMFS believes it is likely that between 20 and 30 percent 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.

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.

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. 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. In lieu of estimating 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 can be calculated. For estimating the number of juvenile and subadult green sturgeon adversely affected, NMFS will use estimates of the area of potential impact due to pile driving and the potential life stage (juvenile, subadult, and adult) of green sturgeon present or passing through the active pile driving area to assess the level of impact. For the purposes of this analysis, the zone of potential impact is defined as the area where there may be injury or mortality to listed anadromous salmonids and green sturgeon. Based on current pile driving research, the area of injury and mortality of salmonids and juvenile and adult green sturgeon is defined as the area with sound pressure levels exceeding 206 dB (re: 1 µPa), or 187 SEL. This zone of impact is within the 2491 m distance (4982 m diameter) from an active pile driving operation. Within this zone, CCC steelhead and green sturgeon could experience a range of barotraumas, including the damage to the inner ear, eyes, blood, nervous system, kidney, and liver. These injuries are expected to result in the delayed mortality of many of these fish. Beyond this range, NMFS estimates fish greater than 2 grams will generally survive during the large hammer pile driving and not sustain permanent harm or injury. These fish may demonstrate temporary abnormal behavior indicative of stress or exhibit a startle response. As describe previously, a fish that exhibits a startle response is not injured, 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.

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 an adult green sturgeon documented during the construction of the Benicia-Martinez Bridge installation.

In summary, based upon the information above, our reasonable worst case scenario assumes: 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 three 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 is the greatest distance considered due to the maximum peak dB level obtained from initial hydroacoustic measures during the construction of Temporary Tower D. With these assumptions, roughly two percent of the outmigrating juvenile and post-spawned adult population of steelhead originating from south San Francisco Bay tributaries will be injured or killed by sound pressure levels exceeding 206 dB (re: 1 μPa), 187 SEL during the remaining pile driving in 2009. The two percentage of steelhead is determined based upon the following: Approximately 25 percent of the south Bay CCC steelhead population are estimated to transit east of YBI through the action area. Given the assumption that three piles will be installed within a given 24 hour period, approximately 8 days are required for the remaining pile installation from April to May 31st. Eight days is about 7 percent of the time that the majority of salmonids are migrating (February 1 through May 31st). Thus 7 percent of the estimated 25 percent of steelhead using the East side of YBI are likely to be adversely affected. For green sturgeon, primarily juvenile and subadult green sturgeon and some adults located within the San Francisco Bay within a distance of 2491 m of pile driving in 2009 will be injured or killed by sound pressure levels exceeding 206 dB (re: 1 μPa), 187 SEL. For the two percent spawning adult green sturgeon estimation, NMFS based this upon an average abundance estimate of 125 returning annual 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. The 125 estimate is derived by taking one quarter of the total number of 500 adult green sturgeon spawners, since green sturgeon return to spawn about every four years (D. Woodbury, pers. comm. 2008). As previously discussed, the high sound pressure levels achieved during the installation of piles for Temporary Tower D and F were likely a result of the methods required to install the piles and the hard substrate which prevented vibrating many of the piles into place. The remaining Temporary Tower G is located in areas further away from YBI in deeper water. Caltrans anticipates the substrate in this area to consist primarily of soft bay mud, and therefore the use of vibratory hammers can be used to install the bulk of the remaining piles. Caltrans estimates that for the Temporary Tower G all piles (42 and 48-inch) will be installed with a vibratory hammer to within five meters of their tip elevation. An impact hammer will then be used to drive the final five meters. This method will reduce the number of strikes required for impact hammering and thereby significantly reduce the level of accumulated sound pressure impacts. 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 remaining piles with the use a vibratory hammer, and only uses an impact hammer for the five meter tip-elevation and re-tap after the 15 day period[7], the remaining pile driving activities are not anticipated to result in physical injury or mortality to fish; and our reasonable worst case scenario may not be realized. However, should impact hammers be required to install the piles for more than driving the final, five meter tip-elevation and re-tap, NMFS assumes that injury and even death may occur for fish within the pile driving area.

2. Turbidity

Pile driving activities 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.

B. Dismantling of the Existing Bridge

1. Dredging and Disposal

The potential impacts of dredging associated with the SFOBB East Span Seismic Project include both direct and indirect adverse effects. Potential direct 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).

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 above the surface of material being removed and fish are present, they may be unable to overcome the water velocities near the dredging

7 Fifteen days is the typical amount of time piles are allowed to settle in the substrate prior to re-tapping.

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). Presumably, similar effects for green sturgeon could occur during dredging activities for the project. Juvenile, subadult and non-spawning adult green sturgeon may be present year-round within the active dredging area, however, current distribution and abundance data for the species is limited, so precise assessments for green sturgeon in the area are not possible at this time.

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. Barges for holding, transport, and disposal of dredged material will be selected by the contractor, so their size, sediment holding capacity, and characteristics cannot be accurately estimated.

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 these effects may not cause direct mortality to individual fish, they may adversely affect growth and 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.

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). 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 (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 an upland location.

Although the Dredge Material Management Office (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[8]), 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 anticipated to re-suspend and rapidly disperse, they appear unlikely to result in any acute toxicity to listed anadromous green sturgeon. However, there remains a concern for chronic effects that may occur as a result of the uptake of contaminants by green sturgeon during juvenile rearing and 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). However, since the action area occupies a small area of the Bay, only a small number of green sturgeon may experience similar risks. Because salmonids do not spend long time periods in the Bay, they are less likely to experience these impacts.

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. Although for the SFOBB East Span Seismic Project it appears unlikely that acute, short-term effects due to increased levels of NH_3 at either the dredge site or the disposal site will occur due to tidal influence and water column mixing at the disposal site, and to a slightly lesser extent at the dredge site. The un-ionized form of NH_3 has potential for adversely affecting listed salmonids and green sturgeon, but the limited concentrations anticipated 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, and tidally influenced with consistent water column mixing.

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[8]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).

Because the dredge removal and disposal sites are located in a large, open body of water the principal impacts involved with the 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, indirect effects, in a similar pattern as is described for turbidity, may occur through behavior modification resulting from 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 to occur 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; however, rapid recolonization rates indicate that this would be of minimal impact to green sturgeon. Within the upper portion of the water column at the disposal site there may be some loss of prey items.

f. Dredging and Disposal Summary

The precise number of salmonids and green sturgeon affected by dredging and disposal activities is unknown, but only a small percentage of the population 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 green sturgeon in the Bay.

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 proposed designated critical habitat for southern DPS green sturgeon. Temporary impacts to designated critical habitat for salmonids, and the proposed designated critical habitat of southern DPS green sturgeon, are expected during construction 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.

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.

VI. 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 4982 m diameter surrounding the East Span of the SFOBB, and an area extending approximately 2000 m south of Alcatraz Island at the SF-11 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.

VII. INTEGRATION AND SYNTHESIS OF EFFECTS

A. Effects to Species

As previously discussed, the remaining pile driving 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. 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 listed salmonids and green sturgeon, 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 a negligible effect on future adult returns.

However, both adult and juvenile CCC steelhead, along with juvenile, subadult and non-spawning adult green sturgeon may be present in relatively larger numbers within the action area and encounter these sound pressure levels.

CCC steelhead 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 two percent of the outmigrating juvenile and post-spawned adult population originating from south San Francisco Bay tributary streams may be adversely affected during 2009 by pile driving during the construction of the SFOBB East Span Seismic Project. In addition, a very small number of CCC steelhead would likely be killed, injured or harassed by bridge dismantling activities. These small steelhead losses from bridge demolition are unlikely to increase the total percentage of CCC steelhead losses beyond two percent. 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. The effects of the project, including impacts from bridge demolition, that are anticipated to cause losses of up to two percent of adult and juvenile salmonids are temporary, and such losses will only occur during one year of juvenile outmigration and adult migration. While the magnitude of loss is small, these combined losses of adult and juvenile salmonids associated with the SFOBB East Span Seismic Project may manifest as a reduction in the number of adults returning to the next generation of the south Bay CCC steelhead populations because, for example, these losses are compounded with previous pile driving impacts. However, these losses are unlikely to propagate forward in time to more than one to two years of adult returns. The potential 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 may allow for subsequent years with greater population abundance. Plus, other factors such as streamflow and water temperature are expected to exert greater influence on spawning, incubation, and juvenile survival rates. Salmonid population abundance tends to be highly variable with interannual fluctuation in the range of 40 to 70 percent (Bisson *et al*. 1997). Variability in the freshwater and marine environments is thought to be a primary factor driving fluctuations in juvenile and adult abundance.

Improvements to baseline conditions as a result of the restoration efforts funded by Caltrans to restore, enhance, or create salmonid habitat is expected to improve reproductive success and survival of CCC steelhead. In consideration of the above, the SFOBB East Span Seismic Project is 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 two percent of spawning adult green sturgeon are likely to be harassed, injured or killed by the project's remaining activities. This estimate is based upon an average annual abundance estimate of 125 returning spawners (D. Woodbury, pers. comm. 2008), 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 and likely found in intertidal sloughs and benthic substrates with water depths less than 10 m deep. The dredging areas are also relatively distant from the primary migration routes of adult green sturgeon, but the disposal site at SF-11 near Alcatraz Island could subject both juvenile and adult green sturgeon to degraded water quality during a disposal event. Therefore, it is expected the remaining activities of the SFOBB East Span Seismic Project will result in harassment, injury or mortality to a small number of threatened adult and juvenile green sturgeon, although the exact extent number affected remains uncertain.

Similar to CCC steelhead, the potential impacts from pile driving that have occurred from the installation of temporary piles since the project began construction may have caused harm through harassment, injury or mortality 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 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 project's actions during construction of the SFOBB East Span Seismic Project.

B. Effects to Designated and Proposed 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 construction as a result of pile driving. Pile driving will adversely affect critical habitat within the action area though temporary elevated SPLs and turbidity. However, as discussed previously, restoration efforts resulting in improved access to significantly better habitat conditions in Bay tributaries 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 proposed as 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 activities 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 by the proposed actions, impacts from the project's activities are not expected to result reduce the value of proposed critical habitat for green sturgeon for the conservation of this species.

VIII. CONLUSION

A. Consultation

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 remaining 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, or Sacramento River winter-run Chinook salmon.

B. Conference

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' conference opinion that the proposed remaining activities for the SFOBB East Span Seismic Project are not likely to adversely modify or destroy the proposed critical habitat for southern DPS green sturgeon.

