UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL MARINE FISHERIES SERVICE
West Coast Region
777 Sonoma Avenue, Room 325
Santa Rosa, California 95404-4731

OCT 0 3 2017

Refer to NMFS No: WCR-2016-5894

Craig Kenkel
Acting General Superintendent
Golden Gate National Recreation Area
Fort Mason
San Francisco, California 94123

Re: Endangered Species Act Section 7(a)(2) Biological Opinion and Magnuson-Stevens Fishery Conservation and Management Act Essential Fish Habitat Response for the Alcatraz Ferry Embarkation Project (NPS File No. L76 (GOGA-PL))

Dear Superintendent Kenkel:

Thank you for your letter of March 3, 2017, requesting initiation of consultation with NOAA's National Marine Fisheries Service (NMFS) pursuant to section 7 of the Endangered Species Act of 1973 (ESA) (16 U.S.C. 1531 *et seq.*) for the Alcatraz Ferry Embarkation Project. The National Park Service (NPS) proposes construction of facilities for Alcatraz Ferry embarkation points at two locations: Pier 31.5 on the City of San Francisco waterfront in San Francisco County, California; and at the Fort Baker Pier within Horseshoe Cove in the County of Marin, California.

Thank you, also, for your request for consultation pursuant to the essential fish habitat (EFH) provisions in Section 305(b) of the Magnuson-Stevens Fishery Conservation and Management Act (MSA)(16 U.S.C. 1855(b)) for this action. NMFS has determined that the proposed action would adversely affect EFH for various federally managed fish species under the Coastal Pelagic and Pacific Groundfish Fishery Management Plans (FMPs). We have included the results of that review in Section 3 of the enclosed document.

The enclosed biological opinion is based on our review of the work proposed by NPS, and describes NMFS's analysis of potential effects on threatened Southern distinct population segment (Southern DPS) of North American green sturgeon (*Acipenser medirostris*), threatened Central California Coast (CCC) steelhead (*Oncorhynchus mykiss*), threatened Central Valley spring-run Chinook salmon (*O. tshawytscha*), threatened California Central Valley steelhead (*O. mykiss*), endangered Sacramento River winter-run Chinook salmon (*O. tshawytscha*), and designated critical habitat in accordance with section 7 of the ESA.

In the biological opinion NMFS concludes that the project is not likely to jeopardize the continued existence of Southern DPS green sturgeon, nor is the project likely to result in the destruction or adverse modification of critical habitat for Southern DPS green sturgeon. However, NMFS anticipates take of green sturgeon in the form of injury or mortality during the use of an impact hammer for pile installation. An incidental take statement with non-discretionary terms and conditions is included with the enclosed biological opinion. NMFS has also found that the proposed project is not likely to adversely affect threatened CCC steelhead, threatened Central Valley spring-run Chinook salmon, threatened California Central Valley steelhead, endangered Sacramento River winter-run Chinook salmon, or salmonid designated critical habitat in accordance with section 7 of the ESA.

Regarding EFH, NMFS has reviewed the proposed project for potential effects and determined that the proposed project would adversely affect EFH for various federally managed fish species under the Coastal Pelagic and Pacific Coast Groundfish Fishery Management Plans (FMPs). However, the anticipated effects are minor, temporary, and localized. Therefore, we have no practical EFH Conservation Recommendations to provide and no EFH Conservation Recommendations are included in this document.

Please contact John McKeon of NMFS North-Central Coast Office in Santa Rosa, California at (707) 575-6069, or via email at john.mckeon@noaa.gov, if you have any questions concerning this consultation, or if you require additional information.

Sincerely,

for

Barry A. Thom
Regional Administrator

Enclosure

cc: Darren Fong, NPS San Francisco, CA
Brian Aviles, NPS San Francisco, CA
Copy to ARN File #151422WCR2016SR00369

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

National Park Service Alcatraz Ferry Embarkation Project

NMFS Consultation Number: WCR-2016-5894

Action Agency: National Park Service, Golden Gate National Recreation Area

Affected Species and NMFS' Determinations:

ESA-Listed Species	Status	Is Action Likely to Adversely Affect Species or Critical Habitat?	Is Action Likely To Jeopardize the Species?	Is Action Likely To Adversely Affect Critical Habitat?	Is Action Likely To Destroy or Adversely Modify Critical Habitat?
California Central Valley steelhead (*Oncorhynchus mykiss*)	Threatened	No	N/A	N/A	N/A
Central California Coast steelhead (*O. mykiss*)	Threatened	No	N/A	N/A	N/A
Sacramento Valley Winter-run Chinook (*O. tshawytscha*)	Endangered	No	N/A	N/A	N/A
Central Valley Spring-run Chinook (*O. tshawytscha*)	Threatened	No	N/A	N/A	N/A
North American Green Sturgeon (*Acipenser medirostris*)	Threatened	Yes	No	Yes	No

Fishery Management Plan That Describes EFH in the Project Area	Does Action Have an Adverse Effect on EFH?	Are EFH Conservation Recommendations Provided?
Pacific Coast Groundfish	Yes	No
Pacific Coast Salmon	No	No
Coastal Pelagic	Yes	No

Consultation Conducted By: National Marine Fisheries Service, West Coast Region

Issued By: [signature] for

Barry A. Thom
Regional Administrator

Date: OCT 03 2017

1. INTRODUCTION

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

1.1 Background

NOAA's National Marine Fisheries Service (NMFS) prepared the biological opinion (opinion) and incidental take statement portions of this document in accordance with section 7(b) of the Endangered Species Act (ESA) of 1973 (16 U.S.C. 1531 *et seq*.), and implementing regulations at 50 CFR 402.

We also completed an essential fish habitat (EFH) consultation on the proposed action, in accordance with section 305(b)(2) of the Magnuson-Stevens Fishery Conservation and Management Act (MSA) (16 U.S.C. 1801 *et seq*.) and implementing regulations at 50 CFR 600.

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

1.2 Consultation History

On November 21, 2016, NMFS received a letter from the National Park Service (NPS) requesting initiation of informal section 7 consultation to address a proposal by NPS to perform a retrofit and renovation of the Alcatraz Ferry embarkation point at Pier 31.5 on the City of San Francisco waterfront, and to construct an additional embarkation point at the Fort Baker Pier within Horseshoe Cove in Marin County, California (Project). The NPS letter requested informal consultation and concurrence with NPS's initial determination the Project was not likely to adversely affect (NLAA) Sacramento River winter-run Chinook salmon (*Oncorhynchus tshawytscha*), Central Valley spring-run Chinook salmon (*O. tshawytscha*), California Central Valley steelhead (*O. mykiss*), Central California Coast (CCC) steelhead (*O. mykiss*), and North American green sturgeon (*Acipenser medirostris*). The letter also requested NMFS' concurrence with their determination that the proposed Project is not likely to adversely affect these species' designated critical habitat. Pursuant to the MSA, NPS made a finding that the Project may adversely affect EFH and requested EFH consultation with NMFS.

By letter dated December 22, 2016, NMFS informed NPS that sufficient information regarding the Project had not been provided to initiate the consultation. The NMFS letter requested NPS provide additional information regarding the Project's pile driving plans, an effects analysis of pile driving sounds on listed species, and proposed minimization and mitigation measures. On March 3, 2017, NPS provided by letter the information requested by NMFS along with a renewed request for informal ESA section 7 consultation and concurrence with a NPS NLAA effects determination.

In a letter dated May 26, 2017, NMFS informed NPS that given the size of the piles, the effects resulting from Project pile driving sounds, despite NPS's proposed additional minimization measures, are likely to adversely affect listed species under NMFS jurisdiction. NMFS offered additional potential minimization measures to avoid adverse effects; however, NMFS's letter stated that if no further minimization measures were possible or practical, then NPS should request formal ESA section 7 consultation with NMFS.

In an email dated June 7, 2017, NPS informed NMFS that further measures to reduce the sound effects of pile driving on fish, other than utilization of a bubble curtain and a wood or plastic cushion block atop the piles, were determined by NPS engineers and planners to be infeasible due to design and logistical considerations. In the email, NPS also informed NMFS that the project design had changed. NPS proposed an additional four steel piles of 24-inch diameter to be installed for the Pier 31.5 embarkation location. The NPS email asked if NMFS could concur with their NLAA determination, and if not what additional information would be required to initiate formal ESA section 7 consultation.

On June 9, 2017, NMFS responded by email that we could not concur with a NLAA determination for the project as proposed due to the potential for injury or mortality to listed species resulting from pile driving sounds. The email also stated that an analysis of the sound effects on fish of the additional four 24-inch steel piles proposed to be driven, along with development of an acoustic monitoring plan to monitor the effects on listed species of pile driving sounds would be necessary prior to completing formal ESA section 7 consultation.

On June 13, 2017, NPS responded by email to confirm NPS would like to proceed with formal consultation. The email included an analysis of the sound impacts on fish of the additional four 24-inch piles proposed for the Pier 31.5 location; and also stated NPS would be preparing an acoustic monitoring plan for pile driving proposed to occur during project implementation, and an adaptive management plan to further attenuate sound impacts if monitoring results indicated sound impacts exceeded the effects as predicted through analysis provided to NMFS.

On June 30, 2017, NPS provided to NMFS via email a hydroacoustic monitoring and analysis plan. On July 20, 2017, NMFS requested by email that NPS modify the hydroacoustic monitoring plan to include an additional hydrophone at distance from the piles at the deep water site of Pier 31.5. This additional hydrophone would allow for the calculation of the site specific transmission loss to insure it is similar to that assumed and predicted for determining the threshold distance of potential injuries to fish from cumulative sound-exposure-level (cSEL) impacts. On August 3, 2017, NPS provided NMFS via email a revised hydro-acoustic monitoring plan that incorporated additional hydrophones in order to monitor site specific acoustic transmission loss with increasing distance from the pile driving sound sources.

By phone on July 28, 2017, NMFS requested modification of the pile driving work windows to avoid impacts on migrating California Central Valley (CCV) and California Central Coast (CCC) steelhead. By email on August 10, 2017, NPS agreed to modify pile driving work windows to avoid impacts to CCV and CCC steelhead.

1.3 Proposed Federal Action

For section 7 of the ESA, "action" means all activities or programs of any kind authorized, funded, or carried out, in whole or in part, by Federal agencies (50 CFR 402.02). For EFH consultation, federal action means any action authorized, funded, or undertaken, or proposed to be authorized, funded, or undertaken by a Federal Agency (50 CFR 600.910).

NPS published the Final Environmental Impact Statement (FEIS) for the Alcatraz Ferry Embarkation Project (Project) in January 2017 (NPS 2017). The preferred alternative selected in the FEIS is the Pier 31.5 Alternative, along with Fort Baker construction activities common to all EIS alternatives. Based on the FEIS and information provided during consultation, NPS proposes to fund and implement renovation and expansion of the Alcatraz Ferry Embarkation point at its current location at the Port of San Francisco waterfront property, Pier 31.5 Embarcadero Street, and construction of a new, limited use embarkation facility at the NPS-owned Fort Baker Pier in Horseshoe Cove in Marin County. Horseshoe Cove is located across San Francisco Bay near the north landing of the Golden Gate Bridge on the Marin County shore of the Bay.

Pier 31.5 Activities
Proposed activities at Pier 31.5 consist of improvements and expansion of the existing docking facilities, and renovation of the wharf, enclosing bulkhead buildings and piers. NPS will use the historic Pier 31 north and south bulkhead building on the Embarcadero, portions of the Pier 31 and Pier 33 sheds, and all of the outdoor space between Piers 31 and 33 for embarkation services. The existing single dock and gangway will be replaced with two parallel floating docks and connecting gangways accessed from the existing bulkhead. Improvements will include retrofit and expansion of the existing docking facilities, consisting of installation of a new gangway, floating docks, and guide and breasting piles; and repair or replacement of concrete and reinforcing bars in the substructures of the existing piers and wharf. The existing interior space plan of the bulkhead buildings will be extensively reconfigured on all floors. Project construction will result in a third berth at Pier 31.5, which will increase Pier 31.5's operational capacity and provide visitors the potential future opportunity to visit other park sites within San Francisco Bay, as well as accommodate potential weekend special ferry service to Fort Baker.