IX. 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.

Take prohibitions via section 4(d) of the ESA have not been applied to green sturgeon prior to the issuance of this supplemental biological opinion. NMFS may issue green sturgeon take prohibitions before work on the SFOBB is completed. Once green sturgeon take prohibitions under section 4(d) become effective, the measures described below will become non-discretionary for green sturgeon. When the measures become non-discretionary, they must be undertaken by Caltrans for the exemption of 7(o)(2) to apply to listed green sturgeon.

A. Amount or Extent of Take Anticipated

It is anticipated that take associated with remaining activities SFOBB East Span Seismic Project will be in the form of mortality, injury, harassment, and disturbance through temporary impacts from construction activities associated with pile driving and 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. <u>SAS</u>

Underwater sound pressure waves generated by pile driving activities are expected to expose both adult and juvenile CCC steelhead and green sturgeon to lethal and injurious conditions. Most fish within 20 m (217 dB re: 1 μPa) radius of the pile during the operation of large hammers will be killed instantaneously. Beyond this 20 m radius, up to a distance of 2491 m (206 dB re: 1 μPa) from each pile driving operation, fish are expected to experience trauma in many organs including the inner ear, eyes, blood, nervous system, kidney, and liver. These injured fish are expected to have some difficulty in maneuvering or maintaining orientation in the water column, and many will be subject to delayed mortality.

Based on the bathymetry of San Francisco Bay and the distribution of tidal currents, NMFS anticipates juvenile and post-spawned adult salmonids, and juvenile, subadult and non-spawning adult green sturgeon located within a radial distance of 2491 m (1.55 miles) of the SFOBB Seismic Safety Project in the central and south San Francisco Bay will be harassed, injured or killed by pile driving and any spawning salmonids and adult green sturgeon that may transit through the action area could be similarly affected. The actual number of affected anadromous fish is dependent upon a number of factors including the pile driving schedule and sequence established by the contractor. As described in the biological opinion, the number of salmonids and green sturgeon is expected to be small. Because NMFS cannot precisely determine the number of salmonids and green sturgeon harmed, harassed or killed, we use the radial distance of these impacts (2491m) and the time period for pile driving remaining (April through May 31st) as the surrogate for number of fish. If Caltrans' monitoring indicates that sound levels greater than 206 dB (re: 1 μPa), or 187 SEL extend beyond this distance, or pile driving occurs past May 31st, the amount of incidental take may be exceeded.

2. Dismantling of the Existing Bridge

Dredging and disposal activities are expected to result in incidental take in the form of harassment and disturbance through temporary habitat impacts at and near the dredging and disposal sites. Habitat within several hundred meters at both the dredge and aquatic disposal sites will be temporarily degraded due to localized turbidity produced by dredge and disposal activities. Migration behavior and foraging of juvenile and adult salmonids and green sturgeon are likely to be disrupted by the plume of turbid water occurring during and immediately following dredging and disposal events. Impacts from turbidity are not expected to result in lethal take of any green sturgeon or salmonids. Mortality of juvenile and adult salmonids and green sturgeon due to entrainment in a mechanical dredge is unlikely, and entrainment in a hydraulic dredge is expected to be very low due to the relatively limited area affected by dredging for this project.

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 CCC steelhead or green sturgeon.

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 CCC steelhead and green sturgeon.

Caltrans shall:

1. Utilize measures to minimize and avoid the take of salmonids and green sturgeon from pile driving.
2. Utilize measures to minimize and avoid the take of green sturgeon from dredging.
3. Utilize measures to minimize and avoid the take of salmonids and green sturgeon from dismantling the existing bridge.
4. 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. Once take prohibitions under section 4(d) become effective, the measures described below will become non-discretionary for green sturgeon.

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

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. Dredging/disposal associated with barge access for the dismantling of the existing bridge shall be restricted to the period between June 1st and November 30th.

   b. All activities that will generate high sound pressure levels (>150 dB re: 1 µPa) associated with the dismantling of the existing bridge shall be restricted to the period between June 1st and November 30th.

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

   a. A fisheries and hydroacoustic monitoring plan shall be implemented that includes the following:

      i) Underwater sound measurements at various distances and depths from pile driving operations;
      ii) Evaluation of fish mortality and injury rates through the use of visual observations and collections during pile driving events;
      iii) Observations of bird predation and behavior.

   b. Data from the monitoring program shall be made available to NMFS on a real-time basis.

   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:

Central Coast Team Supervisor
National Marine Fisheries Service
777 Sonoma Ave., Room 325
Santa Rosa, California 95404

Phone (707) 575-6064
Fax (707) 578-3435

X. REINITATION NOTICE

This concludes formal consultation on the proposed 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.

XI. 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 installation during peak migration periods should be avoided.

2. To avoid attracting fish with lights during nighttime pile driving operations, 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. 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 green sturgeon and their habitats.

5. 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.

6. 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.

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A. Personal Communications

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UNITED STATES DEPARTMENT OF COMMERCE
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In response refer to:
2009/04385

AUG 2 1 2009

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Dear Mr. Richards:

Thank you for your July 7, 2009, letter requesting changes to the project description of the San Francisco-Oakland Bay Bridge Retrofit Project (SFOBB). On April 10, 2009, NOAA's National Marine Fisheries Service (NMFS) issued a Supplemental Biological Opinion and Conference Opinion (NMFS File No. 151422SWR99SR190) for the SFOBB. Consultation was reinitiated for the project to include effects of the remaining project activities on North American green sturgeon southern Distinct Population Segment (DPS) (*Acipenser medirostris*), and proposed critical habitat for the species. This letter is in response to the July 7, 2009, request from the California Department of Transportation (Caltrans) to modify the project description and construction method described in the April 10, 2009, Supplemental Biological Opinion and Conference Opinion for the construction of the Self-Anchored Suspension Span (SAS) of the SFOBB. NMFS received your letter regarding the requested changes on July 14, 2009, and received the request for reinitiation of consultation on August 7, 2009.

This document transmits NMFS' Supplemental Biological Opinion and Conference Opinion for the additional construction activities required for the SAS (enclosure). The supplemental biological and conference opinions analyze the effects of the project's activities on the following listed species (Evolutionary Significant Units [ESU]) or DPS, designated critical habitat, and proposed critical habitat in accordance with section 7 of the Endangered Species Act (ESA) of 1973, as amended (16 U.S.C. 1531 *et seq.*).

Sacramento River winter-run Chinook salmon ESU (*Oncorhynchus tshawytscha*)
endangered (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)
proposed critical habitat (September 8, 2008, 73 FR 52084)

In the Supplemental Biological and Conference 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 critical habitat, or proposed critical habitat for green sturgeon. NMFS anticipates that no additional take of listed salmonids and southern DPS green sturgeon will occur as a result of the project modifications than what was anticipated in the April 10, 2009, Supplemental Biological Opinion and Conference Opinion. All other impacts to listed species from construction of the SAS portion of the SFOBB analyzed in the April 10, 2009, Supplemental Biological Opinion and Conference Opinion remain unchanged. However, additional temporary adverse impacts to critical and proposed critical habitat for listed salmonids and green sturgeon will result from the project's proposed changes.

Caltrans may ask NMFS to confirm the conference opinion as a biological opinion issued through formal consultation once critical habitat is designated for the southern DPS of green sturgeon. The request must be in writing. If NMFS reviews the proposed action and finds there have been no significant changes in the action as planned or in the information used during the conference, NMFS will confirm the conference opinion as part of the biological opinion for this project.

Pursuant to 50 CFR 600.920(l) of the Essential Fish Habitat (EFH) regulations, Caltrans must reinitiate EFH consultation with NMFS if a proposed action is substantially revised in a way that may adversely affect EFH. However, the proposed project modification contains adequate measures to avoid, minimize, mitigate, or otherwise offset potential adverse effects to EFH. Thus, no reinitiation of EFH consultation is required.

Please contact Jacqueline Pearson Meyer at (707) 575-6057, or by electronic mail at Jacqueline.Pearson-Meyer@noaa.gov if you have any questions concerning this consultation or require additional information.

Sincerely,

Rodney R. McInnis
Regional Administrator

Enclosure

cc: Tony Morton, NMFS, Long Beach
Jeff Jensen, Caltrans District 4, Oakland
Copy to file: ARN# 151422SWR99SR190

Enclosure

SUPPLEMENTAL BIOLOGICAL OPINION AND CONFERENCE OPINION

ACTION AGENCY:	California Department of Transportation
ACTION:	Completion of Pile Driving and Other Remaining Activities for the San Francisco-Oakland Bay Bridge East Span Seismic Project.
CONSULTATION CONDUCTED BY:	National Marine Fisheries Service, Southwest Region
TRACKING NUMBER:	F/SWR/2009/04385
DATE ISSUED:	AUG 21 2009

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). A 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 Highway 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.*).

[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.

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 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 eel grass 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 nine times[2] with NMFS to address proposed changes to the project, and to address impacts of the project to recently Federally-listed species.

NMFS received a letter dated May 7, 2008, from Caltrans requesting reinitiation of consultation pursuant to section 7 of the 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).

The majority of work for the construction of the new bridge has already been completed. However, in the October 2001 BO impacts from the installation of temporary piles were not analyzed for impacts to salmonids, analysis was only conducted for sound impacts associated with the installation of the permanent piles. The decision to exclude analyses on impacts associated with temporary pile installation was based generally upon the lack of information at the time on pile driving impacts and sound attenuation technology, and because Caltrans and NMFS anticipated the temporary piles required to build falsework would be substantially smaller than the permanent piles (18 to 24-inch diameter piles), and, therefore, sound impacts would not be at levels injurious to fish. However, changes to the project during the course of various planning phases resulted in plans consisting of temporary piles twice as large as what was originally proposed (42 to 48-inch diameter piles); and more information regarding the effects of pile driving on fish is available today. Thus, the anticipated effects from pile driving for temporary piles will be considered in this opinion for salmonids. All other remaining components (dredging/disposal and bridge dismantling) for the project remain the same as what were analyzed in the 2001 BO, and are not expected to vary from what was originally considered in prior consultations. Therefore, impacts on salmonids from dredging and disposal, and bridge dismantling that were originally analyzed in the October 2001 BO, are incorporated here by reference, and updated with additional information if warranted.

Additionally, since the signing of the October 2001 BO, green sturgeon were Federally-listed (71 FR 17757). Impacts on green sturgeon from construction activities were not considered in the 2001 BO, therefore all remaining project activities and associated impacts to green sturgeon will be included in this supplemental consultation.

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[2] This BO represents the ninth 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 North American southern DPS green sturgeon, and their respective critical and proposed critical habitats.

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.

Several meetings, telephone conference calls, and electronic mail communications were exchanged between January 2008 and January 2009 regarding the remaining activities and revisions for the project, and assessment of potential impacts to the southern DPS green sturgeon associated with pile installation, placing of temporary fill, dredging, and bridge dismantling activities.

Between March 4, 2009 and May 15, 2009, Caltrans completed the pile driving of temporary falsework described in the April 10, 2009, Supplemental Biological Opinion and Conference Opinion. During June and July 2009, two meetings, several telephone conferences, and electronic communications occurred regarding a change to the SFOBB project description. By letter dated July 7, 2009, Caltrans requested a modification to the project description and construction method used during the construction of the Self-Anchored Suspension Span 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. All other project plans (such as demolition of the old bridge) analyzed in the April 10, 2009, Supplemental Biological Opinion and Conference Opinion remain unchanged.

A complete administrative record of this consultation is on file in the NMFS Santa Rosa Area Office, Santa Rosa, California (Administrative Record #151422SWR99SR190).

II. DESCRIPTION OF THE PROPOSED ACTION

Caltrans is reinitiating consultation on the SFOBB East Span Seismic Project in order to address a change proposed for the project description and method used to construct the Self-Anchored Suspension Span of the SFOBB. 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. 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 a MCE on the San Andreas or Hayward fault. The existing East Span does not meet lifeline criteria for providing emergency relief access following a 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 2013.

A. Proposed Actions

Construction of the bridge has been ongoing since 2001, therefore, much of the project activities have been completed. 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 primary remaining and ongoing projects include 1) YBIT; 2) SAS; and 9) Dismantling of the existing East Span of the bridge. Construction activities for the remaining projects will include: installation of temporary access trestle for the SAS, and dredging for a barge access channel for dismantling the bridge. The project description presented below focuses on the remaining construction activities for the SFOBB East Span Seismic Project, including the contractor's temporary work, and will be the only actions analyzed as effects of the action in this BO.

1. YBIT

The YBIT is the portion of the new bridge that will extend northward from the SAS onto YBI. All construction of the YBIT will occur on YBI once demolition of the existing bridge is complete. The construction of the YBIT is expected to occur in three phases, however, as of the date of this BO, the construction contract for the YBIT has not been awarded and final designs are not confirmed for this component of the project. Caltrans does not anticipate any portion of the YBIT construction will require in-water work. For this reason, NMFS does not anticipate any impacts to Federally-listed anadromous species; therefore, the YBIT will not be discussed further in this document.

2. July 2009 Temporary Access Trestle for the SAS

Temporary towers for construction of the SAS are now complete and Caltrans proposes to construct a temporary access trestle for emergency response and evacuation during the construction of the SAS. The temporary trestle will be located at the eastern side of YBI, extending to the main tower (T1) of the SAS. The temporary trestle will require the installation of twenty-two, 36-inch diameter steel pipe piles. The contractor will install all piles with a vibratory hammer, and then drive them with an impact hammer to ensure load bearing capacity. The vibratory hammer will be used to the extent practicable. It is anticipated the piles will be vibrated in for a depth of two to five meters, then impact driven for an additional depth of one to two meters. The impact driven piles will require approximately 60 strikes per pile, which is about five minutes driving time each to reach the required depth. Only four piles will be installed per day, totaling approximately 20 minutes of impact hammering per day. A maximum of two hours of impact driving is expected to install the 22 piles. The four piles located closest to YBI will be installed during low-tide in water less than five meters deep. For the remaining 18 piles, located in water depths greater than five meters, Caltrans will incorporate an air bubble curtain sound attenuation system to reduce sound pressure and exposure levels during impact pile driving. All pile installation will be restricted to the period between June 1st and November 30th, 2009. Upon completion of the SFOBB East Span Seismic Project, temporary piles, barges and other falsework will be removed from the area.

To assess the level of impact to fisheries, monitoring will be implemented within the vicinity of impact hammer pile driving operations. The fisheries monitoring program will include: 1) observations on predation by gulls and other birds; 2) examination of injured fish collected from the water; 3) the implementation of a hydroacoustic monitoring program; and 4) real-time data reports. The biological monitoring program will be designed to document near-term fish mortalities and the likelihood of delayed mortality of differing sizes and species of fish that have swim bladders. In addition to the biological monitoring, measurements of sound pressure and other parameters will be monitored via the hydroacoustic monitoring plan.

3. <u>Dismantling of the Existing Bridge</u>

a. Dredging

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. It is anticipated 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. The proposed disposal of a portion of the dredged material at SF-DODS is not expected 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. Therefore, 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 not likely 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).

b. Dismantling

Once the construction of the new East Span for the SFOBB is completed and put into service, the dismantling of the existing bridge structure will begin. The dismantling of the existing East Span is expected to occur in seven major stages, anticipated to be completed by 2013. An access channel will be constructed just south of the existing structure through dredging. Decks will be cut into pieces or disassembled panel-by-panel. Truss spans near the Oakland shore may be removed by conventional barge and crane methods because of the shallow water conditions and low clearance under the deck. Substructure elements may be lifted from their bases in one piece, or piece-by-piece. Options include constructing temporary supports under the span and disassembling the truss segment-by-segment, dredging for barge clearance, constructing temporary embankments of engineered fill within the bay for access, or using special shallow-draft barges or rigging devices for lowering sections onto barges from the bridge deck. Protective measures will be taken to prevent materials or debris from falling into the bay. Depending on location, materials could be removed by barge or truck to a predetermined site for reuse, recycling, or disposal.

Dismantling concrete foundations will require reducing the concrete into pieces small enough for transport; and may be accomplished either by saw-cutting, flame-cutting, mechanical splitting, pulverizing or hydro-cutting. The hollow interiors of piles remaining below the mud line could also be used as receptacles for concrete debris as the pier above is being dismantled. The piles remaining below the mudline could be capped or would gradually fill in through siltation. Any remaining steel would be cut flush with the remaining concrete face that remains below the mud line. Removal of the piles to 1.5 feet (0.46 meter (m)) below the mudline could be completed by an underwater dismantling method or by constructing cofferdams at each pier. The use of cofferdams at YBI would depend on methods selected by the contractor; however, since the final plans for bridge dismantling are not yet available, the use of cofferdams is not yet known.

All activities that will generate high sound pressure levels (>150 decibels [dB] re: 1 μPa) associated with the dismantling of the existing East Span of the SFOBB will be restricted to the period between June 1st and November 30th in order to avoid the peak migration period for salmonids, and spawning adult green sturgeon.

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 the central and south San Francisco Bay, extending for a distance of approximately 2.18 miles long and 2000 m wide (including the old bridge and new bridge footprint) from the eastern portal on YBI, across the Bay to the western section at the Oakland Touchdown, and 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. This action area has been determined due to the direct and indirect effects of the project's remaining pile driving and dredging/disposal activities.

III. STATUS OF THE SPECIES AND CRITICAL HABITAT

The following Federally-listed species (DPS) and designated critical habitat, and proposed critical habitat occur in the action area and may be affected by bridge construction, dismantling, and dredging activities:

Sacramento River winter-run Chinook salmon Evolutionary Significant Unit (ESU) (*Oncorhynchus tshawytscha*)
endangered (June 28, 2005, 70 FR 37160)
critical habitat (June 16, 1993, 58 FR 33212)
Central Valley spring-run Chinook (CVSR) 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)
proposed critical habitat (September 8, 2008, 73 FR 52084)

For the above salmonid species, only Central California Coast steelhead has designated critical habitat in south San Francisco Bay. There is no designated critical habitat for salmonids in the marine waters west of the Golden Gate Bridge. A proposed critical habitat designation for North American green sturgeon southern DPS was completed September 8, 2008 (73 FR 52084). As of the signing of this opinion, the take prohibitions under section 4(d) of the ESA, as well as final critical habitat designations have yet to be determined for green sturgeon.

A. Species and Critical Habitat Listing Status

1. Salmonids

NMFS completed an updated status review of 16 salmon ESUs, including Sacramento River winter-run Chinook salmon and Central Valley spring-run Chinook salmon; and concluded the species' status should remain as previously listed (70 FR 37160). NMFS also completed an updated review for ten steelhead ESUs, including Central California Coast steelhead and Central Valley steelhead. The new listing determination concludes that Central California Coast steelhead and Central Valley steelhead will remain listed as threatened and all ten steelhead populations will be newly classified as DPS, rather than as ESUs (71 FR 834).

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 the most recent status review, NMFS reconfirmed the endangered status of Sacramento River winter-run Chinook salmon on June 28, 2005 (70 FR 37160). As part of the new listing determinations, NMFS made several changes involving West Coast hatchery populations. For Sacramento winter-run Chinook salmon, two artificial propagation programs are considered to be part of the ESU: the Livingston Stone National Fish Hatchery (LSNFH) Conservation Program and the Captive Broodstock Program (LSNFH and Bodega Marine Laboratory) (70 FR 37160).

Designated critical habitat 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. The action area for this project includes designated critical habitat north of the SFOBB for Sacramento River winter-run Chinook salmon. Primary constituent elements (PCEs) of designated critical habitat in the action area include the estuarine water column, foraging habitat, and natural cover including large substrate and aquatic vegetation.

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. Critical habitat has recently 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). The action area north of the SFOBB is within designated critical habitat for threatened Central Valley spring-run Chinook salmon. Primary constituent elements of designated critical habitat in the action area include the estuarine water column, foraging habitat, and natural cover including large substrate and aquatic vegetation.

After completing the most recent status review, NMFS reconfirmed the threatened status of Central Valley spring-run Chinook salmon on June 28, 2005 (70 FR 37160). As part of the new 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 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 new listing determination, NMFS included Central Valley steelhead produced at the Coleman and FRH hatcheries as part of the DPS. Critical habitat has been designated for Central Valley steelhead, including 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). The action area north of the SFOBB is within designated critical habitat for threatened Central Valley steelhead. Primary constituent elements of designated critical habitat in the action area include the estuarine water column, foraging habitat, and natural cover including large substrate and aquatic vegetation.

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, and 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. 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 action area containing central and south San Francisco Bay is located within designated critical habitat for Central California Coast steelhead. Primary constituent elements of designated critical habitat in the action area include the estuarine water column, foraging habitat, and natural cover including large substrate and aquatic vegetation.