At Pier 31.5, the Project will replace the existing single dock and gangway with two parallel floating docks (to accommodate three berths) and two connecting gangways accessed from the existing bulkhead. The existing Pier 31.5 substructure is a marginal wharf structure located between Piers 31 and 33. It comprises two distinct pier construction types: an old pier, built in the 1910s; and a newer pier, built in the 1960s. The old pier is located adjacent to the Embarcadero and is a contiguous part of the original Pier 33 construction. The two bulkhead buildings are situated on this older portion of Pier 31.5. The condition of this portion of the pier is relatively poor, due to the advanced state of corrosion and the high chloride contamination of the concrete, and will require significant upgrade and repair. The Port Engineer determined that the Pier 31.5 marginal wharf substructure is "yellow-tagged" based on the Port's 2013 Rapid Structural Assessment Report. Repair actions are limited by the existing bulkhead building above. The adjacent newer pier is a paved parking and assembly area currently used by the existing ferry concessioner. Retrofit of the existing substructure without demolition and replacement will require several actions. A number of piles under the pier will be repaired. Damaged concrete and steel reinforcing bars will be repaired and replaced on significant portions of the deck soffit (underside), perimeter deck edge, and bulkhead wall. Minor cracking of the asphalt paving on top of the deck will be sealed. Abandoned utilities will be removed, and new utilities installed. Most of these under-pier activities will be performed from floats staged under the pier. Containment measures using heavy tarps and float platforms will prevent construction materials and debris from falling in the water. A new gangway and two parallel floats will be installed using eight 36-inch diameter steel guide piles to be installed on the sides of the floats (four guide piles per float). An additional four 24-inch diameter steel breasting piles will be also be installed along the northern edge of Pier 31 for additional structural protection from vessels.

Fort Baker Activities

NPS proposed to develop a ferry berth at Fort Baker for special service that could operate for special events, such as conferences, occasional excursions, or special occasional service between other parklands and the primary ferry embarkation site in San Francisco. A NPS 2012 feasibility analysis that evaluated expanding ferry service to Fort Baker focused on capital development needed to create an operational ferry embarkation site where one does not currently exist. Evaluation of Fort Baker service was limited to special events, occasional excursions, or special employee occasional service - due to a variety of operational and physical constraints including the following: a lack of existing parking at Fort Baker; the current condition of the pier; and the fact that Fort Baker, as a destination by itself, would not draw enough visitors to justify regular service. The construction necessary to establish ferry service at Fort Baker will primarily involve upgrades to the existing concrete pier, which was constructed in the late 1930s. The structural deck is constructed of cast-in-place concrete and is topped with an asphalt wearing surface. The concrete deck is supported by plumb, precast concrete piles, and lateral support to the pier is provided by rows of similar battered piles at the northeast, southeast, and southwest sides. The existing pier has significant damage and deterioration, and precast-concrete piles show significant damage (in the form of large cracks, rust stains, and exposed reinforcing steel) visible above the waterline. Repairs and upgrades to the existing pier substructure will be needed. A new gangway and float will be installed. A total of four 30-inch diameter steel piles will be installed for the gangway landing, and four 36-inch diameter steel guide piles will be installed for the float. Additional piles will need to be repaired. Damaged concrete and steel reinforcing bars will need to be repaired and replaced on significant portions of the deck soffit and bulkhead wall. Fender piles, the asphalt paving on top of the deck, and the existing guardrails will be replaced. Utilities (water and lighting) will be extended and rerouted to the pier. Most of these pier improvements are under-pier activities and will be performed from floats staged under the pier. Containment measures using heavy tarps and float platforms will prevent construction material and debris from falling in the water.

Construction

Project construction at Pier 31.5 is scheduled to occur between June 1 and November 30 in either 2018 or 2019. Construction at the Fort Baker site will occur during a subsequent season (June 1 through November 30) after construction is completed at Pier 31.5. Construction-related activities will generally occur Monday through Friday between 7:00 am and 8:00 pm. Construction is not anticipated to regularly occur on weekends or major legal holidays, but may occur on an as-needed basis. Construction staging will primarily occur within the sites and on barges in the adjacent water. Construction will occur simultaneously with and adjacent to the operation of the existing embarkation facility at Pier 31.5, which may increase conflicts with pedestrians and visitors to the site. NPS will work to ensure that safe staging areas for visitors will be provided and maintained at all times.

Pile driving windows to avoid the primary migration seasons of ESA listed salmonids were developed by NPS in consultation with NMFS. These agreed upon work windows to avoid listed salmonid species impacts from pile driving are from July 1st through September 30th at the Fort Baker construction site, and from July 1st through November 30th at the Pier 31.5, San Francisco waterfront site. The shorter work window for the Fort Baker site, terminating at the end of September is designed to be protective of adult CCV steelhead migrating from the ocean into the Sacramento and San Joaquin River systems. CCV salmonids are known to migrate along the north shore of San Francisco Bay and to use the Angel Island Strait along the Marin County shoreline in North San Francisco Bay, immediately east of the Fort Baker site. With much longer migrations up these major river systems, the presence of CCV steelhead in the San Francisco Bay is anticipated to occur up to two months earlier than the presence of CCC steelhead which migrate to and spawn in the much shorter tributaries of the Bay, and are thus expected to enter San Francisco Bay at a later time of the year just prior to their spawn timing when Bay tributaries have sufficient winter flows to support migration and spawning. With later migration timing, CCC steelhead migrating to South San Francisco Bay tributaries, and thus passing by the Pier 31.5 construction site will likely be unaffected by the longer pile driving work window.

The eight 36-inch diameter steel guide piles and the four 24-inch diameter steel breasting piles to be installed at Pier 31.5, and the four 36-inch diameter guide piles and four 30-inch diameter gangway piles to be installed at Fort Baker will be driven with a barge mounted impact hammer. At this time, NPS engineers expect that a Delmag D46-32, D62-22, or D80-23 hammers will be suitable for the pile types involved (most likely the D62-22). The exact equipment will be determined following site-specific geotechnical investigations.

NPS engineers anticipate driving from two to three piles per day. Thus, the pile driving for the project at Pier 31.5 is expected to occur for between four to six days. To install each of the eight 36-inch diameter steel float guide piles, NPS anticipates 1800 strikes per pile will be necessary. To install each of the four 24-inch diameter steel breasting piles, NPS anticipates 1100 strikes will be needed. Thus the number of impact hammer strikes per day at Pier 31.5 are anticipated to range from 3300 to 5400.

The Fort Baker 30-inch diameter gangway piles are expected to require 1500 strikes, and the four 36-inch diameter float guide piles, 1800 strikes. Between two to three piles per day are expected to be driven. Thus, the Fort Baker site may see between 3000 to 5400 pile strikes per day. The pile driving by impact hammer at Fort Baker will require between three and four days total. Thus including both pile driving locations of the action area, the total number of days pile driving by impact hammer is anticipated to result in between seven to ten days of pile driving over a two-year period.

Avoidance, Minimization and Mitigation Measures

To minimize potential construction-related effects to ESA listed species, NPS has agreed to limit pile driving to a work window between July 1st and October 1st at the Fort Baker site and from July 1st to November 30th at the Pier 31.5 construction site in order to avoid the migration seasons of ESA listed salmonid species in San Francisco Bay. To further minimize impacts to the threatened Southern DPS of North American green sturgeon, NPS has agreed to use of a bubble curtain surrounding piles while the piles are being driven in order to attenuate underwater sound levels. NPS has also developed a hydroacoustic monitoring plan described below to evaluate and monitor underwater sound pressure levels (SPLs) generated from pile driving. If the hydroacoustic monitoring during pile driving indicates significantly higher SPLs are being generated than have been calculated and analyzed in this opinion, the contractor will incorporate the use of a wood or plastic cushion block atop the steel piles in order to further attenuate pile driving sound pressure levels generated.

To avoid the discharge of construction debris into San Francisco Bay waters, tarping or similar methods will be utilized under the over-water pier substructure renovation work areas to collect construction materials and debris during the substructure renovation work. The Project proposes to conduct the general construction/renovation work activities from June 1 through November 30; although pile driving will be restricted the time periods identified above.

Additional minimization and mitigation measures included are that NPS will ensure the contractor:

- maintains a 500-meter safety zone around sound sources in the event that the sound level is unknown or cannot be adequately predicted for marine mammals. Work activities will be halted when a marine mammal enters the 500-meter safety zone; and
- brings loud mechanical equipment online slowly.

Pile Installation Monitoring
In addition to the above measures, hydroacoustic monitoring will be conducted for impact pile driving of the first pile of each type driven at each location. Piles chosen to be monitored will be driven in water depths that are representative of typical water depths at the project location where piles will be driven.

At the Pier 31.5 location, hydroacoustic monitoring of 36-inch, and 24-inch diameter steel piles with impact hammer driving will include the following:

- monitoring the first 36-inch diameter pile, out of a total of eight 36-inch diameter piles driven for the project;
- monitoring the first 24-inch diameter pile, out of a total of four 24-inch diameter piles driven for the project;
- use of two hydrophones at two separate hydrophone monitoring locations for monitoring 36-inch and 24-inch diameter piles; and
- testing sound attenuation system effectiveness.[1]

At the Fort Baker location, hydroacoustic monitoring of 30-inch and 36-inch diameter steel piles with impact hammer driving will include the following:

- monitoring the first 36-inch diameter pile, out of a total of four 36-inch diameter piles driven for the project;
- monitoring the first 30-inch diameter pile, out of a total of four 30-inch diameter piles driven for the project;
- use of a single hydrophone at one hydrophone monitoring location for monitoring 36-inch and 30-inch diameter piles; and
- testing sound attenuation system effectiveness.[1]

At both project locations, one hydrophone will be placed at 10 meters (or greater if required for safety or operational purposes) from each pile being monitored, at approximately mid-depth (*i.e.*, middle of the water column; (see Figures 1 and 2). At the Pier 31.5 location in deeper water, a second hydrophone will be placed at a minimum of 34 meters (distance equal to three times the approximate water depth at the pile) from the first hydrophone location, at a water depth between 7.5 meters and 9.1 meters (distance between 0.7 and 0.85 times the approximate depth at the pile), in order to evaluate site-specific sound level transmission losses in the deeper water location of the action area. All monitoring hydrophones will be located with a clear acoustic line of sight to the pile being monitored.

The hydrophone calibration will be checked at the beginning of each day of monitoring activity. National Institute of Standards and Technology traceable calibration forms will be provided for all relevant monitoring equipment. Prior to the initiation of pile driving, the hydrophone will be placed at the appropriate distance and depth as described above. The on-site inspector/contractor will inform the acoustics specialist when pile driving is about to start to ensure that the monitoring equipment is operational. Underwater sound levels will be continuously monitored during the entire duration of each pile being driven and monitored, with a minimum one third octave band frequency resolution. The wideband instantaneous absolute peak pressure and Sound Exposure Level (SEL) values of each strike, and daily cumulative SEL, will be monitored in real time during construction to ensure that the project does not exceed its authorized take level. Peak and root mean square (RMS) pressures will be reported in decibels (dB; re 1 μPa). SEL will be reported in dB (re 1 μPa2•sec). Wideband time series recording is recommended during all impact pile driving.

Prior to and during the pile driving activity, environmental data will be gathered, such as water depth and tidal level, wave height, and other factors that could contribute to influencing the underwater sound levels (*e.g.*, the presence of aircraft, boats, *etc*.). The start and stop time of each pile driving event and the time at which the bubble curtain or functional equivalent is turned on and off will be logged. The contractor or agency will provide the following information, in

[1] Testing of the sound attenuation system would require pile driving by an impact hammer when the air bubble curtain is both on and off. There may be circumstances where NMFS determines that unattenuated pile driving (striking the pile with the bubble curtain turned off) would pose a significant risk of injury to fish or marine mammals. In those situations, the Service may request that unattenuated pile driving does not occur and that hydroacoustic monitoring be conducted to determine the extent at which certain thresholds are met instead. This will need to be determined on a case by case basis.

writing, to the contractor conducting the hydroacoustic monitoring for inclusion in the final monitoring report: a description of the substrate composition, approximate depth of significant substrate layers, hammer model and size, pile cap or cushion type, hammer energy settings and any changes to those settings during the piles being monitored, depth pile driven, blows per foot for the piles monitored, and total number of strikes to drive each pile that is monitored.