2. <u>Green Sturgeon</u>

Two sub-populations, or DPS of North American green sturgeon have been identified along the Pacific Coast, and qualify as species under the ESA. 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.

Because of 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, the southern DPS green sturgeon was listed as threatened on April 7, 2006 (71 FR 17757). Adult green sturgeon migrate through the action area, and juvenile and subadult green sturgeon utilize the action area as rearing and migration habitat. The action area is within proposed designated critical habitat for southern DPS green sturgeon. Proposed designated critical habitat for North American green sturgeon southern DPS was completed September 8, 2008 (73 FR 52084). Critical habitat has includes approximately 325 miles of freshwater river habitat, 1,058 square miles of estuarine habitat, including 270 square miles in the San Francisco Bay, and 11,927 square miles of marine habitat (73 FR 52084). The action area within central and south San Francisco Bay is located within designated critical habitat for southern DPS green sturgeon. Primary constituent elements of designated critical habitat in the action area include adequate food resources and foraging habitat, the estuarine water column including suitable water quality and depths, sediment quality, and an unimpeded migratory corridor.

B. Species Life History and Population Dynamics

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 enter the Sacramento Delta beginning in January and enter natal streams from March to July (Myers *et al.* 1998). 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 (°F) (Chambers 1956) to 57 °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.* (1981) reported that juvenile Chinook salmon demonstrated a diel migration pattern, orienting themselves to nearshore cover and structure during the day, but moving into more open, offshore waters at night. The fish also distributed themselves vertically in relation to ambient light. 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). Most Central Valley spring-run Chinook salmon smolts are present in the delta from mid-March through mid-May depending on flow conditions (CDFG 2000).

b. Population Trend - Sacramento River winter-run Chinook Salmon

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; however, returns of several West Coast Chinook salmon and coho salmon stocks were lower than expected in 2007 (Southwest Fisheries Science Center 2008) and preliminary data for 2008 indicates similar declines in returns (Jeffrey Jahn, NMFS, personal communication).

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).

c. Population Trend - Central Valley spring-run Chinook Salmon

Historically, the predominant salmon run in the Central Valley was the spring-run Chinook salmon. Extensive construction of dams throughout the Sacramento-San Joaquin basin has reduced the Central Valley spring-run Chinook salmon run to only a small portion of its historical distribution. The Central Valley drainage as a whole is estimated to have supported Central Valley spring-run Chinook salmon runs as large as 600,000 fish between the late 1880s and 1940s (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.[3] 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.

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 FRH population is closely related genetically to the natural Feather River population. The FRH's goal is to release five million spring-run Chinook salmon per year. Recent releases have ranged from about one-and-a-half to five million fish, with most releases below five million fish (Good *et al.* 2005).

Several actions have been taken to improve habitat conditions for Central Valley spring-run Chinook salmon, including: 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) concluded that the ESU is likely to become endangered within the foreseeable future.

Data from the 2007 adult CVSR Chinook salmon return counts and estimates indicates a decline in returning adults across the range of CVSR Chinook salmon within the Central Valley of California. Ocean conditions are suspected as the principal short term cause because of the wide geographic range of declines (Southwest Fisheries Science Center 2008). Preliminary data from the 2008 adult CVSR Chinook salmon returns also indicate a decline in returning adults across their range compared to recent returns (Jeffrey Jahn, NMFS, personal communication).

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

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. 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. Barnhart (1986) reported that steelhead smolts in California range in size from 140 to 210 millimeter (mm) fork length. 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.

b. Population Trend - Central Valley steelhead

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 are estimated at 1 to 2 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 most recent 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.

c. Population Trend - Central California Coast (CCC) steelhead

Historically, approximately 48 populations[4] of steelhead existed in the CCC steelhead DPS (Bjorkstedt *et al.* 2005). Many of these populations (about 20) were independent, or potentially independent, meaning they had a high likelihood of surviving for 100 years absent anthropogenic impacts. The remaining populations were dependent upon immigration from nearby CCC steelhead DPS populations to ensure their viability (Bjorkstedt *et al.* 2005, McElhaney *et al.* 2000).

[4] 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). Although there were average returns of adult CCC steelhead during 2007/08, preliminary data from the 2008/09 adult CCC steelhead returns indicate a decline in returning adults across their range compared to recent returns (Jeffrey Jahn, NMFS, personal communication). For more detailed information on long term trends in CCC steelhead abundance, see: Busby *et al.* 1996, NMFS 1997, and Good *et al.* 2005.

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). Reduced population sizes and fragmentation of habitat in San Francisco streams has likely also led to loss of genetic diversity in these populations.

CCC steelhead have experienced serious declines in abundance, and long-term population trends suggest a negative growth rate. This indicates the DPS's 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. The most 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

3. <u>Green Sturgeon</u>

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).

As mentioned previously, two DPS of green strugeon have been identified along the western coast of North America, and 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. 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). 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).

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. Recent analysis by Israel (2006a) indicates a substantial population of southern DPS green sturgeon to be present in the Columbia estuary (50-80 percent). This information also agrees with the results of green sturgeon tagging studies completed by the California Department of Fish and Game (CDFG) where they tagged a total of 233 green sturgeon in the San Pablo Estuary between 1954 and 2001. A total of 17 tagged fish were recovered, 12 from commercial fisheries off of Oregon and Washington, with eight of the 12 recoveries in the Columbia estuary, three in the Sacramento-San Joaquin estuary, and two in the Pacific Ocean off of California (CDFG 2002).

Kelley *et al.* (2007) studied the movement of six green sturgeon (one adult and five sub-adults) in the San Francisco Estuary (tagged in San Pablo Bay) and discovered while adults and subadults occupied shallow water depths, there were distinct directional movements. In contrast, when the fish exhibited non-directional movements, they remained close to the bottom. The movements were not found to be related to salinity, current, or temperature and the authors surmised they are related to resource availability. Although Heublein (2006) thought that all adult green sturgeon left the Sacramento River prior to September 1, recent monitoring data reveals that post-spawned green sturgeon can remain in the river for several additional months. Accoustical 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 freshwater. They were found to inhabit deep (> 5m), low gradient reaches or off-channel sloughs or coves of the river during summer and autumn months when water temperatures were between 59 and 73°F. The authors presumed that holding in deep pools was to conserve energy and utilize abundant food resources. When ambient temperatures in the river dropped in autumn and early winter (< 50 °F) and flows increased, the majority of fish emigrated from freshwater into the ocean (Erickson *et al.* 2002). Recent evidence of similar behavior has been noted for post-spawned green sturgeon in the Sacramento River (Vogel 2008). Based on several tagged adult green sturgeon detected in the Sacramento River during their spawning migration in 2007, it appears that they spend several months in holding pools on the Sacramento River above the Glenn-Colusa Irrigation District (GCID) diversion (RM 205).

The life cycle of southern DPS green sturgeon can be broken into four distinct phases based on developmental stage and habitat use: (1) larvae and post-larvae less than 10 months of age; (2) juveniles less than or equal to three or four years of age; (3) coastal migrant females between three or four and thirteen, and males between three or four and nine years of age; and (4) adult females greater than or equal to thirteen years of age and males greater than or equal to nine years of age (Nakamoto *et al.* 1995). The largest fish have been aged at 42 years, but this is probably an under estimate and maximum ages of 60-70 years or more are likely (Emmett *et al.* 1991). Adult green sturgeon can reach lengths up to 270 centimeters (cm) and weigh up to 175 kilograms (kg) (Moyle 2002); although adult sturgeon longer than 2 m and over 90 kg in weight are uncommon (Skinner 1962). Males reach maturity at younger ages than females, thus females tend to be larger and older than males (Nakamoto *et al.* 1995).

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).

Recent data regarding adult southern DPS green sturgeon has been collected from monitors located from the Golden Gate Bridge to the upper Sacramento River. Some fish that entered the estuary continued to the Sacramento River to spawn. Spawning has been documented on the mainstem over 240 miles upstream, both upstream and downstream of the Red Bluff Diversion Dam (RBDD) (Brown, 2007 cited in 73 FR 52084, September 8, 2008). Based on the distribution of sturgeon eggs, larvae, and juveniles in the Sacramento River, CDFG (2002) indicated that southern DPS green sturgeon spawn in late spring and early summer above Hamilton City possibly to Keswick Dam.

Adult female green sturgeon produce between 59,000 and 242,000 eggs, depending on body size, with a mean egg diameter of 4.3 mm (Moyle *et al.* 1992, Van Eenennaam *et al.* 2001, 2006). Eggs are broadcast spawned, and either adhere to substrate or settle into crevices between river substrate, which ranges from clean sand to bedrock (Deng 2000, Van Eenennaam *et al.* 2001). Like salmonids, green sturgeon require cool water temperatures for egg and larval development, with optimal temperatures ranging from 11 to 17-18°C. Laboratory studies have shown 15°C to be optimal for larval growth, whereas temperatures below 11°C and above 19°C may be detrimental. Higher temperatures may cause cellular stress and decreased swimming performance (Cech, Jr. *et al.* 2000, Mayfield and Cech 2004, Allen *et al.* 2006), and temperatures ≥ 23°C have been found lethal for embryos (Van Eenennaam *et al.* 2005). Larvae supplemented with live food in lab conditions exhibited significantly higher survival rates (Van Eenennaam *et al.* 2001). The type of substrate may also affect larval growth and foraging behavior. Nguyen and Crocker (2007) found that larvae reared on flat-surfaced substrates (*e.g.*, glass or slate-rock) had higher specific growth rates than larvae reared on cobble or sand. The authors surmised that this was likely due to lower foraging effectiveness and greater activity level in cobble and sand substrates.

Newly hatched green sturgeon are approximately 12.5 to 14.5 mm in length. Metamorphosis from larvae to juvenile stage (62.5mm – 94.4mm) is completed by 45 days post hatch (dph). Exogenous feeding starts at approximately 10 dph (23-25 mm)(Deng *et al.* 2002), and at this time larvae are believed to initiate downstream migration from spawning areas staying close to the bottom, with downstream migration periodically interrupted by foraging bouts upstream (Kynard *et al.* 2005). Green sturgeon larvae do not exhibit the initial pelagic swim-up behavior characteristic of other members of the Acipenseridae family. As mentioned previously, they are strongly oriented to the bottom and exhibit nocturnal activity patterns. Under laboratory conditions, green sturgeon larvae cling to the bottom during the day, and move into the water column at night (Van Eenennaam *et al.* 2001). After five to six dph, the larvae exhibit nocturnal swim-up activity (Van Eenennaam *et al.* 2001, Deng *et al.* 2002) and nocturnal downstream migrational movements (Kynard *et al.* 2005). Juvenile green sturgeon continue to exhibit nocturnal behavioral beyond the metamorphosis from larvae to juvenile stages. Green sturgeon larvae grow rapidly, reaching 300 mm in one year, and over 600 mm within 2-3 years. Laboratory studies by Kynard *et al.* (2005) indicated that juvenile fish continued to migrate downstream at night for the first six months of life. When ambient water temperatures reached 46 °F, downstream migrational behavior diminished and holding behavior increased. These data suggests that nine to ten-month-old fish would hold over in their natal rivers during the ensuing winter following hatching, but at a location downstream of their spawning grounds.

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 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 the U.S. Fish and Wildlife Service (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).

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 1 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 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.

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), and designated critical habitat was proposed on September 8, 2008 (73 FR 52084).

IV. 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 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 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 (greater 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.

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, Central Valley spring-run Chinook salmon, and Central Valley steelhead. Both central and south San Francisco Bay are designated critical habitat for Central California Coast steelhead. Essential features of critical habitat in the action area include the estuarine water column, foraging habitat, and food resources used by these salmonids as part of their juvenile downstream migration or adult spawning upstream migration (58 FR 33212). Primary constituent elements 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 with: 1) water quality, water quantity and salinity conditions supporting juvenile and adult physiological transitions between freshwater and saltwater; 2) natural cover such as submerged and overhanging large wood, aquatic vegetation, large rocks and boulders, and side channels; and 3) juvenile and adult forage, including aquatic invertebrates and fishes, supporting growth and maturation (69 FR 71880).

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 and Upper Penitencia creeks, 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.

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, it is assumed 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 Biological Opinion 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, trawls 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 proposed 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 (D. Woodbury, NMFS, personal communication 2008). 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 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; and 6) ecosystem restoration.

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 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.

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 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 large species, they are likely to bioacumulate 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).

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 and Upper Penitencia creeks, 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.

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 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. 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 2004. 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[5] (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 swimbladders 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 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 has not been 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

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

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 degrade 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 approximately 10 percent of the time, the possibility exists of unrecorded impacts to listed anadromous fish. 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 and Conference 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 three 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 is 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 harassed, injured, or killed by these sound pressure levels.

Preliminary results from Caltran's hydroacoustic and biological monitoring indicate that the maximum sound pressure levels we expected did not extend beyond the area of impact we analyzed in the April 10, 2009, Supplemental Biological Opinion and Conference 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 most recent 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, Supplemental Biological Opinion and Conference Opinion. In that supplemental opinion, 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.

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 was likely from dredge disposal. However, as discussed in the previous dredging and disposal section, 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, along with the NMFS Restoration Center and the 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.

V. EFFECTS OF THE ACTION

The remaining construction 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 during construction. For the three listed salmonids 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 adult salmon have been recorded feeding near YBI in the summer, the number of adults is probably small. For juvenile 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 remaining construction activities may affect the species and critical habitat for all the ESUs described above, however, most of the impacts are likely to be on CCC steelhead and their designated critical habitat. The analysis of impacts on salmonids from bridge dismantling and dredging/disposal activities was described in the October 2001 biological opinion and is included below and in our integration and synthesis of effects. Bridge dismantling and dredging/disposal activities are likely to adversely affect listed southern DPS green sturgeon and their proposed designated critical habitat.

A. Pile Driving

1. <u>Sound Pressure and Accumulated Sound Exposure</u>

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.

NMFS has evaluated the remaining activities of the proposed project for potential adverse effects to ESA-listed salmonids, green sturgeon and their designated and proposed critical habitat. These activities, especially the SAS component, may affect listed salmonids and green sturgeon through exposure to high underwater sound levels produced during pile driving and degradation of water quality during pile driving activities. Available information indicates that fish may be injured or killed when exposed to highly elevated underwater sound pressure waves generated by steel piles installed with impact hammers. Pathologies 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 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[6] swim bladder).

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. 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

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6 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.

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 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.

Pile driving may result in "agitation" of salmonids and green sturgeon indicated by a change in swimming behavior detected by Shin (1995) with salmonids. 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 is not thought to be injured, but it is exhibiting behavior that suggests it perceives a stimulus indicating potential danger in its immediate environment. Fish do not exhibit a startle response every time they experience a strong hydroacoustic stimulus. The startle response is likely to extinguish after a few pile strikes.

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. Caltrans contracted with prominent experts in the field of underwater acoustics to review existing literature on the effects of underwater sound on fish. The result of that effort (Hastings and Popper 2005) indicated the use of the SEL metric, which is expressed as decibels (dB) re one micropascal squared-second (re: 1 μPa^2-sec), would be a better metric to use to correlate physical injury to fish from underwater sound pressure produced during the installation of piles than peak SPL that was currently being used. The primary rationale for this new metric was the ability 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.

A white paper written for the FHWG by Popper *et al.* (2006) proposed a dual metric approach, incorporating both SEL and peak pressure, in assessing potential physical injuries to fish from exposure to high levels of underwater sound produced during pile driving. The authors proposed interim single strike thresholds of and 208 dB peak and 187 dB SEL. In a critique of the white paper, NMFS scientists from the Northwest Fisheries Science Center in Seattle, Washington (memorandum to Mr. Russ Strach and Mr. Mike Crouse, NMFS, from Tracy Collier, NMFS, September 19, 2006) stated that exposure to multiple strikes must be considered in assessing impacts. They further stated that the method described in Hastings and Popper (2005) is appropriate. Specifically, to account for exposure to sound impulses generated by multiple hammer strikes, the single strike SEL at a given distance from the pile is added to 10*log (number of strikes). 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. 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. Until new information indicates otherwise, NMFS believes a 150 dB root-mean-square pressure (RMS) threshold for behavioral responses for salmonids and green sturgeon is appropriate. Given the typical 15 decibel or so difference between peak SPL and RMS, a value of 150 dB RMS (re: 1 μPa) is approximately equivalent to 165 dB peak SPL (re: 1 μPa).

Caltrans proposes to use a vibratory hammer and a Delmag D-62 diesel impact hammer to install the remaining temporary piles. In *A Compendium of Pile Driving Sound Data* (Illingworth and Rodkin 2007) the most recent pile driving case studies are reviewed in order to provide information regarding the underwater sound pressure levels generated with the installation of different pile types, hammer types, and effectiveness of sound attenuation systems (*e.g.*, bubble curtains). Several pile driving case studies conducted within the San Francisco Bay region are included in the compendium. Currently, there are 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 an adult green 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, NMFS, personal communication 2008).

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. Project Specific Considerations

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 the Temporary Access Trestle for the SAS but some uncertainty remains. Effects on an individual fish during pile driving 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

c. July 2009 Pile installation for Temporary Access Trestle of the SAS

The temporary trestle will require the installation of twenty-two, 36-inch diameter steel pipe piles. The contractor will install all piles with a vibratory hammer, and then drive them with an impact hammer to ensure load bearing capacity. Caltrans anticipates the piles will be vibrated in for a depth of two to five meters, then impact driven for an additional depth of one to two meters. The impact driven piles will require approximately 60 strikes per pile, which is about five minutes driving time each to reach the required depth. A maximum of two hours of impact driving is expected to install the 22 piles over a 5 to 6 day period. In order to minimize the adverse effects of impact pile driving to Federally-listed salmonids and green sturgeon southern DPS during the installation of piles, Caltrans has incorporated the following avoidance and minimization measures: 1) all pile installation will be restricted to the period between June 1st and November 30th, 2009, avoiding salmonid and spawning adult green sturgeon migration periods; 2) the four piles located closest to YBI will be installed during low-tide in water less than five meters deep; 3) Caltrans will incorporate an air bubble curtain sound attenuation system to reduce sound pressure and exposure levels during impact pile driving for the 18 piles located in water depths greater than five meters; 4) only four piles will be installed per day, totaling approximately 20 minutes of impact hammering per day; and 5) 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 sound pressure and exposure levels do not exceed what has been analyzed in this supplemental and conference BO.

NMFS has analyzed the effects of the proposed pile driving for the SAS temporary access trestle, including the proposed avoidance and minimization measures. Using the methodology described above, NMFS does not anticipate SPLs and SELs to exceed the current criteria for physical injury or death to fish 206 dB (re: 1 μPa), 187 SEL (re: 1 μPa^2-sec) beyond a 28 m radius (56 m diameter), surrounding each pile for fish greater than 2 grams. As distance from the pile increases, sound pressure levels decrease and the potential harmful effects to fish also decrease. Hence the distance within which the 150 dB RMS corresponding to sub-injurious sound levels (*i.e.* non-lethal, behavioral responses) is likely to occur is not expected to extend beyond a 1000 m radius (2000 m diameter). Data taken from *A Compendium of Pile Driving Sound Data* was used to obtain reference SPLs produced during unattenuated impact hammer (Delmag D 36-32) pile driving for 36-inch diameter steel pipe piles in Humboldt County. Using those reference values of 210 dB peak (re: 1 μPa), 185 db SEL (re: 1 μPa^2-sec) and 193 dB RMS measured at 10 meters, and estimating a total of 240 strikes per day (60 strikes per pile, 4 piles maximum) with a transmission loss (TL) of 15 dB[7]; results in a radius of 209 m for the 187 dB SEL distance, 18 m radius for the 206 dB peak, and a 7,356 m radius for the 150 dB RMS. However, 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 (Wursig *et a.* 1999, Reyff 2003, D. Woodbury, NMFS, personal communication 2008, Caltrans 2009). Caltrans expects to achieve a 13-18 dB reduction in sound pressure through incorporation of a specially designed bubble curtain, thus (using the methodology described above) the new reference estimates become 192 peak dB (re: 1 μPa), 170 dB SEL (re: 1 μPa^2-sec), and 180 dB RMS at a distance of 10 m, and the 150 dB RMS at a distance of 1,000 m. Therefore, the incorporation of sound attenuation is expected to effectively reduce the area of impact to the smaller distances described above.