Signal Processing

Post-analysis of the underwater pile driving sounds will include the following:

- Number of pile strikes per pile and per day.
- For each recorded strike (or each strike from a subset), the following will be determined:
  – The peak pressure, defined as the maximum absolute value of the instantaneous pressure (overpressure or underpressure).– The root mean squared sound pressure across 90% of the strikes energy (RMS90%).
  – Sound exposure level, measured across 90% of the accumulated sound energy (SEL90%; calculation methodology as provided in NMFS Appendix B, Pile Driving Compendium).
- Maximum, mean, and range of the peak pressure, with, and if applicable, without attenuation.
- Maximum, mean, range, and Cumulative Distribution Function (CDF) of the RMS90%, both with, and if applicable, without attenuation where the CDF is used to report the percentage of RMS90% values above the thresholds.
- Maximum, mean, and range of the SEL90%, both with and if applicable, without attenuation.
- Cumulative SEL (cSEL) across all the pile strikes. If SEL was calculated for all strikes, cSEL is estimated as indicated in NMFS Appendix B. If SEL was calculated for a subset of strikes, cSEL will be estimated as follows: cSEL = SELmean + 10*log(total number of strikes).
- Where surrogate piles are monitored to represent a larger project, an estimate of the cSEL during a typical day of construction driving will be reported by summing the SEL over the expected number of pile strikes in a typical day for the larger project: cSEL = SELmean + 10*log(number of strikes). The SEL mean used in this calculation will correspond with the actual sound attenuation measures that will be used during construction of the larger project.
- A frequency spectrum both with and, if applicable, without attenuation, between a minimum of 20 and 20 kilohertz, or up to eight successive strikes with similar sound levels.

Analysis and Reporting

The RMS values computed for this project will be computed over the duration between 5% and 95% of the energy of the pulse. The SEL energy plot will assist in interpretation of the single strike waveform. The single strike SEL associated with the highest absolute peak strike, along with the total number of strikes per pile and per day, will be used to calculate the cumulative SEL for each pile and each 24-hour period. In addition, a waveform analysis of the individual absolute peak pile strikes will be performed to determine any changes to the waveform with the bubble curtain. A comparison of the frequency content with and without noise attenuation will be conducted. Units of underwater sound pressure levels will be dB (re 1 μPa), and units of SEL will be re 1 μPa2●sec.

An analysis of the change in the waveform and sound levels with and without the bubble curtain operating will be conducted. Preliminary results for the daily monitoring activities, if required, will be submitted/reported to the primary point of contact at each of the Services within 48 hours after monitoring concludes for the day. In addition, a final draft report, including data collected and summarized from all monitoring locations, will be submitted to the Services within 90 days of the completion of hydro-acoustic monitoring. The results will be summarized in graphical form and will include summary statistics and time histories of impact sound values for each pile. A final report will be prepared and submitted to NMFS within 30 days following receipt of comments on the draft report from NMFS. The report will include the following:

1. Size and type of piles;
2. A detailed description of the bubble curtain, including design specifications, if required;
3. The impact hammer energy rating used to drive the piles, and the make and model of the hammer;
4. A description of the sound monitoring equipment;
5. The distance between hydrophone(s) and pile;
6. The depth of the hydrophone and depth of water at hydrophone locations;
7. The distance from the pile to the water's edge;
8. The depth of water in which the pile was driven;
9. The depth into the substrate that the pile was driven;
10. The physical characteristics of the bottom substrate into which the piles were driven;
11. The total number of strikes to drive each pile and for all piles driven during a 24-hour period;
12. The underwater wideband background sound pressure level reported as the 50% CDF, if required; and
13. The results of the hydroacoustic monitoring, as described under *Signal Processing* above.

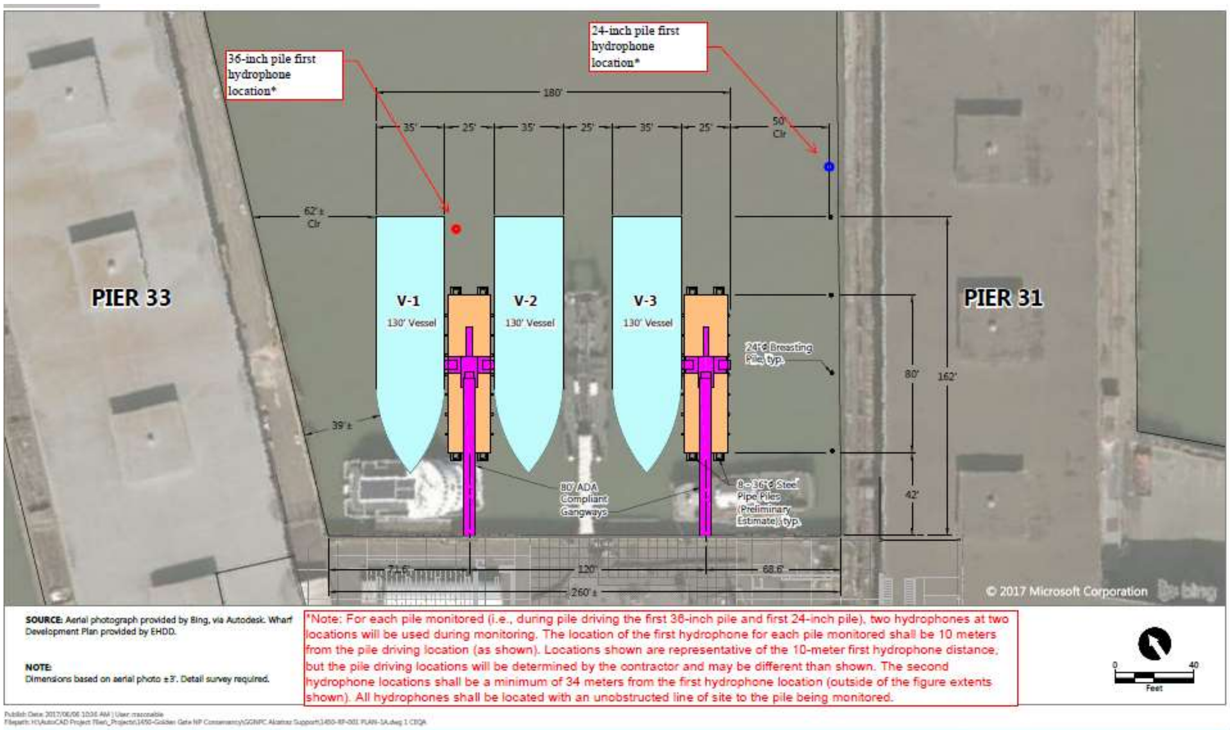

Figure 1. Pier 31.5 New Floating Docks and Gangways, Piles, and Hydrophone hydro-acoustic monitoring locations. A second hydrophone, not shown, will be placed a minimum of 34 meters distant from the hydrophone locations shown in order to monitor site specific transmission loss.

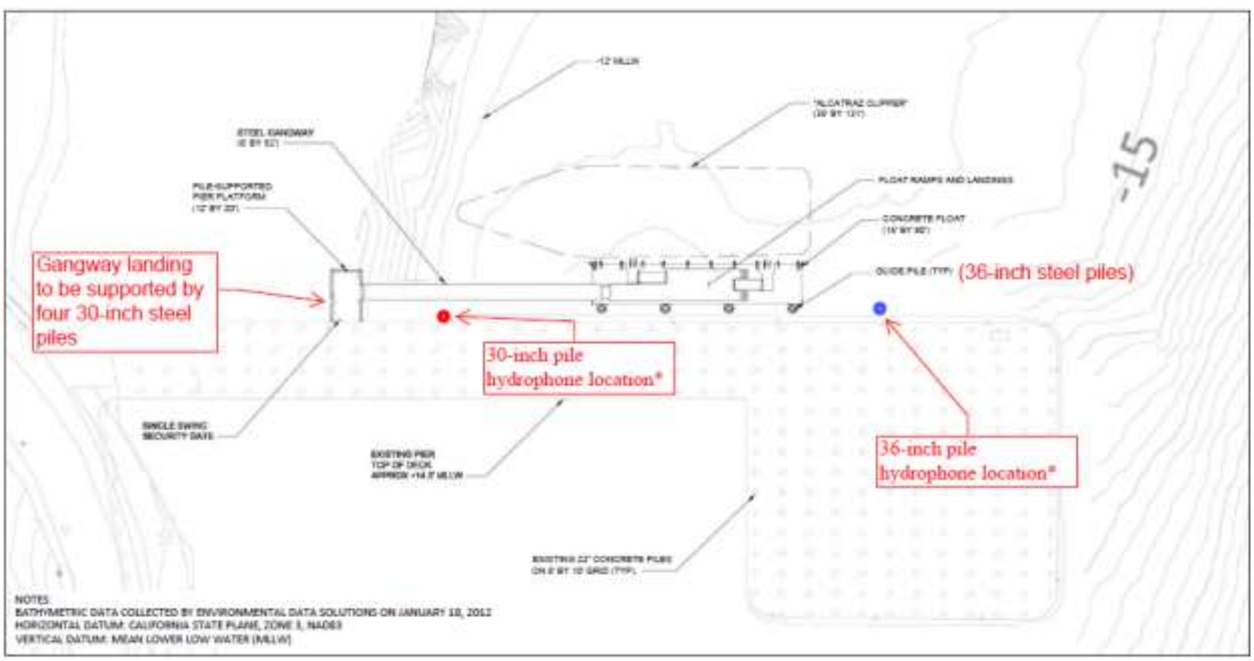

Figure 2. Fort Baker Pier, New Floating Dock and Gangway, Piles, and Hydrophone hydro-acoustic monitoring locations.

Future Ferry Operations

Completion of the Project will provide a new NPS Alcatraz Ferry embarkation point at the NPS owned facility at the Fort Baker Pier in Horseshoe Cove on the Marin County shore of San Francisco Bay. The new embarkation point will be used by NPS for occasional special events only. As such, no appreciable increase in vessel traffic to and from Horseshoe Cove is likely to occur above that which currently occurs in Horseshoe Cove. At Pier 31.5, the Project will replace the existing single dock and gangway with two parallel floating docks (to accommodate three berths) and two connecting gangways accessed from the existing bulkhead. No expansion of the existing NPS Alcatraz ferry service will occur as a result of improvements at Pier 31.5.

Interrelated or Interdependent Actions

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

2. ENDANGERED SPECIES ACT:
BIOLOGICAL OPINION AND INCIDENTAL TAKE STATEMENT

The ESA establishes a national program for conserving threatened and endangered species of fish, wildlife, plants, and the habitat upon which they depend. As required by section 7(a)(2) of the ESA, Federal agencies must ensure that their actions are not likely to jeopardize the continued existence of endangered or threatened species, or adversely modify or destroy their designated critical habitat. Per the requirements of the ESA, Federal action agencies consult with NMFS and section 7(b)(3) requires that, at the conclusion of consultation, NMFS provides an opinion stating how the agency's actions would affect listed species and their critical habitat. If incidental take is reasonably certain to occur, section 7(b)(4) requires NMFS to provide an incidental take statement (ITS) that specifies the impact of any incidental taking and includes non-discretionary reasonable and prudent measures (RPMs) and terms and conditions to minimize such impacts.

The NPS determined the proposed action may affect but is not likely to adversely affect Sacramento River winter-run Chinook salmon, Central Valley spring-run Chinook salmon, California Central Valley steelhead, CCC steelhead, and North American green sturgeon, and designated critical habitat for those species. Our concurrence with the NPS' determination related to the ESA-listed salmonids and their designated critical habitat is documented in the "Not Likely to Adversely Affect" Determinations Section 2.12 of this opinion. This opinion discusses the potential adverse effects to North American green sturgeon.

2.1 Analytical Approach

This opinion includes both a jeopardy analysis and/or an adverse modification analysis. The jeopardy analysis relies upon the regulatory definition of "to jeopardize the continued existence of a listed species," which is "to engage in an action that would be expected, directly or indirectly, to reduce appreciably the likelihood of both the survival and recovery of a listed species in the wild by reducing the reproduction, numbers, or distribution of that species" (50 CFR 402.02). Therefore, the jeopardy analysis considers both survival and recovery of the species.

This opinion relies on the definition of "destruction or adverse modification," which "means a direct or indirect alteration that appreciably diminishes the value of critical habitat for the conservation of a listed species. Such alterations may include, but are not limited to, those that alter the physical or biological features essential to the conservation of a species or that preclude or significantly delay development of such features" (81 FR 7214).

The designation of critical habitat for the Southern DPS of green sturgeon uses the term primary constituent element (PCE) or essential features. The new critical habitat regulations (81 FR 7414) replace this term with physical or biological features (PBFs). The shift in terminology does not change the approach used in conducting a ''destruction or adverse modification'' analysis, which is the same regardless of whether the original designation identified PCEs, PBFs, or essential features. In this opinion, we use the term PBF to mean PCE or essential feature, as appropriate for the specific critical habitat.

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

- Identify the range-wide status of the species and critical habitat likely to be adversely affected by the proposed action.
- Describe the environmental baseline in the action area.
- Analyze the effects of the proposed action on both species and their habitat using an "exposure-response-risk" approach.
- Describe any cumulative effects in the action area.
- Integrate and synthesize the above factors by: (1) reviewing the status of the species and critical habitat; and (2) adding the effects of the action, the environmental baseline, and cumulative effects to assess the risk that the proposed action poses to species and critical habitat.
- Reach a conclusion about whether species are jeopardized or critical habitat is adversely modified.
- If necessary, suggest a reasonable and prudent alternative to the proposed action.

2.1.1 Use of Best Available Scientific and Commercial Information

To conduct the assessment presented in this opinion, 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 potential effects of the proposed activities of the Project at the San Francisco City waterfront Pier 31.5, and at the NPS Fort Baker Pier 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 Project's January 2015 Draft EIS, the Project's January 2017 Final EIS, and NPS's March 2017, submittal of additional information requested by NMFS for ESA section 7 consultation for the Project.

Information was also provided in email messages and telephone conversations between December 2016 and August 2017 between NPS and NMFS staff. 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 in Santa Rosa, California (Administrative Record Number 151422WCR2016SR00369).

2.2 Rangewide Status of the Species and Critical Habitat

This opinion examines the status of each species that would be adversely affected by the proposed action. The status is determined by the level of extinction risk that the listed species face, based on parameters considered in documents such as recovery plans, status reviews, and listing decisions. This informs the description of the species' likelihood of both survival and recovery. The species status section also helps to inform the description of the species' current "reproduction, numbers, or distribution" as described in 50 CFR 402.02. The opinion also examines the condition of critical habitat throughout the designated area, evaluates the conservation value of the various watersheds and coastal and marine environments that make up the designated area, and discusses the current function of the essential PBFs that help to form that conservation value.

2.2.1 Species Description, Life History and Status

This opinion analyzes the effects of the proposed NPS Alcatraz Ferry Embarkation project activities at Pier 31.5 located on the City of San Francisco waterfront, and at the NPS Fort Baker Pier located within Horseshoe Cove along the Marin County shore of San Francisco Bay on the Southern DPS of North American green sturgeon and their designated critical habitat.

2.2.1.1. Green Sturgeon General Life History

Green sturgeon is an anadromous, long-lived, and bottom-oriented fish species in the family Acipenseridae. Sturgeon have skeletons composed mostly of cartilage and lack scales, instead possessing five rows of characteristic bony plates on their body called "scutes." On the underside of their flattened snouts are sensory barbels and a siphon-shaped, protrusible, toothless mouth. Large adults may exceed 6 feet (2 meters (m)) in length and 100 kilograms in weight (Moyle 1976). Based on genetic analyses and spawning site fidelity, NMFS determined that North American green sturgeon are comprised of at least two DPSs: a northern DPS consisting of populations originating from coastal watersheds northward of and including the Eel River ("northern DPS green sturgeon"), with spawning confirmed in the Klamath and Rogue river systems; and a Southern DPS consisting of populations originating from coastal watersheds south of the Eel River ("Southern DPS green sturgeon"), with spawning confirmed in the Sacramento River system (Adams *et al*. 2002).

Green sturgeon are the most marine-oriented species of sturgeon (Moyle 2002). Along the West Coast of North America, they range in nearshore waters from Mexico to the Bering Sea (Adams *et al*. 2002), with a general tendency to head north after their out-migration from freshwater (Lindley *et al*. 2011). While in the ocean, archival tagging indicates that green sturgeon occur in waters between 0 and 650 foot depths, but spend most of their time in waters between 65-260 feet (20–80 m), and temperatures of 9.5–16.0°C (Huff *et al*. 2011, Nelson *et al*. 2010). Subadult and adult green sturgeon move between coastal waters and estuaries, but relatively little is known about how green sturgeon use these habitats (Lindley *et al*. 2011). Lindley *et al*. (2011) report multiple rivers and estuaries are visited by aggregations of green sturgeon in summer months, and larger estuaries (*e.g.*, San Francisco Bay) appear to be particularly important habitat. During the winter months, green sturgeon generally reside in the coastal ocean. Areas north of Vancouver Island are favored overwintering areas, with Queen Charlotte Sound and Hecate Strait likely destinations based on detections of acoustically-tagged green sturgeon (Lindley *et al*. 2008, Nelson *et al*. 2010).

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

Adult Southern DPS green sturgeon spawn in the Sacramento River watershed during the spring and early summer months (Moyle *et al*. 1995). Eggs are laid in turbulent areas on the river bottom and settle into the interstitial spaces between cobble and gravel (Adams *et al*. 2007). Like salmonids, green sturgeon require cool water temperatures for egg and larval development, with optimal temperatures ranging from 11 to 17˚C (Van Eenennaam *et al*. 2006). Eggs hatch after 6–8 days, and larval feeding begins 10–15 days post-hatch. Metamorphosis of larvae into juveniles typically occurs after a minimum of 45 days (post-hatch) when fish have reached 2-inches (60–80 millimeters (mm)) total length (TL). After hatching, larvae migrate downstream and metamorphose into juveniles. Juveniles spend their first few years in the Sacramento-San Joaquin Delta (Delta) and San Francisco Estuary before entering the marine environment as subadults. Juvenile green sturgeon salvaged at the State and Federal water export facilities in the southern Delta are generally between 200 mm and 400 mm TL (Adams *et al*. 2002), which suggests Southern DPS green sturgeon spend several months to a year rearing in freshwater before entering the Delta and San Francisco Estuary. Laboratory studies conducted by Allen and Cech (2007) indicated juveniles approximately 6-months old were tolerant of saltwater, but approximately 1.5-year old green sturgeon appeared more capable of successful osmoregulation in salt water.

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

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

Green sturgeon feed on benthic invertebrates and fish (Adams *et al*. 2002). Radtke (1966) analyzed stomach contents of juvenile green sturgeon captured in the Sacramento-San Joaquin Delta and found the majority of their diet was benthic invertebrates, such as mysid shrimp and amphipods (*Corophium* spp). Manual tracking of acoustically-tagged green sturgeon in the San Francisco Bay estuary indicates they are generally bottom-oriented, but make occasional forays to surface waters, perhaps to assist their movement (Kelly *et al*. 2007). Dumbauld *et al*. (2008) report that immature green sturgeon found in Willapa Bay, Grays Harbor, and the Columbia River Estuary, fed on a diet consisting primarily of benthic prey and fish common to these estuaries (*e.g.*, ghost shrimp, crab, and crangonid shrimp), with burrowing thalassinid shrimp representing a significant proportion of the sturgeon diet. Dumbauld *et al*. (2008) observed feeding pits (depressions in the substrate believed to be formed when green sturgeon feed) in soft-bottom intertidal areas where green sturgeon are believed to spend a substantial amount foraging time.

2.2.1.2 Status of Southern DPS Green Sturgeon and Critical Habitat

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

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

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

During the spring and summer spawning period, researchers with University of California Davis have utilized dual-frequency identification sonar (*i.e*., DIDSON) to count adult green sturgeon in the upper Sacramento River. These surveys estimated 175 to 250 sturgeon (±50) in the mainstem Sacramento River during the 2010 and 2011 spawning seasons (Mora, personal communication, January 2012).[2] However, it is important to note that this estimate may include some white sturgeon, and movements of individuals in and out of the survey area confound these estimates. Given these uncertainties, caution must be taken in using these estimates to infer the spawning run size for the Sacramento River until further analyses are completed.

The NMFS status review completed in 2005 concluded the Southern DPS green sturgeon is likely to become endangered in the foreseeable future due to the substantial loss of spawning

[2] January 10, 2012, telephone conversation between Ethan Mora (University of California, Davis) and Susan Wang (NMFS), regarding estimates of green sturgeon abundance in Southern DPS rivers in 2010 and 2011.

habitat, the concentration of a single spawning population in one section of the Sacramento River, and multiple other risks to the species such as stream flow management, degraded water quality, and introduced species (NMFS 2005). Based on this information, the Southern DPS green sturgeon was listed as threatened on April 7, 2006 (71 FR 17757). The most recent status review was completed by NMFS in 2015. This review concluded the DPS remains likely to become endangered in the foreseeable future and NMFS affirmed no change to the determination that the Southern DPS of green sturgeon is a threatened species (NMFS 2015).

Critical habitat was designated for the Southern DPS of green sturgeon on October 9, 2009 (74 FR 52300), and includes coastal marine waters within 60 fathoms depth from Monterey Bay, California to Cape Flattery, Washington, including the Strait of Juan de Fuca to its United States boundary. Designated critical habitat also includes the Sacramento River, lower Feather River, lower Yuba River, Sacramento-San Joaquin Delta, Suisun Bay, San Pablo Bay, and San Francisco Bay in California. PBFs of designated critical habitat in estuarine areas are food resources, water flow, water quality, migration corridor, depth, and sediment quality. In freshwater riverine systems, PBFs of green sturgeon critical habitat are food resources, substrate type or size, water flow, water quality, migratory corridor, depth, and sediment quality. In nearshore coastal marine areas, PBFs are migratory corridor, water quality, and food resources.

The current condition of critical habitat for the Southern DPS of green sturgeon is degraded over its historical conditions. It does not provide the full extent of conservation values necessary for the recovery of the species, particularly in the upstream riverine habitat of the Sacramento River. In the Sacramento River, migration corridor and water flow PCEs have been impacted by human actions, substantially altering the historical river characteristics in which the Southern DPS of green sturgeon evolved. In addition, the alterations to the Sacramento-San Joaquin River Delta may have a particularly strong impact on the survival and recruitment of juvenile green sturgeon due to their protracted rearing time in brackish and estuarine waters.

2.2.2 Factors Responsible for Green Sturgeon Stock Declines

NMFS cites many reasons (primarily anthropogenic) for the decline of the Southern DPS of green sturgeon (Adams *et al*. 2002, NMFS 2005). The foremost reason for the decline is the degradation and/or destruction of freshwater and estuarine habitat. Additional factors contributing to the decline of this population include: commercial and recreational harvest, natural stochastic events, marine mammal predation, reduced marine-derived nutrient transport, ocean conditions, and global climate change. The NMFS 2015 five-year status review found that evaluation of new information since the previous status review does not suggest a significant change in the status of Southern DPS green sturgeon and, with respect to threats, the available information indicates that some threats, such as those posed by fisheries and impassable barriers, have been reduced (NMFS 2015).

2.2.2.1 Habitat Degradation and Destruction

The best scientific information presently available demonstrates a multitude of factors, past and present, have contributed to the decline of green sturgeon by reducing and degrading habitat by adversely affecting essential habitat features. Most of this habitat loss and degradation has resulted from anthropogenic watershed disturbances (Adams *et al*. 2002). A significant conservation measure implemented in California is the change in operations of the Red Bluff Diversion Dam (RBDD) (now open from mid-September to mid-May) to allow access to spawning areas above the dam. Originally, RBDD was closed year around and was a significant barrier for green sturgeon to access spawning areas upstream of the dam.

2.2.2.2 Commercial and Recreational Harvest

Until recently, commercial and recreational harvest of Southern DPS green sturgeon was allowed under State and Federal law. Since 2006, the threat posed by commercial and recreational fishing has decreased given that intentional lethal take of green sturgeon has been prohibited through fishing regulations (NMFS 2015). However, Southern DPS green sturgeon may be incidentally encountered, though not retained, in the recreational white sturgeon fishery in California. This reduction in harvest is expected to allow green sturgeon population abundance to increase. Given their highly migratory nature, adult Southern DPS green sturgeon may be encountered in commercial and recreational fishing activities in Oregon, Washington, and British Columbia. Regulations in California, Oregon and Washington prohibit retention of green sturgeon and these regulations pertain to the range of both Southern and Northern DPS green sturgeon. Lethal take still occurs as a result of by-catch mortality associated with the California halibut bottom trawl fishery and incidental catch of green sturgeon occurs in the west coast Pacific Groundfish fisheries. The impact of by-catch in these fisheries on the overall population abundance of the Southern DPS is still unknown (NMFS 2015).