The project's pile driving activities from June 1st through November 30th, 2009, for the temporary access trestle connecting YBI to the T1 Tower of the SAS is not expected to result in adverse effects to listed salmonids because no life stage is expected to be present during construction between June 1 and November 30, 2009. Additionally, due to the timing of construction, the project's pile driving activities are not expected to result in impacts to adult spawning green sturgeon. Juvenile, subadult and some non-spawning adult green sturgeon have the potential to be within the action area year-round. However, the incorporation of a bubble curtain system is expected to significantly reduce injurious sound levels from impact hammer pile driving surrounding each pile to a confined area of 28 m (56 m diameter), which is very small compared with the size of the action area, and overall habitat range within the San Francisco Bay for green sturgeon. Moreover, this portion of the action area along the eastern shore of YBI has been disturbed during the past several years' construction of the SAS. The presence of barges, boats, recently constructed towers and work equipment in the nearshore waters along the eastern side of YBI 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

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

construction in this small area. These life stages of green sturgeon are more likely to be located in areas of the Bay that possess higher quality habitat. In addition, adverse behavioral effects to green sturgeon present within the 1,000 m distance from the pile estimated to reach 150 dB RMS are expected to be very minor. Sound pressure levels extending out to his distance would only reach to the north, south and east of the pile driving area as YBI is immediately to the west. In addition, the area within the 1000 m radius is located in deeper waters in the Bay (green sturgeon are expected to be located in shallower areas), and the duration of pile driving will only occur for a maximum of two hours over a 5 to 6 day period. 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 compared to the available habitat within the Bay for green sturgeon. NMFS expects green sturgeon to quickly return to normal behavior patterns once pile driving ceases and experience no lasting adverse effects due to their larger bodies (above two grams) and pile driving activities will occur only in the daytime which would avoid crepuscular and nocturnal periods when sturgeon migratory activity is likely the highest.

2. <u>Turbidity</u>

Pile driving activities 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. As described above, listed salmonids and green sturgeon are not likely to be within the vicinity of localized elevated turbidity levels during pile driving for the SAS temporary access trestle. 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.

B. Dismantling of the Existing Bridge

1. <u>Dredging and Disposal</u>

The potential impacts of dredging associated with the SFOBB East Span Seismic Project include both direct and indirect adverse effects. Potential direct 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, Kim *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).

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 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). Presumably, similar effects for green sturgeon could occur during dredging activities for the project. Juvenile, subadult and non-spawning adult green sturgeon may be present year-round within the active dredging area, however, current distribution and abundance data for the species is limited, so precise assessments for green sturgeon in the area are not possible at this time.

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. Barges for holding, transport, and disposal of dredged material will be selected by the contractor, so their size, sediment holding capacity, and characteristics cannot be accurately estimated.

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 these effects may not cause direct mortality to individual fish, they may adversely affect growth and 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.

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). 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 (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 an upland location.

Although the Dredge Material Management Office (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[8]), 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 anticipated to re-suspend and rapidly disperse, they appear unlikely to result in any acute toxicity to listed anadromous green sturgeon. However, there remains a concern for chronic effects that may occur as a result of the uptake of contaminants by green sturgeon during juvenile rearing and 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). However, since the action area occupies a small area of the Bay, only a small number of green sturgeon may experience similar risks. Because salmonids do not spend long time periods in the Bay, they are less likely to experience these impacts.

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. Although for the SFOBB East Span Seismic Project it appears

[8]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).

unlikely that acute, short-term effects due to increased levels of NH_3 at either the dredge site or the disposal site will occur due to tidal influence and water column mixing at the disposal site, and to a slightly lesser extent at the dredge site. The un-ionized form of NH_3 has potential for adversely affecting listed salmonids and green sturgeon, but the limited concentrations anticipated 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 (DO) 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, and 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 impacts involved with the 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, indirect effects, in a similar pattern as is described for turbidity, may occur through behavior modification resulting from 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 to occur 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; however, rapid recolonization rates indicate that this would be of minimal impact to green sturgeon. Within the upper portion of the water column at the disposal site there may be some loss of prey items.

f. Dredging and Disposal Summary

The precise number of salmonids and green sturgeon affected by dredging and disposal activities is unknown, but only a small percentage of the population 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 green sturgeon in the Bay.

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 critical habitat for CCC steelhead, and is proposed designated critical habitat for southern DPS green sturgeon. Temporary impacts to critical habitat for salmonids, and the proposed critical habitat of southern DPS green sturgeon, are expected during the remaining construction 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.

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.

VI. 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 4982 m diameter surrounding the East Span of the SFOBB, and an area extending approximately 2000 m south of Alcatraz Island at the SF-11 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.

VII. INTEGRATION AND SYNTHESIS OF EFFECTS

A. Effects to Species

As previously discussed, the remaining 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. 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 as 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. Thus impacts to Central Valley Salmonid numbers are very small and likely exert a negligible 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 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.

Sound levels from pile driving capable of causing physical injury to fish are predicted to extend only a short distance from the pile 28 m (56 m diameter) during impact hammer pile driving. Sub-injurious sound pressure levels affecting behavior, may extend out to 1000 m (2000 m diameter) from piles driven with an impact hammer. Although fish may be harmed or killed within this 28 m limited zone, and may exhibit behavioral responses within 1000 m, given the timing of construction (June 1st – November 30th 2009), and known behavior patterns of CCC steelhead, no life stage of CCC steelhead are expected to be present during the installation of the remaining temporary piles. Therefore, no CCC steelhead are expected to be harmed, injured, or harassed during the project's remaining 2009 temporary pile driving. In addition, a very small number of CCC steelhead will likely be killed, injured or harassed by bridge dismantling activities. 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. The effects of the remaining pile driving and bridge demolition are anticipated to cause losses of less than two percent of adult and juvenile salmonids.[9] These losses are temporary, and will only occur during one year of juvenile outmigration and adult migration. While the magnitude of loss is small, these combined losses of adult and juvenile salmonids associated with the SFOBB East Span Seismic Project may manifest as a reduction in the number of adults returning to the next generation of the south Bay CCC steelhead populations because, for example, these losses are compounded with previous pile driving impacts. However, these losses are unlikely to propagate forward in time to more than one to two years of adult returns. The potential 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 may allow for subsequent years with greater population abundance. Plus, other factors such as streamflow and water temperature are expected to exert greater influence on spawning, incubation, and juvenile survival rates. Salmonid population abundance tends to be highly variable with interannual fluctuation in the range of 40 to 70 percent (Bisson *et al.* 1997). Variability in the freshwater and marine

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[9] In the April 10, 2009, Supplemental Biological and Conference Opinion, NMFS calculated that losses would be up to 2 percent. Because some of the bridge construction activities, *i.e.*, pile driving, analyzed in that opinion have already occurred, NMFS assumes that CCC steelhead losses for the remaining project activities will be less than 2 percemt.

environments is thought to be a primary factor driving fluctuations in juvenile and adult abundance.

Improvements to baseline conditions as a result of the restoration efforts funded by Caltrans to restore, enhance, or create salmonid habitat are expected to improve reproductive success and survival of CCC steelhead. In consideration of the above, the SFOBB East Span Seismic Project is 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 less than two percent[10] of spawning adult green sturgeon are likely to be harassed, injured or killed by the project's remaining activities. This estimate is based upon an average annual abundance estimate of 125 returning spawners (D. Woodbury, NMFS, personal communication 2008), 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. As with CCC steelhead, no spawning adults are expected to be present during the installation of the remaining temporary piles since the construction of the temporary access trestle for the SAS will occur outside the migration period for returning spawners. Additionally, no juvenile, subadult and non-spawning adult green sturgeon are expected to be present within the 28 m (56 m diameter) zone where onset of physical injury is expected. However, since juvenile, subadult and non-spawning adult fish may be located elsewhere within the action area year-round, they may be harassed or otherwise disturbed if located within 1000 m (2000 m diameter) during impact hammer pile driving during the installation of the project's remaining temporary piles. Underwater sound pressure produced from pile driving may cause startling and/or avoidance of habitat by fish within 1000 m of the project site. The startling of fish can cause harm by temporarily disrupting normal behaviors that are essential to growth and survival such as feeding, sheltering, and migrating. Disruption of these behaviors would occur for specific periods during daylight operation hours of the pile driving hammer. However, given the very short time required to install the temporary piles (no more than two hours over a 5 – 6 day period), adverse behavioral effects to green sturgeon are expected to be extremely minor.

Although it is not possible to predict the exact percentage of juvenile green sturgeon that may be adversely affected by the project's remaining construction 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 and likely found in intertidal sloughs and benthic substrates with water depths less than 10 m deep. The dredging areas are also relatively distant from the primary migration routes of adult green sturgeon, but the disposal site at SF-11 near Alcatraz Island could subject both juvenile and adult green sturgeon to degraded water

[10] In the April 10, 2009, Supplemental Biological and Conference Opinion, NMFS calculated that losses would be up to 2 percent. Because some of the bridge construction activities, *i.e.*, pile driving, analyzed in that opinion have already occurred, NMFS assumes that spawning adult green sturgeon losses for the remaining project activities will be less than 2 percent.

quality during a disposal event. Therefore, it is expected the remaining bridge dismantling activities of the SFOBB East Span Seismic Project will result in harassment, injury or mortality to a small number of threatened adult and juvenile green sturgeon, although the exact extent number affected remains uncertain.

Similar to CCC steelhead, the potential impacts from pile driving that have occurred from the installation of temporary piles since the project began construction may have caused harm through harassment, injury or mortality 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 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 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 project's actions during construction of the SFOBB East Span Seismic Project.

B. Effects to Designated and Proposed 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 are designated critical habitat for CCC steelhead. Temporary impacts to critical habitat of anadromous salmonids are expected during construction as a result of the remaining pile driving activities. Pile driving will adversely affect critical habitat within the action area though temporary elevated SPLs and turbidity. However, as discussed previously, restoration efforts resulting in improved access to significantly better habitat conditions in Bay tributaries 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 proposed as critical habitat for green sturgeon. Impacts to the water column and bay substrate are expected to occur as a result of remaining 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 activities 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 by the proposed actions, impacts from the project's activities are not expected to reduce the value of proposed critical habitat for green sturgeon for the conservation of this species.

VIII. CONLUSION

A. Consultation

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 remaining 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, or Sacramento River winter-run Chinook salmon.

B. Conference

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' conference opinion that the proposed remaining activities for the SFOBB East Span Seismic Project are not likely to adversely modify or destroy the proposed critical habitat for southern DPS green sturgeon.

IX. 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.

Take prohibitions via section 4(d) of the ESA have not been applied to green sturgeon prior to the issuance of this supplemental biological opinion. NMFS may issue green sturgeon take prohibitions before work on the SFOBB is completed. Once green sturgeon take prohibitions under section 4(d) become effective, the measures described below will become non-discretionary for green sturgeon. When the measures become non-discretionary, they must be undertaken by Caltrans for the exemption of 7(o)(2) to apply to listed green sturgeon.