2.2.2.3 Natural Stochastic Events

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

2.2.2.4 Global Climate Change

One factor affecting the range wide status of threatened Southern DPS of North American green sturgeon is climate change. Impacts from global climate change are already occurring in California. For example, average annual air temperatures, heat extremes, and sea level have all increased in California over the last century (Kadir *et al.* 2013). Snow melt from the Sierra Nevada has declined (Kadir *et al.* 2013). However, total annual precipitation amounts have shown no discernable change (Kadir *et al.* 2013). Green sturgeon may have already experienced some detrimental impacts from climate change. NMFS believes the impacts on listed species to date are likely fairly minor because natural, and local climate factors likely still drive most of the climate conditions species experience, and many of these factors have much less influence on green sturgeon abundance and distribution than human disturbance across the landscape.

The threat to listed green sturgeon from global climate change will increase in the future. Modeling of climate change impacts in California suggests that average summer air temperatures are expected to continue to increase (Lindley *et al.* 2007, Moser *et al.* 2012). Heat waves are expected to occur more often, and heat wave temperatures are likely to be higher (Hayhoe *et al.* 2004, Moser *et al.* 2012, Kadir *et al.* 2013). Total precipitation in California may decline; and critically dry years may increase (Lindley *et al.* 2007, Schneider 2007, Moser *et al.* 2012).

In the San Francisco Bay region, warm temperatures generally occur in July and August, but as climate change takes hold, the occurrences of these events will likely begin in June and could continue to occur in September (Cayan *et al.* 2012). Climate simulation models project that the San Francisco region will maintain its Mediterranean climate regime, but experience a higher degree of variability of annual precipitation during the next 50 years, and years that are drier than the historical annual average during the middle and end of the twenty-first century. The greatest reduction in precipitation is projected to occur in March and April, with the core winter months remaining relatively unchanged (Cayan *et al.* 2012).

Estuaries may also experience changes detrimental to green sturgeon. Estuarine productivity is likely to change based on changes in freshwater flows, nutrient cycling, and sediment amounts (Scavia *et al.* 2002, Ruggiero *et al.* 2010). In marine environments, ecosystems and habitats important to sturgeon are likely to experience changes in temperatures, circulation, water chemistry, and food supplies (Brewer and Barry 2008, Feely *et al*. 2004, Osgood 2008, Turley 2008, Abdul-Aziz *et al*. 2011, Doney *et al*. 2012). The projections described above are for the mid to late 21st century. In shorter time frames, climate conditions not caused by the human addition of carbon dioxide to the atmosphere are more likely to predominate (Cox and Stephenson 2007, Smith *et al.* 2007, Santer *et al.* 2011).

2.3 Action Area

"Action area" means all areas to be affected directly or indirectly by the Federal action and not merely the immediate area involved in the action (50 CFR 402.02). The action area for this project is comprised of component parts that are geographically separate from each other: one at Pier 31.5 on the City of San Francisco waterfront and another at the Fort Baker Pier within Horseshoe Cove in the County of Marin, California. The action area for the proposed Project is analyzed to extend the maximum distance which pile driving sounds may potentially affect fish behavior. For both the Pier 31.5 and Fort Baker sites, the largest steel pile diameter proposed for installation by impact hammer is 36 inches. Thus, for the two component parts of the action area, that maximum distance where pile driving sound transmission may affect fish behavior during the driving of the 36-inch diameter steel piles is a distance calculated as 1585 meters from where the pile driving will occur. This distance from the pile driving sites includes all areas that may be directly or indirectly affected by the Project, including the maximum area that could be affected by elevated underwater sound levels during pile driving. For both the Fort Baker site and the Pier 31.5 site, the action area extends a significant distance into the adjacent San Francisco Bay. However, the enclosing confines of the waterfront at Piers 31 and 33, and of the shoreline of Horseshoe Cove at the Fort Baker site limit that extended distance to a small arc of less than 45 degrees, and extending 1585 meters from the pile driving location. (Figures 3 and 4).

Figure 3. Action Area extent at the Pier 31.5 Project site (~ approximately 405 acres) is the open water arc inside the purple lines (non-hatched area) within which behavioral effects may occur to fish resulting from pile driving sounds. The area within the yellow circle (~approximately 32 acres) is the zone of potential barotrauma injuries to fish resulting from cumulative sound exposure levels (cSEL) generated by pile driving over a full day.

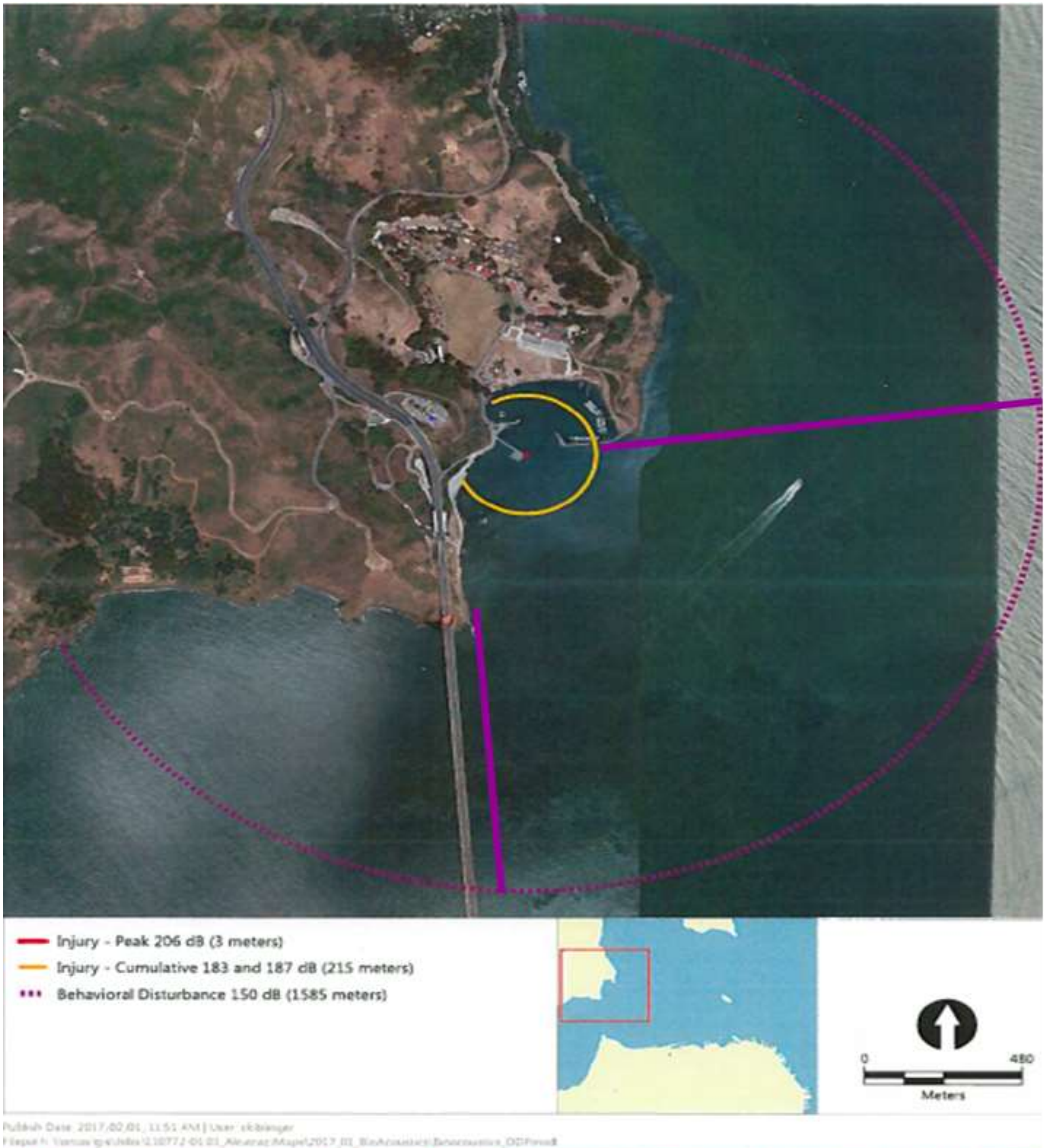

Figure 4. Action Area extent at the Fort Baker Project site (approximately 580 acres) is the open water arc inside the purple lines, which is the area of potential behavioral effects on fish resulting from pile driving sounds generated from drivng four 36-inch diameter piles. The area within the yellow circle (approximately 36 acres) is the zone of potential barotrauma injuries to fish resulting from cSEL generated over a full day of pile driving.

2.4 Environmental Baseline

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

2.4.1. Action Area Overview

The two components of the Project action area are located within San Francisco Bay at: 1) the San Francisco City waterfront at Pier 31.5 at the juncture of the South San Francisco Bay with the Central San Francisco Bay; and 2) at the NPS Fort Baker Pier within and extending from Horseshoe Cove near the entrance to San Francisco Bay, and below the northern landing of the Golden Gate Bridge. San Francisco Bay is the largest estuary on the west coast of North America and is located about halfway up the California coast from the U.S./Mexico border; it is the natural discharge point of 40 percent of California’s freshwater outflow. The climate within the Action Area 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 within San Francisco Bay is seasonal; highest outflow occurs in winter and spring. Current and wave patterns in the action area are largely generated by the tides and wind interacting with the bottom and shoreline and breakwater configurations.

The Pier 31.5 portion of the action area also receives inputs from stormwater runoff, and wastewater from municipal and industrial sources that vary in volume depending on the location and seasonal weather patterns. The action area section near Pier 31.5 consists of a densely developed City of San Francisco waterfront area, and nearshore and open waters of the Central and South San Francisco Bay. The Project’s proposed in-water construction activities in this part of the action area will occur in waters along and adjacent to the San Francisco waterfront from Pier 31 to Pier 33. The water depth at the Pier 31.5 construction site is generally about -35 feet at Mean Lower Low Water (MLLW). No eelgrass occurs within the Pier 31.5 section of the action area. Open water areas are likely influenced seasonally from freshwater discharge from the rivers and streams of the South San Francisco Bay. The transition zone between the upland areas to the subtidal zone primarily consists of rock rip rap, concrete rubble, and an existing deteriorated seawall. The majority of benthic aquatic habitats within the project area are soft mud and/or clay sediments.

The Fort Baker portion of the action area is located primarily within and around Horseshoe Cove on the Marin County shore near the entrance to San Francisco Bay and the northern landing of the Golden Gate Bridge, and extends into the open water of the Central San Francisco Bay near the Golden Gate. The bottom of the Fort Baker section of the action area is primarily soft mud substrates within Horseshoe Cove, and sand substrates in the open water areas of San Francisco Bay below and inland from the Golden Gate Bridge. Eelgrass beds are located in shallow water areas near shore within Horseshoe Cove, approximately 220 meters distant from where construction will occur at the NPS Fort Baker Pier. Water depths at the NPS Fort Baker Pier range from – 5 feet MLLW to -13 feet MLLW. The shoreline within Horseshoe Cove, and the transition to subtidal habitats is generally stabilized with rip-rap. The benthic community of both portions of the action area is likely comprised of a number of invertebrates associated with soft bottom habitat, including bivalves, polychaetes, and amphipods (Thompson *et al.* 2007). Development surrounding Horseshoe Cove includes the historical military site of Fort Baker, including the Fort Baker Pier.

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

2.4.2.1 Green Sturgeon

Green sturgeon are iteroparous[3], and adults pass through the San Francisco Bay estuary during spawning, and post-spawning migrations. Pre-spawn green sturgeon enter the Bay between late February and early May, as they migrate to spawning grounds in the Sacramento River (Heublein *et al*. 2009). Post-spawning adults may be present in San Francisco Bay after spawning in the Sacramento River in the spring and early summer for months prior to immigrating to the ocean. Juvenile green sturgeon move into the Delta and San Francisco Estuary early in their juvenile life history, where they may remain for 2-3 years before migrating to the ocean (Allen and Cech 2007, Kelly *et al*. 2007). Sub-adult and non-spawning adult green sturgeon utilize both ocean and estuarine environments for rearing and foraging. Due to these life-history characteristics, juvenile, sub-adult, and adult green sturgeon may be present in the two components of the action area year-round.

While surveys for green sturgeon have not been conducted in both portions of the action area, the shallow water and eelgrass along the shoreline of the Fort Baker site within Horseshoe Cove may be used as foraging habitat by green sturgeon. The Pier 31.5 portion of the action area does not appear to offer any unique habitat or foraging conditions which would attract green sturgeon to the San Francisco City waterfront. Within San Francisco Bay, green sturgeon likely prey on demersal fish (*e.g.*, sand lance [*Ammodytes hexapterus*]) and benthic invertebrates similar to those that green sturgeon are known to prey upon in estuaries of Washington and Oregon (Dumbauld *et al*. 2008). Green sturgeon are also known to be generalist feeders and may feed opportunistically on a variety of benthic species encountered. For example, the invasive overbite clam (*Corbula amurensis*) has become a common food of white sturgeon and green sturgeon in San Francisco Bay (CDFG 2002).

Based on distribution data and foraging habits of green sturgeon, NMFS assumes this species could occasionally be present in the action area to forage on benthic prey and fish commonly found in soft-bottom habitats (*e.g.*, ghost shrimp, crab, and crangonid shrimp) of the San Francisco Estuary. Although soft-bottom habitat exists in the action area, the San Francisco waterfront and Horseshoe Cove are regularly disturbed by dredging which likely has reduced the quality and quantity of benthic prey organisms available for green sturgeon foraging.

2.4.2.2 Green Sturgeon Critical Habitat

The action area for this project is located within designated critical habitat for the Southern DPS of green sturgeon. PBFs for green sturgeon in estuarine areas are: food resources, water flow, water quality, migratory corridor, water depth, and sediment quality. These PBFs for green

[3] They have multiple reproductive cycles over their lifetime.

sturgeon critical habitat in the action area are degraded. Habitat degradation in the action area is primarily due to shoreline development, shoreline stabilization, non-native invasive species, discharge and accumulation of contaminants, loss of tidal wetlands, and periodic dredging for navigation.

2.4.3 Factors Affecting the Species Environment in the Action Area

The San Francisco Bay/Delta is one of the most human-altered estuaries in the world (Knowles and Cayan 2004). Major drivers of change in the Bay that are common to many estuaries are water consumption and diversion, human modification of sediment supply, introduction of nonnative species, sewage and other pollutant inputs, and climate shifts. Responses to these drivers in the Bay include shifts in the timing and extent of freshwater inflow and salinity intrusion, decreasing turbidity, restructuring of plankton communities, nutrient enrichment and metal contamination of biota, and large-scale food web changes (Cloern and Jassby 2012).

The land, shoreline and subtidal areas of the Port of San Francisco waterfront Pier 31.5 action area have been highly modified by urban, industrial, and maritime development. The Port contains commercial and high density residential development and high use streets. The hydrology of the Pier 31.5 action area is modified as a result. Terrestrial portions of this part of the action area include large amounts of bay fill and receive water from direct precipitation in the surrounding steep neighborhood of the Telegraph Hill/Coit Tower drainage area which will flow into storm drains and into a stormwater management system. Bay water and sediment quality within the Pier 31.5 portion of the action area is thus affected by stormwater runoff, industrial activities, intensive street use and other urban influences. The Port of San Francisco is one of several Federal navigation channels within San Francisco Bay, and thus portions of the action area are typically dredged annually to a depth of -38 feet MLLW.

The Fort Baker portion of the action area within and around Horsehoe Cove is less developed than the Pier 31.5 portion. However past developments and current uses which affect the species environment include: the historical military development of Fort Baker and the Fort Baker Pier; the 80 berth Presidio Yacht Club Marina floating docks; a 260-meter long breakwater; and the US Coast Guard Station San Francisco Bay; along with stabilization of the shoreline within the cove with rip-rap and concrete rubble.

2.4.3 Previous Section 7 Consultations and Section 10 Permits in or near the Action Area

Pursuant to section 7 of the ESA, NMFS has conducted multiple interagency consultations for projects near the action area related primarily to wharf maintenance activities and dredging. The following is a brief summary of previous interagency consultations within in the Bay near the action area.

To address maintenance dredging throughout the greater San Francisco Bay, NMFS completed a programmatic consultation with the US Army Corps of Engineers (USACE) and the U.S. Environmental Protection Agency (EPA) on the Long Term Management Strategy for Disposal of Dredged Materials in the San Francisco Bay Region (LTMS). The LTMS programmatic consultation resulted in the issuance of an opinion on July 9, 2015, to the USACE and EPA

(WCR-2014-1599). The July 9, 2015, opinion concluded the LTMS program was not likely to jeopardize the continued existence of listed fish species under the jurisdiction of NMFS, or adversely modify or destroy designated critical habitat.

The Downtown San Francisco Ferry Expansion Project was a 2014 ESA section 7 formal consultation (SWR-2013-9595) by NMFS with the Federal Transit Authority (FTA), the US Coast Guard (USGS) and the USACE as action agencies, and with the San Francisco Bay Area Water Emergency Transport Authority as the non-federal Project Applicant for a proposal to authorize and fund construction of three new gates and overwater berthing facilities and supporting landside facilities at the San Francisco Ferry Terminal. The June 30, 2014, opinion concluded the project was not likely to jeopardize the continued existence of listed fish species under the jurisdiction of NMFS, or adversely modify or destroy designated critical habitat.

NMFS and the Corps completed consultation in 2016 on the replacement of a boat ramp in Horseshoe Cove by California State Parks (WCR-2016-4733). Consultation concluded with a June 2, 2016, letter from NMFS concurring with the Corps' determination that the project was not likely to adversely affect listed fish species or designated critical habitat under the jurisdiction of NMFS.

NMFS and the Corps completed consultation in 2009 on the repair of the guest dock at the Travis Marina in Horseshoe Cove (SWR-2008-4435). Consultation concluded with a September 3, 2009, letter from NMFS concurring with the Corps' determination that the project was not likely to adversely affect listed fish species or designated critical habitat under the jurisdiction of NMFS.

NMFS and the US Coast Guard completed consultation in 2008 on the repair of a fixed pier abutment at Coast Guard Station Golden Gate on Horseshoe Cove (SWR-2008-1549). Consultation concluded with a May 9, 2008, letter from NMFS concurring with the US Coast Guard's determination that the project was not likely to adversely affect listed fish species or designated critical habitat under the jurisdiction of NMFS.

Research and enhancement projects resulting from NMFS' Section 10(a)(1)(A) research and enhancement permits and section 4(d) limits or exceptions could potentially occur in the action area. Sturgeon monitoring approved under these programs includes juvenile and adult net surveys and tagging studies. In general, these activities are closely monitored and require measures to minimize take during the research activities. As of August 2017, no research or enhancement activities requiring Section 10(a)(1)(A) research and enhancement permits or section 4(d) limits have occurred in the action area.

2.4.4 Climate Change Impacts in the Action Area

Information discussed above in the Range-wide Status of the Species and Critical Habitat section of this opinion (Section 2.2) indicates that green sturgeon in the action area may have already experienced some detrimental impacts from climate change. These detrimental impacts across the action area are likely to be minor because natural and local climate factors continue to drive most of the climatic conditions green sturgeon experience. These natural factors are likely less influential on fish abundance and distribution than anthropogenic impacts across the action area. However, in the future impacts in the action area from climate change are likely to increase as air and water temperatures warm, and precipitation rates change.

2.5 Effects of the Action

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

In this opinion, our approach to determine the direct and indirect effects of the proposed action, and interrelated or interdependent activities, on Southern DPS green sturgeon was based on knowledge and review of the ecological literature and other relevant materials. We used this information to gauge the likely effects of the proposed project via an exposure and response framework that focuses on what stressors (physical, chemical, or biotic) directly or indirectly caused by the proposed action to which Southern DPS green sturgeon are likely to be exposed. Next, we evaluated the likely response of green sturgeon to these stressors in terms of changes to survival, growth, and reproduction, and changes to the ability of PBFs to support the value of critical habitat in the action area. Where data to quantitatively determine the effects of the proposed action on sturgeon and their critical habitat were limited or not available, our assessment of effects focused mostly on qualitative identification of likely stressors and responses.

Approximately six months of project activities are proposed to occur at the Pier 31.5 and Fort Baker construction sites between June 1st and November 30th, and Southern DPS green sturgeon may occur in the action area during these construction periods. The project activities will not occur at both locations in the same year. The Pier 31.5 activities are expected to be completed in 2018 (or 2019) and at Fort Baker in a subsequent year. Elevated underwater sound levels from pile installation and degradation of water quality are expected to occur at each location.

2.5.1 Effects of Construction Activities on Listed Species and Critical Habitat

2.5.1.1 Overview of Pile Driving Impacts

Green sturgeon may be affected by exposure to high underwater sound pressure levels (SPLs) produced by pile driving with an impact hammer. Fish may be injured or killed when exposed to impulsive sound sources such as pile driving with impact hammers. Pathologies of fish associated with very high sound level exposure and drastic, near instantaneous changes in pressure are collectively known as *barotraumas.* These include hemorrhage and rupture of blood vessels and internal organs, including the swim bladder and kidneys. Death can be instantaneous, occur within minutes after exposure, or occur several days later. Fish can also die when exposed to lower, continuous 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 for two hours or less to continuous sound at 192 decibels (dB) root-mean-square pressure (RMS) (re: 1 micropascal [μPa]) at 400 Hertz (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.[4] 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 these sound levels.

Hearing loss in fishes can occur from exposure to high intensity sounds, which can over-stimulate the auditory system of fishes and may result in temporary threshold shifts (TTS). TTS is considered a non-injurious temporary reduction in hearing sensitivity. Physical ear injury may also occur for fish exposed to high levels or continuous sound, manifested as a loss of hair cells, located on the epithelium of the inner ear (Hastings and Popper 2005). These hair cells are capable of sustaining injury or damage that may result in a temporary decrease in hearing sensitivity. However, this type of noise-induced hearing loss in fishes is generally considered recoverable, as fish possess the ability to regenerate damaged hair cells (Lombarte *et al.* 1993, Smith *et al.* 2006). Permanent hearing loss has not been documented in fish. Even if threshold shifts in hearing do not occur, loud sounds can mask the ability of fish to hear their environment. This effect from loud sound exposure is referred to as acoustic or auditory masking. Masking generally results from an unwanted or unimportant sound impeding a fish's ability to hear sounds of interest.

Underwater sound exposures have also been shown to alter the behavior of fishes (see review by Hastings and Popper 2005). The observed behavioral changes include startle responses and increases in stress hormones. Exposure to pile driving sound pressure levels may also result in "agitation" of fishes indicated by a change in swimming behavior detected by Shin (1995) or "alarm" detected by Fewtrell (2003). Other potential changes include reduced predator awareness and reduced feeding. The potential for adverse behavioral effects will depend on a number of factors, including the sensitivity to sound, the type and duration of the sound, as well as life stages of fish that are present in the areas affected by underwater sound produced during pile driving. A fish that exhibits a startle response to a sudden loud sound 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.

In order to assess the potential effects to fish exposed to pile driving sound, a coalition of federal and state resource and transportation agencies along the West Coast, the Fisheries Hydroacoustic Working Group (FHWG), used data from a variety of sound sources and species to establish interim acoustic criteria for the onset of injury to fishes from impact pile driving exposure (FHWG 2008). Most historical research has used peak pressure to evaluate the effects on fishes from underwater sound. Current research, however, suggests that sound exposure level (SEL), a measure of the total sound energy expressed as the time-integrated, sound pressure squared, is also a relevant metric for evaluating the effects of sound on fishes. An advantage of the SEL metric is that the acoustic energy can be accumulated across multiple events and expressed as the cumulative SEL (cSEL). Therefore a dual metric criteria was established by the FHWG and includes a threshold for peak pressure (206 dB) and cSEL (187 dB for fishes 2 grams or larger

[4] Pressures will not be added to each metric for the remainder of the section: dB peak has a pressure of 1μPa, dB sound exposure level (SEL) has a pressure of $1\mu Pa^2$ sec, and a root-mean-square (RMS) dB has a pressure of 1μPa.

and 183 dB for fishes smaller than 2 grams). Injury would be expected if either threshold is exceeded. There is uncertainty as to the behavioral response of fish to underwater sound produced when driving piles in or near water. Until new information indicates otherwise, NMFS believes a 150 dB RMS threshold for behavioral responses for green sturgeon is appropriate.

Currently, there are few data available regarding effects of pile driving directly focused on green sturgeon. There is some evidence of pile driving-related underwater sound pressures resulting in mortality of white sturgeon during the construction of the Benicia-Martinez Bridge. In 2002, unattenuated piles driven with a large impact hammer at the Benicia-Martinez Bridge Project resulted in the mortality of a 24-inch white sturgeon. The piles for the bridge piers were 98-inch diameter steel piles and were driven in water ranging from 40 to 50 feet deep in the main channel of Carquinez Strait. Peak underwater sound pressure levels ranged from 227 dB, at approximately 16 feet from the pile, to 178 dB, at approximately 3,600 feet from the pile (Buehler *et al.* 2015).