A. Amount or Extent of Take Anticipated

It is anticipated that take associated with remaining activities SFOBB East Span Seismic Project will be in the form of mortality, injury, harassment, and disturbance through temporary impacts from 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. Dismantling of the Existing Bridge

Dredging and disposal activities are expected to result in incidental take in the form of harassment and disturbance through temporary habitat impacts at and near the dredging and disposal sites. Habitat within several hundred meters at both the dredge and aquatic disposal sites will be temporarily degraded due to localized turbidity produced by dredge and disposal activities. Migration behavior and foraging of juvenile and adult salmonids and green sturgeon are likely to be disrupted by the plume of turbid water occurring during and immediately following dredging and disposal events. Impacts from turbidity are not expected to result in lethal take of any green sturgeon or salmonids. Mortality of juvenile and adult salmonids and green sturgeon due to entrainment in a mechanical dredge is unlikely, and entrainment in a hydraulic dredge is expected to be very low due to the relatively limited area affected by dredging for this project.

1. July 2009 Pile installation for Temporary Access Trestle of the SAS

Pile driving with an impact hammer is expected to result in_incidental take in the form of harassment and disturbance to juvenile, subadult and non-spawning adult green sturgeon through exposure to temporary high SPLs (> 150 dB RMS) within the water column during the installation of the temporary access trestle for the SAS. Impacts from pile driving are not expected to result in physical injury or lethal take of any green sturgeon or salmonids.

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 CCC steelhead or green sturgeon.

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 CCC steelhead and green sturgeon.

Caltrans shall:

1. Utilize measures to minimize and avoid the take of green sturgeon and salmonids 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 and outline required reporting/monitoring requirements. These terms and conditions are non-discretionary for listed salmonids. Once take prohibitions under section 4(d) become effective, the measures described below will become non-discretionary for green sturgeon.

1. <u>Utilize measures to reduce the take of green sturgeon and salmonids from dredging.</u>

   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. <u>Utilize measures to reduce the take of listed salmonids and green sturgeon from dismantling the existing bridge.</u>

   a. Dredging/disposal associated with barge access for the dismantling of the existing bridge shall be restricted to the period between June 1st and November 30th.

b. All activities that will generate high sound pressure levels (>150 dB re: 1 μPa) associated with the dismantling of the existing bridge shall be restricted to the period between June 1st and November 30th.

3. <u>Ensure the approved fisheries and hydroacoustic monitoring program is properly implemented.</u>

a. Real time monitoring shall be conducted to ensure that underwater sound levels analyzed in this biological opinion: 187 dB accumulated SEL at 28 m (56 m diameter), 206 dB peak SPL at 1m (2 m diameter), and 150 dB RMS at 1000 m (2000 m diameter) from the piles being driven are not exceeded.

b. Caltrans shall monitor underwater sound during all impact hammer pile driving activities. If underwater sound exceeds 187 dB accumulated SEL at 28 m (56 m diameter), and 206 dB peak SPL at 1 m (2 m diameter) from the piles being driven, then NMFS must be contacted within 24 hours.

c. Caltrans shall submit to NMFS daily biological and hydroacoustic monitoring reports (by noon of the day following pile driving) that provide 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. Specifically, the reports shall:

- Describe 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;

- Include 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;

- Include a monitoring and reporting program that will include provisions to provide daily summaries of the hydroacoustic monitoring results to NMFS, as well as more comprehensive summary reports on a monthly basis during the pile-driving season;

- 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.

d. Caltrans shall submit to NMFS a hydroacoustic monitoring summary due 30 days following pile driving that provides a review of the monitoring data and process, as well as any problems that were encountered.

e. Pile driving shall occur only during daylight hours from one hour after sunrise to one hour before sunset. This is to ensure that pile driving does not occur at dawn or dusk, during peak salmonid migration and feeding times.

f. 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:

Central Coast Team Supervisor
National Marine Fisheries Service
777 Sonoma Ave., Room 325
Santa Rosa, California 95404
Phone (707) 575-6064
Fax (707) 578-3435

X. REINITATION NOTICE

This concludes formal consultation on the proposed 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.

XI. 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 installation during peak migration periods should be avoided.

2. 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.

3. 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 green sturgeon and their habitats.

4. 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.

5. 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.

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A. Federal Register Notices Cited

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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.

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B. Personal Communications

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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,

Kevin Chu

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

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[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.

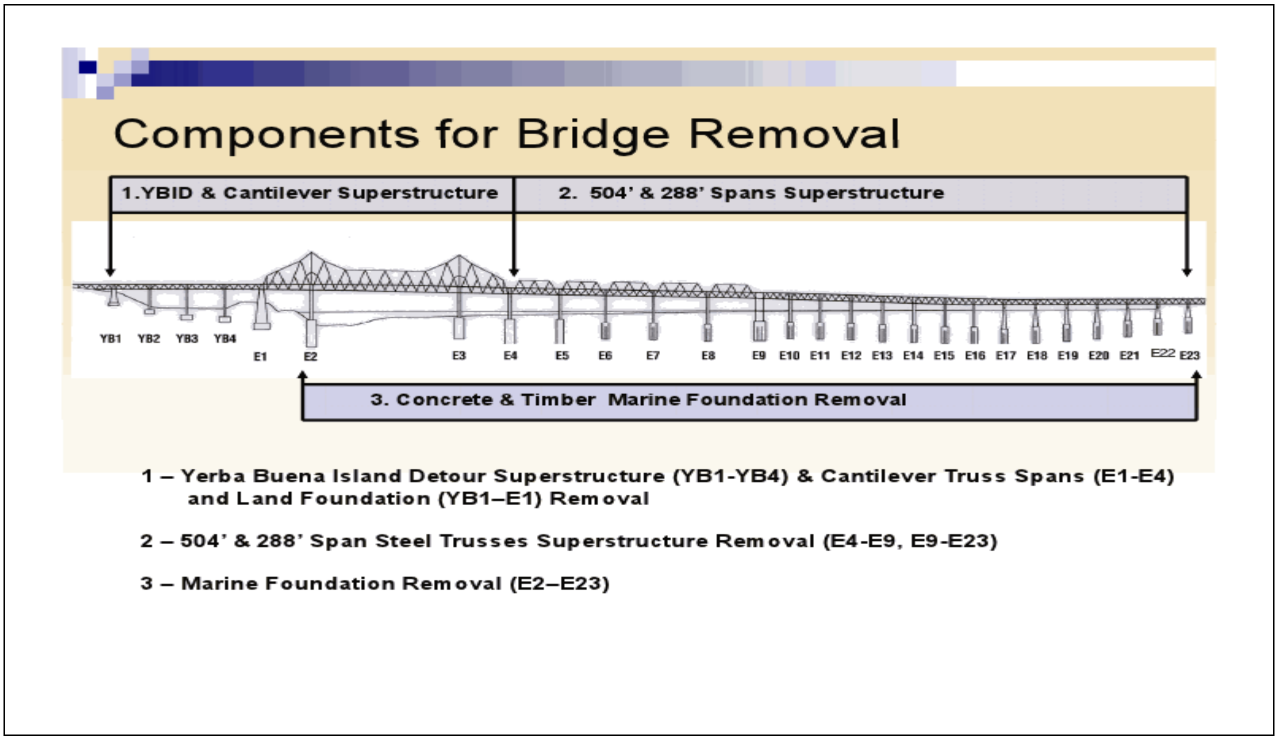

Figure 1. SFOBB Sections for Removal (Caltrans 2011).

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. <u>Proposed Avoidance and Minimization Measures</u>

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. <u>Steelhead</u>

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).

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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. <u>Green Sturgeon</u>

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*.

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[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. <u>Salmonids</u>

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. Green Sturgeon

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. <u>Dam Construction and Water Development</u>

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. <u>Introduction of Non-Native Species</u>

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

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[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 μPa^2sec), 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. <u>Utilize measures to reduce the take of green sturgeon from dredging.</u>

    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. <u>Utilize measures to reduce the take of listed salmonids and green sturgeon from dismantling the existing bridge</u>.

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

3. <u>Ensure the approved fisheries and hydroacoustic monitoring program is properly implemented.</u>

    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.

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B. Personal Communications

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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.

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UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL MARINE FISHERIES SERVICE
Silver Spring, MD 20910

DEPARTMENT OF COMMERCE

NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION

NATIONAL MARINE FISHERIES SERVICE

Incidental Harassment Authorization

The California Department of Transportation (CALTRANS) is hereby authorized under section 101(a)(5)(D) of the Marine Mammal Protection Act (16 U.S.C. 1371(a)(5)(D)) and 50 CFR 216.106, to take, incidentally by Level B harassment, small numbers of marine mammals incidental to construction of a replacement bridge for the East Span of the San Francisco-Oakland Bay Bridge (SF-OBB), California:

1. This Authorization is valid from January 8, 2014, until January 7, 2015.

2. This Authorization is valid only for activities involving the construction and dismantling of the East Span of SF-OBB, California.

3. Species Impacted and Level of Takes

(a) The species authorized for takings by incidental harassment are the California sea lion (*Zalophus californianus*), Pacific harbor seal (*Phoca vitulina richardsi*), harbor porpoise (*Phocoena phocoena*), and gray whale (*Eschrichtius robustus*).

(b) The taking of any marine mammal in a manner prohibited under this Authorization must be reported within 24 hours of the taking to the Director, Southwest Regional Office, National Marine Fisheries Service, Telephone (562) 980-4000 and the Director, Office of Protected Resources, National Marine Fisheries Service, Telephone (301) 427-8400.

4. The holder of this Authorization is required to cooperate with the National Marine Fisheries Service and any other Federal, state or local agencies monitoring the impacts of the activity on marine mammals. The holder must notify Monica DeAngelis of the Southwest Regional Office (562-980-3232) at least 24 hours prior to starting activities.

5. Prohibitions

(a) The taking, by incidental harassment only, is limited to the species listed under condition 3(a) above and by the numbers listed in Table 2 (attached). The taking by Level A harassment, injury, serious injury, or death of these species or the taking by harassment, injury, serious injury, or death of any other species of marine mammal is prohibited and may result in the modification, suspension, or revocation of this Authorization.

6. Mitigation Requirements

(a) Use of Noise Attenuation Devices
Pile driving energy attenuator (such as air bubble curtain system or dewatered cofferdam) shall be used for all impact pile driving of pipe piles, with the exception of pile proofing and H-piles.