2.5.1.2 Project Specific Considerations

Several site-specific conditions should be considered when conducting an assessment of the potential effects of pile driving associated with construction projects. Effects on an individual fish during pile driving are dependent on variables such as environmental conditions at the project site, specific construction techniques, and the construction schedule. A dual metric criteria of 206 dB peak SPL for any single strike and a cSEL of 187 dB are currently used by NMFS 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. Green sturgeon that may be present within the action area of this project are significantly greater than 2 grams in size.

Different types of piles (*e.g.*, wood, steel, concrete) result in different levels of underwater sound when struck with a pile driver. For the proposed Project, only steel piles will be used for construction. In the updated Compendium of Pile Driving Sound Data (Buehler *et al.* 2015), the most recent pile driving monitoring results are compiled in order to provide information regarding the potential levels of underwater sound pressure levels generated with the installation of different pile and hammer types. Several pile driving case studies conducted within the San Francisco Bay region using steel, concrete, and composite piles are included in the compendium. Impact hammers produce the highest elevated underwater sound levels, particularly when used in combination with steel cylindrical piles. Vibratory hammers produce less sound than impact hammers and are often employed as a measure to reduce the sound generated by pile driving, and in turn, the potential for adverse effects on fish (Buehler *et al.* 2015).

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. Within shallow water, the rate of attenuation is expected to be much higher, reducing the area of adverse effects as compared to deeper water. Pile driving for the proposed project will occur in water about 35 feet deep at the Pier 31.5 portion of the action area, and in 5 to 14 feet of depth in the Fort Baker section of the action area, depending on the specific location of the pile and tidal phase. Additionally, as distance from the pile increases, sound attenuation reduces sound pressure levels and the potential harmful effects to fish also decreases.

For this Project, the Applicant proposes to use only an impact hammer to install the piles due to engineering and practical considerations. However, the Applicant proposes to use a bubble curtain to attenuate underwater sound levels during installation of all the piles. Based on the use of a bubble curtain and pile sizes proposed for this Project, the assessment of acoustic impacts presented in this opinion assumes an estimated reduction of 10 dB in sound pressure. Although reductions as high as 20 dB have been measured, as a general rule, sound reductions of greater than 10 dB with attenuation systems cannot be reliably predicted (ICF Jones and Stokes and Illingworth and Rodkin, Inc. 2009).

The season and duration which pile driving occurs can influence potential impact level on fish. Some species of fish occur seasonally in San Francisco Bay and in-water construction activities can be scheduled to avoid periods when the fish species of concern is mostly likely to be present. The duration of pile driving also influences the level of risk to fish. If pile driving extends continuously for hours or days, the chance of encounters with fish in the vicinity increases, accordingly, as does the degree of impact on individual fish present. Pile driving activities for the proposed Project are expected to occur during daylight hours between July 1, and November 30, in 2018 or 2019 at Pier 31.5, and during a work window from July 1 to September 30 during a subsequent summer at Fort Baker. Pile driving with an impact hammer is expected to occur for 9 to 10 hours per day or less. At Pier 31.5, the four 24-inch diameter steel piles will take 1.5 to 2 days of pile driving to install. The eight 36-inch diameter piles will take an additional 3 to 4 days. In total, up to 60 hours of impact hammer pile driving are anticipated to be performed by the Project at Pier 31.5 over a period of four to six days. At Fort Baker, the four 30-inch diameter steel piles will take 1.5 to 2 days to drive; and the four 36-inch diameter piles an additional 1.5 to 2 days - resulting in up to four days and up to 40 hours of pile driving that will occur the Fort Baker Pier.

2.5.1.3 Assessment of Pile Driving Effects at Pier 31.5 and Fort Baker

For the purposes of this analysis we have used the maximum distances peak SPLs and accumulated SELs could travel as a reasonable worst case scenario. Elevated sound levels associated with construction of the Project will occur during the driving of the 24-inch, 30-inch and 36-inch diameter steel piles with an impact hammer (Table 1). NMFS and NPS examined hydro-acoustic monitoring results for similar sized piles and in similar conditions presented in the Compendium of Pile Driving Sound Data (Buehler *et al*. 2015) and generated estimates with a spreadsheet model to estimate peak SPLs and cSELs at various distances from the source.

Table 1. Anticipated sound levels associated with impact hammer pile driving of 36-inch; 30-inch; and 24-inch diameter steel piles with sound attenuation using a bubble curtain.

Pile type and size	Max single strike peak dB at 33 feet (10 m)	Single strike SEL at 33 feet (10 m)	Single strike RMS at 33 ft. (10 m)	Distance (m) to 206 dB peak	Distance (m) to 187 dB accumulated cSEL/pile	Maximum Number of strikes per day (3 piles)	Distance (m) to 150 dB RMS
36-inch diameter steel piles; Eight @ Pier 31.5; & Four @ Fort Baker	198	170	183	3	215	5400	1585
30-inch diameter steel piles; Four at Fort Baker	177	153	167	0	16	4500	136
24-inch diameter steel piles; Four at Pier 31.5	193	168	180	1	120	3300	1000

The potential behavioral effects of pile driving on green sturgeon are presented below.

Although the spreadsheet utilized by NMFS can predict sound pressure levels at a distance of less than 33 feet (10 m) from a pile, hydroacoustic measurements in the field generally cannot be made this close to a pile. Near-field effects of sound waves, on-site equipment, the air bubble curtain, and safety typically don't allow for hydroacoustic monitoring to be performed within a few feet of a pile. The spreadsheet model predicts the 206 dB peak single strike barotrauma threshold is exceeded within 3 meters from a driven 36-inch diameter pile, and within 1 meter from a 24-inch diameter pile driven in deep water. At these close ranges, NMFS believes it is very unlikely that a green sturgeon will be present due the placement of an air bubble curtain system which will occupy several feet of the radial distance immediately outward from the pile. Thus, sound pressure levels created by a single strike are not expected to result in the injury or mortality of green sturgeon (the 30-inch diameter piles driven in shallow water are not anticipated to produce single strike peak sound levels of 206 dB).

Although sound levels associated with the single strike of an impact hammer on a 24-inch, 30-inch, and 36-inch diameter piles will not cause injury or mortality, cumulative SEL has the potential to result in injury or mortality of green sturgeon during impact hammer pile driving by the Project. The spreadsheet model predicts the extent of SPLs above an accumulated SEL (cSEL) of 187 dB for the 36-inch diameter piles would extend up to a radial distance of approximately 215 meters from the pile. For impact hammer driving of 24-inch diameter piles, the radius of potential for barotrauma resulting from cSEL is calculated as 120 meters, and for the 30-inch diameter piles driven in shallow water, 16 meters is the estimated radius. For the purposes of this analysis, the zone of potential injury or mortality to threatened green sturgeon is associated with accumulated SEL and is defined as the area in which fish could experience a range of barotraumas, including damage to the inner ear, eyes, blood, nervous system, kidney, and liver. These injuries have the potential to result in the mortality of an individual fish either immediately or later in time.

Depending on the time of year, green sturgeon may be commonly found within San Pablo Bay, to the north and east of the project sites of the action area, as indicated by the results of acoustic tag monitoring conducted by the California Fish Tagging Consortium. Tag monitoring results reported by Hearn *et al.* (2010) indicates that most adult green sturgeon that are detected in the summer and fall occur from the Golden Gate and up to the Carquinez Bridge. Of 47 tagged adult green sturgeon monitored between May 2009 and August 2010, two individuals were detected at near the Bay Bridge, about 1.4 miles south of the Pier 31.5 action area. Fish were not generally detected at marina tag detection sites, with the exception of at the Martinez Marina in Suisun Channel, where 33 fish were detected. Those fish that were detected at marina sites were typically only present for less than a couple of hours, with the exception of one individual which remained within range of the Vallejo Marina receiver for two days. This information suggests that a low proportion of adult green sturgeon occur in this Project's action area, and those that do occur, likely only reside in the action area for minutes to a couple of hours. To date, tagging studies provide little information on juvenile green sturgeon distribution and behavior, but sampling has indicated juveniles mostly occur in small groups in the Bay/Delta region (Adams *et al.* 2002, Hearn *et al.* 2010) and are unlikely to occur in more than small numbers and for only brief periods in the action area. The two sites within the action area of this Project do provide sites with soft bottom substrate suitable for green sturgeon foraging, and the Fort Baker action area within Horseshoe Cove supports eelgrass beds. However the eelgrass beds therein are at a distance of 220 meters from the Fort Baker Pier construction site, thus outside of the maximum 215 meter radius of potential barotrauma resulting from accumulated SEL generated during driving of multiple 36-inch diameter piles.[5]

Based on the foraging behavior and movements of green sturgeon within San Francisco Bay, some individuals may be subjected to elevated sound levels during pile driving activities at the Pier 31.5 and Fort Baker project sites. However, NMFS estimates that only a very small number of threatened Southern DPS green sturgeon may potentially be injured or killed by the proposed pile driving because few individuals are likely to be exposed to an accumulated SEL of 187 dB or greater. To incur injury or mortality, an individual fish would need to remain continuously within the zone of accumulated SEL for an extended period of time during use of an impact pile driving hammer. During pile driving for this Project, for barotrauma to occur, a green sturgeon

[5] The radius of the potential barotrauma zone at 215 meters resulting from accumulated SEL is based on driving of three 36-inch diameter steel piles in a single day, and requiring 1800 impact hammer strikes for each pile. Driving a single pile in a day would result in a radius of potential barotrauma of 109 meters. Driving two 36- inch diameter piles in a day, the radius would be 173 meters.

would need to remain within 215 meters of the 36-inch diameter piles for the full day of pile driving three piles (5400 strikes total); within 120 meters of the piles for a full day of driving three 24-inch diameter piles (3300 strikes), and within 16 meters of the piles for a full day of driving three 30-inch diameter piles (4500 strikes). Fish at lesser distances from the piles could be subjected to barotrauma effects in a shorter period than the full 9 hour day (*e.g.*, at a distance within 109 meters of driving the 36-inch diameter piles, a fish would be exposed to sufficient accumulated SEL to cause barotrauma after the driving of a single pile needing 1800 strikes over an estimated 3 hour period.)

Within the zone of accumulated SEL of >187 dB within the action area, most sturgeon exposed to elevated SPLs are unlikely to remain within the radius of cSEL > 187dB for sufficient time to experience barotrauma due to tidal currents and behavioral movements. Thus, few sturgeon are expected to remain stationary long enough to accumulate SEL to levels which cause injury or mortality. Although no data are available to quantify the risk of exposure to the accumulated SEL threshold of >187 dB, NMFS believes that, for the reasons stated herein, the potential risk of injury and mortality to green sturgeon is low. Any sturgeon within the action area are expected to temporarily disperse with this intrusion of elevated SPLs, or move along naturally due to tidal currents and behavioral patterns. The 36-acre and 38-acre zones of potential physical injury during pile driving are relatively small in comparison to the size of Central San Francisco Bay. Thus, the likelihood of an individual green sturgeon's presence in the area subject to exceedance of the cumulative SEL of >187 dB is low; and the likelihood of injury or mortality is proportional to the low likelihood of presence for extended periods.

Beyond the zone of potential injury or mortality, elevated sound levels may result in disturbance and behavioral effects during impact hammer pile driving. During use of the impact hammer, sound levels are projected to exceed 150 dB RMS to a maximum distance of 1585 meters at both portions of the action area during driving of the 36-inch diameter piles. Fish may demonstrate temporary abnormal behavior within this zone during pile driving indicative of stress or exhibit a startle response. A fish that exhibits a startle response may not be injured, but is exhibiting behavior that suggests it perceives a stimulus indicating potential danger in its immediate environment. The maximum behavioral impact zone is approximately 425 acres for the Pier 31.5 portion, and 580 acres for the Fort Baker portion of the action area when the 36-inch diameter piles are being driven. The behavioral impact zone will be proportionally smaller during the driving of the smaller 24- and 30-inch diameter piles. This behavioral impact zone will be present at one or the other of the two sites of the action area during the approximately eight to ten days of pile driving that is the expected total number of days of pile driving for the two parts of the action area over a period of two years.