(b) Establishment and Monitoring of Exclusion and Level B Harassment Zones

(i) For all in-water pile driving and mechanical dismantling activities, CALTRANS shall establish exclusion zones where received underwater sound pressure levels (SPLs) are higher than 180 dB (rms) and 190 dB (rms) re 1 μPa for cetaceans and pinnipeds, respectively, and Level B harassment zones where received underwater sound pressure levels (SPLs) are higher than 160 dB (rms) and 120 dB (rms) re 1 μPa for impulse noise sources (impact pile driving) and non-impulses noise sources (vibratory pile driving and mechanic dismantling), respectively.

(ii) The sizes of the exclusion and Level B harassment zones for different types of activities are provided in Table 1 below. If additional hydroacoustic measurements of construction activities have been conducted, CALTRANS shall revised the sizes of the zones based on updated measurements.

(iii) In cases when multiple vibratory hammers are used at any given time, CALTRANS shall conduct in-situ sound source measurement to adjust the exclusion and Level B harassment zones.

Table 1. Temporary exclusion and Level B harassment zones for various pile driving and dismantling activities

Pile Driving / Dismantling Activities	Pile Size (m)	Distance to 120 dB re 1 μPa (rms) (m)	Distance to 160 dB re 1 μPa (rms) (m)	Distance to 180 dB re 1 μPa (rms) (m)	Distance to 190 dB re 1 μPa (rms) (m)
Vibratory Driving	24	2,000	NA	NA	NA
	36	2,000	NA	NA	NA
	Sheet pile	2,000	NA	NA	NA
Attenuated Impact Driving	24	NA	1,000	235	95
	36	NA	1,000	235	95
Unattenuated Proofing	24	NA	1,000	235	95
	36	NA	1,000	235	95
Unattenuated Impact Driving	H-pile	NA	1,000	235	95
Dismantling		2,000	NA	100	100

(iv) NMFS-approved protected species observers (PSOs) shall conduct initial survey of the safety zone to ensure that no marine mammals are seen within the zones before impact pile driving and mechanical dismantling of bridge foundation. If marine mammals are found within the exclusion zones, impact pile driving and/or mechanical dismantling activity of the segment shall be delayed until they move out of the area. If a marine mammal is seen above water and then dives below, the contractor would wait 15 minutes for pinnipeds and harbor porpoise and 30 minutes for gray whale. If no marine mammals are seen by the observer in that time it would be assumed that the animal has moved beyond the exclusion zone.

(v) If the time between pile-segment driving is less than 30 minutes, a new 30-minute survey is unnecessary provided marine mammal monitors continue observations during the interruption. If pile driving ceases for 30 minutes or more and a marine mammal is sighted within the designated safety zone(s) prior to the commencement of pile-driving, the observer(s) must notify the Resident Engineer (or other authorized individual) immediately (see condition 5(e)).

(c) Soft Start

CALTRANS and its contractor shall implement soft start, i.e., starting the pile driving hammer at the lowest power setting and gradually ramp up to full power, prior to operating pile driving hammers at full capacity for both impact and vibratory pile driving.

(d) Power Down and Shut-down

(i) For mechanical dismantling of bridge foundation, construction activities that generate underwater noise must be powered down or shutdown if a marine mammal is observed within the established 180 dB or 190 dB re 1 μPa exclusion zones for cetaceans or pinnipeds, respectively.

(ii) For pile driving activities, if a marine mammal is sighted within the exclusion zone after pile-driving has begun, CALTRANS must have a qualified marine mammal observer record the species, numbers and behaviors of the animal(s) and report to Monica DeAngelis at the Southwest Regional Office, National Marine Fisheries Service, (phone: 562-980-3232) within 24 hours of the incident.

7. Monitoring Requirements

(a) General.

(1) The holder of this Authorization must designate a minimum of three biologically-trained, on-site protected species observers (PSOs), approved in

advance by the National Marine Fisheries Service's Southwest Regional Office, to monitor the area for marine mammals before, during, and after pile driving activities; and before, during, and after mechanical dismantling of marine foundations .

(2) The National Marine Fisheries Service must be informed immediately of any changes or deletions to any portions of the monitoring plan in accordance with condition 7(a) of this Authorization.

(b) Visual Monitoring

(i) CALTRANS shall implement onsite marine mammal monitoring for 100% of all unattenuated impact pile driving of H-piles for 180- and 190-dB re 1 μPa exclusion zones and 160-dB re 1 μPa Level B harassment zone, attenuated impact pile driving of pipe piles (except pile proofing) and mechanical dismantling for 180- and 190-dB re 1 μPa exclusion zones.

(ii) CALTRANS shall also monitor 20% of the attenuated impact pile driving for the 160-dB re 1 μPa Level B harassment zone, and 20% of vibratory pile driving and mechanic dismantling for the 120 dB re 1 μPa Level B harassment zone.

(iii) Marine mammal monitoring shall begin at least 30 minutes prior to the start of the activities, through the entire construction activities, and continue to 30 minutes after the construction activities.

(iii) Observations shall be made using high-quality binoculars (e.g., Zeiss, 10 x 42 power). PSOs shall be equipped with radios or cell phones for maintaining contact with other observers and CALTRANS engineers, and range finders to determine distance to marine mammals, boats, buoys, and construction equipment.

(iv) Data on all observations would be recorded and shall include the following information:

- location of sighting;
- species;
- number of individuals;
- number of calves present;
- duration of sighting;
- behavior of marine animals sighted;
- direction of travel;
- when in relation to construction activities did the sighting occur (e.g., before, "soft-start", during, or after the pile driving or removal); and
- other human activities in the area.

(c) Hydroacoustic Measurements

At the beginning of pile driving and mechanical dismantling of bridge foundation, CALTRANS shall conduct hydroacoustic measurements to verify the exclusion and Level B harassment zones.

7. Reporting Requirements

(a) CALTRANS shall notify NMFS of the initial sound pressure level measurements for both pile driving and foundation dismantling activities, including the final exclusion zone and Level B harassment zone radii established for impact and vibratory pile driving and marine foundation dismantling activities, within 72 hours after completion of the measurements.

(b) Monitoring reports shall be posted on the SFOBB Project's biological mitigation website (www.biomitigation.org) on a weekly basis if in-water construction activities are conducted. Marine mammal monitoring reports shall include species and numbers of marine mammals observed, time and location of observation and behavior of the animal. In addition, the reports shall include an estimate of the number and species of marine mammals that may have been harassed as a result of activities.

(c) CALTRANS shall provide NMFS with a draft final report within 90 days after the expiration of the IHA. This report shall detail the monitoring protocol, summarize the data recorded during monitoring, and estimate the number of marine mammals that may have been harassed due to pile driving and mechanical dismantling of bridge foundations. If no comments are received from NMFS within 30 days, the draft final report would be considered the final report. If comments are received, a final report must be submitted within 30 days after receipt of comments.

8. (a) In the unanticipated event that CALTRANS' construction activities clearly cause the take of a marine mammal in a manner prohibited by this Authorization, such as an injury (Level A harassment), serious injury or mortality (e.g., ship-strike, gear interaction, and/or entanglement), CALTRANS shall immediately cease construction operations and immediately report the incident to the Supervisor of Incidental Take Program, Permits and Conservation Division, Office of Protected Resources, NMFS, at 301-427-8401 and/or by email to Jolie.Harrison@noaa.gov and Shane.Guan@noaa.gov and NMFS Southwest Regional Stranding Coordinators (Sarah.Wilkin@noaa.gov). The report must include the following information:

(i) time, date, and location (latitude/longitude) of the incident;

(ii) type of activity involved;

(iii) description of the incident;

(iv) status of all sound source use in the 24 hours preceding the incident;

(v) water depth;

(vi) environmental conditions (e.g., wind speed and direction, Beaufort sea state, cloud cover, and visibility);

(vii) description of marine mammal observations in the 24 hours preceding preceding the incident;

(viii) species identification or description of the animal(s) involved;

(ix) the fate of the animal(s); and

(x) photographs or video footage of the animal (if equipment is available).

Activities shall not resume until NMFS is able to review the circumstances of the prohibited take. NMFS shall work with CALTRANS to determine what is necessary to minimize the likelihood of further prohibited take and ensure MMPA compliance. CALTRANS may not resume their activities until notified by NMFS via letter, email, or telephone.

(b) In the event that CALTRANS discovers an injured or dead marine mammal, and the lead PSO determines that the cause of the injury or death is unknown and the death is relatively recent (i.e., in less than a moderate state of decomposition as described in the next paragraph), CALTRANS will immediately report the incident to the Supervisor of the Incidental Take Program, Permits and Conservation Division, Office of Protected Resources, NMFS, at 301-427-8401, and/or by email to Jolie.Harrison@noaa.gov and Shane.Guan@noaa.gov and NMFS Southwest Regional Stranding Coordinators (Sarah.Wilkin@noaa.gov). The report must include the same information identified in Condition 8(a) above. Activities may continue while NMFS reviews the circumstances of the incident. NMFS will work with CALTRANS to determine whether modifications in the activities are appropriate.

(c) In the event that CALTRANS discovers an injured or dead marine mammal, and the lead PSO determines that the injury or death is not associated with or related to the activities authorized in Condition 3 of this Authorization (e.g., previously wounded animal, carcass with moderate to advanced decomposition, or scavenger damage), CALTRANS shall report the incident to the Supervisor of the Incidental Take Program, Permits and Conservation Division, Office of Protected Resources, NMFS, at 301-427-8401, and/or by email to Jolie.Harrison@noaa.gov and

Shane.Guan@noaa.gov and NMFS Southwest Regional Stranding Coordinators (Sarah.Wilkin@noaa.gov), within 24 hours of the discovery. CALTRANS shall provide photographs or video footage (if available) or other documentation of the stranded animal sighting to NMFS. CALTRANS can continue its operations under such a case.

9. A copy of this Authorization must be in the possession of all contractors and marine mammal monitors operating under the authority of this Incidental Harassment Authorization.

Donna S. Wieting
Donna S. Wieting, Director
Office of Protected Resources
National Marine Fisheries Service

DEC 18 2013
Date

Table 2. Species/stocks and numbers of marine mammals allowed to be taken incidental to under this IHA.

Species / Stocks	Take Allowed
Pacific harbor seal / California	50
California sea lion / U.S.	10
Harbor porpoise / San Francisco-Russian Bay	10
Gray whale / Eastern North Pacific	5