If any green sturgeon enter or transit the behavior impact zone described above during pile driving, there could be behavioral reactions. Green sturgeon may avoid the area due to the elevated underwater sound levels. As noted above, many fish species demonstrate an avoidance reaction in the near-field (Dolat 1997). While behavioral impacts to green sturgeon during pile driving have not been specifically studied, NMFS anticipates that green sturgeon, like other fish studied, will exhibit startle and avoidance behavioral reactions. Due to the availability of estuarine habitat directly adjacent to the action area at both locations, and anticipated behavioral responses, green sturgeon are expected to react to the sound produced by pile driving by swimming away from the action area. Adequate water depths and the open water area of Central San Francisco Bay adjacent to the action area will provide startled fish sufficient area to escape, and elevated sound levels should not result in significant effects on these individuals. Areas adjacent to the Project's action area provide habitat of similar or higher quality and provide adequate carrying capacity to support individual sturgeon that are temporarily displaced during pile driving by the Project.

2.5.1.4 Assessment of Effects on Water Quality

Water quality in the action area may be degraded during the Project's construction activities. Disturbance of soft bottom sediments during the installation of new piles is expected to result in temporary increased levels of turbidity. Additionally, water quality may be degraded through the suspension of sediment-associated contaminants in the water column. The effects of elevated levels of turbidity and suspension of contaminants on green sturgeon as a result of pile installation activities are presented below.

Turbidity

High levels of turbidity may affect fish by disrupting normal feeding behavior, reducing growth rates, increasing stress levels, and reducing respiratory functions (Benfield and Minello 1996, Nightingale and Simenstad 2001). There is little direct information available to assess the effects of turbidity in San Francisco Bay estuary on juvenile or adult green sturgeon. However, this benthic species is well adapted to living in estuaries with a fine sediment bottom and is tolerant of high levels of turbidity, because they have adapted to forage for prey organisms in soft bottom sediments.

As piles are driven into the substrate by the Project, fine-grain sediments such as the clay and silt material found under and along the Pier 31.5 and Fort Baker piers will be disturbed and generate increased levels of turbidity in the adjacent water column. The extent of turbidity plumes resulting from the Project construction will depend on the tide, currents, and wind conditions during pile driving activities. Based on observations of similar pile installation activities in San Francisco Bay, increased levels of suspended sediment and turbidity during pile driving by the Project are anticipated to be minor, localized, and short-term. With strong tidal currents in the action area, any elevated levels of suspended sediment or turbidity are anticipated to rapidly return to background levels after work ceases.

Based on the above, the extent and levels of turbidity associated with construction activities by the Project are not expected to result in harm or injury, or behavioral responses that impair migration, foraging, or make green sturgeon more susceptible to predation. If sturgeon temporarily relocate from areas of increased turbidity, habitat of similar value is available in Central San Francisco Bay adjacent to the action area, and other areas in San Francisco Bay offer equal or better habitat value for displaced individuals. Adjacent habitat areas also provide adequate carrying capacity to support individual sturgeon that are temporarily displaced during in-water construction activities that cause increases in turbidity. For these reasons, the potential effects of minor and localized areas of elevated turbidity associated with this Project's construction activities are expected to be negligible to green sturgeon.

Contaminants

As described above in the Environmental Baseline, water and sediment quality within the action area are affected by stormwater runoff, industrial activities, and urban influences. Dillon and Moore (1990) (citing Luoma and Phillips 1988) 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. Environmental contaminants discharged into aqueous systems tend to associate with particulate material in the water column and with consolidated bedded sediments. However, since the U.S. Environmental Protection Agency started the National Pollutant Discharge Elimination System in 1972, water quality in San Francisco Bay has improved considerably.

During the installation of piles, bottom sediments will be suspended and contaminants may be released to the water column. However, based on the project description (including the type of activities conducted, the work span, and equipment used) the suspended plumes of sediment and potential contaminants released during construction are expected to be localized and the concentration is expected to diminish quickly. Any minor and localized elevations in contaminants which might result from those suspended plumes are expected to be quickly diluted by tidal circulation to levels that are unlikely to adversely affect green sturgeon.

Equipment refueling, fluid leakage, equipment maintenance, and construction activities near open waters pose some risk of contamination of aquatic habitat and subsequent injury or death to green sturgeon. Oils and similar substances from construction equipment can contain a wide variety of PAHs and metals. Both can result in adverse impacts to green sturgeon. The Project will have in place a spill and prevention plan which is designed to avoid contamination from equipment refueling, leakage, maintenance or other activities. NMFS anticipates the Project's proposed measures to prevent contamination will adequately protect water quality and avoid adverse effects by contaminants on green sturgeon.

2.5.1.5 Assessment of Effects on Critical Habitat

The action area is designated as critical habitat for Southern DPS green sturgeon and Project implementation is anticipated to impact designated critical habitat. Construction activities are expected to temporarily alter water quality and foraging habitat for green sturgeon designated critical habitat.

Water Quality

The effects of Project construction activities on water quality are discussed above in section 2.5.1.4, Assessment of Effects on Water Quality, of this opinion and also apply to designated critical habitat in the action area. As described above, the effects of the proposed Project may result in increased levels of turbidity and the suspension of sediment-associated contaminants. The impacts on water quality from turbidity and contaminants are not expected to degrade PBFs of green sturgeon because the level of potential contaminant exposure is low and elevated turbidity is expected to be short-term, minor, and localized.

Disturbance of the Benthic Community

The Project's installation of pilings will disturb bottom sediments and disturb the associated benthic community in the action area. Benthic invertebrates that are directly in the footprint of the twenty new piles may be injured or killed. Although information on green sturgeon foraging behavior and their prey organisms in the San Francisco Estuary is limited, it is known that green sturgeon prey on demersal fish and benthic invertebrates in estuaries. Radtke (1966) analyzed stomach contents of juvenile green sturgeon captured in the Sacramento-San Joaquin Delta and found the majority of their diet was benthic invertebrates, such as mysid shrimp and amphipods (*e.g., Corophium* spp).

Pile driving during this Project is expected to remove some prey organisms for green sturgeon and foraging by sturgeon in the action area may be temporarily affected. However, the extent of impacts to the benthic community is expected to be small due to the very small area affected by an individual pile, the small number of Project piles, and water depth at the Pier 31.5 where twelve of the twenty piles will be installed.

Due to several factors, NMFS does not expect the temporary reduction of benthic prey in the action area will prevent sturgeon from finding suitable forage at the quantities and quality necessary for normal behavior (*e.g.*, maintenance, growth, reproduction). First, the area of benthic disturbance due to new permanent pile installation is a very small portion of the action area (total of 117 square feet) and, except for the eight piles at Fort Baker, all are located in relatively deep water. Sturgeon typically forage in shallower waters where concentrations of their common prey organisms are higher. Secondly, many benthic organisms are likely to survive the disturbance associated with Project construction. Thirdly, all pile driving will occur at the existing Pier 31.5 San Francisco waterfront location and the Fort Baker Pier in Horseshoe Cove which are areas which have been highly modified by maritime development and frequent dredging. Collie *et al.* (2000) reported some aquatic invertebrates re-colonize areas within a few months of a disturbance activity and this is expected at individual sites following the completion of pile installation. Given the small portion of the action area disturbed with the driving of piles, the likely availability of forage elsewhere in the action area, and the recovery of the benthic community after disturbance, impacts to prey resource availability due to Project construction are expected to be insignificant.

Reduced Use of Action Area during Pile Driving

As described above in Section 2.5.1.3 of this opinion, elevated SPLs within the action area are expected to create a zone of behavioral impacts (*i.e.*, sound levels greater than 150 dB RMS) that may result in a level of disturbance that causes green sturgeon to avoid using the areas for foraging and migrating during pile driving. Assuming the worst case scenario, elevated sound levels result in an adverse behavioral response during pile driving, and the action area is rendered unusable by green sturgeon during hours when pile driving operations are underway. For the Project's use of an impact hammer to install the largest 36-inch diameter steel piles, the area of behavioral effects may be as large as 580 acres at the Fort Baker site and as large as 425 acres at the Pier 31.5 site and these locations may be avoided by green sturgeon for nine to ten hours a day for a total eight to ten days over a period of two years.

The action area is thought to provide foraging habitat for sturgeon because the sites include soft bottom subtidal habitat. Although pile driving will not exceed nine to ten hours on any one day, this temporal loss of foraging area could be an adverse effect on PBFs for adequate prey/food resources. During the nine to ten hour periods of pile driving over the Project's approximate eight to ten days of pile driving activities, green sturgeon may avoid foraging in portions of the action area. However, when each day's pile driving activities have concluded, the area and its food resources will again be fully accessible to green sturgeon. Due to the short net duration of pile driving episodes (*i.e.*, a total of eight to ten days occurring over a period of two different summer seasons and spread between two distant locations, separated by 4.3 miles), this temporary impact is not anticipated to prevent sturgeon from finding suitable forage at the quantities and quality necessary for normal behavior (*e.g.*, maintenance, growth, reproduction). When all of the Project's pile driving activities have been completed, NMFS does not expect any lasting reduction in habitat value related to elevated sound levels from pile driving.

Effects of Future Operations

Upon completion of the ferry berth at Fort Baker, NPS will have facilities that provide for new ferry vessel service between Alcatraz Island and Horseshoe Cove. However, the new embarkation point in Horseshoe Cove is proposed for occasional special event use only and NPS predicts a very small number of ferry vessel trips will occur annually. Ferry operations have the potential to degrade water quality through the release toxic substances into the water column and increase turbidity during vessel maneuvers. Increased vessel traffic can also result in elevated underwater sound levels and facilitate the spread invasive aquatic plant species. Due to the very small number of new ferry trips from Horseshoe Cove and no change in the ferry service at Pier 31.5, future operations at these two facilities are anticipated to result in no new impacts to Southern DPS green sturgeon or their designated critical habitat.

2.6 Cumulative Effects

"Cumulative effects" are those effects of future state or private activities, not involving Federal activities, that are reasonably certain to occur within the action area of the Federal action subject to consultation (50 CFR 402.02). Future Federal actions that are unrelated to the proposed action are not considered in this section because they require separate consultation pursuant to section 7 of the ESA.

Some continuing non-Federal activities are reasonably certain to contribute to climate effects within the action area. However, it is difficult if not impossible to distinguish between the action area's future environmental conditions caused by global climate change that are properly part of the environmental baseline *vs.* cumulative effects. Therefore, all relevant future climate-related environmental conditions in the action area are described in the environmental baseline (Section 2.4).

2.7 Integration and Synthesis

The Integration and Synthesis section is the final step in our assessment of the risk posed to species and critical habitat as a result of implementing the proposed action. In this section, we add the effects of the action (Section 2.5) to the environmental baseline (Section 2.4) and the cumulative effects (Section 2.6), taking into account the status of the species and critical habitat (Section 2.2), to formulate the agency's opinion as to whether the proposed action is likely to: (1) reduce appreciably the likelihood of both the survival and recovery of a listed species in the wild by reducing its numbers, reproduction, or distribution; or (2) appreciably diminishes the value of designated or proposed critical habitat for the conservation of the species.

Southern DPS green sturgeon have experienced serious declines in abundance and long-term population trends that suggest a negative growth rate. Human-induced factors have reduced populations and degraded habitat, which in turn has reduced the population's resilience to natural events, such as droughts, floods, and variable ocean conditions. Global climate change presents another real threat to the long-term persistence of the population, especially when combined with the current depressed population status and human caused impacts. Within the Project's action area in and adjacent to Central San Francisco Bay, the effects of shoreline development, industrialization, maritime development, and urbanization are evident. As a result, forage species that green sturgeon depend on have been reduced throughout the greater San Francisco Bay Estuary.

During construction activities at the San Francisco waterfront Pier 31.5, and at the Fort Baker Pier, water quality in the action area is expected to be degraded through the disturbance of bottom sediments as piles are installed. Elevated levels of turbidity and the suspension of sediment associated contaminants in the water column are anticipated, but are not expected to adversely affect green sturgeon.

If foraging behavior and movements of green sturgeon bring some individuals into these two locations during pile driving activities by the Project, individuals could be exposed to elevated levels of underwater sound and the effects could range from behavioral disturbance to barotrauma. Injury or mortality of individuals due to barotrauma may occur during the use of an impact hammer for pile driving. However, NMFS expects the number of green sturgeon exposed to this effect to be very small because the duration of pile driving is short (a total of eight to ten days spread over two years), the zones of physical injury/mortality are immediately adjacent to the Fort Baker Pier and the San Francisco Pier 31.5 sites and are relatively small in comparison to the size of the San Francisco Bay/Estuary, and the abundance of green sturgeon in the action area is expected to be low. To incur injury or mortality from accumulated SEL, an individual fish would need to remain continuously within 215 meters from the impact hammer during thousands of pile strikes (up to 5400 strikes over a full day of 9 to 10 hours of pile driving).

The use of a bubble curtain to attenuate generation of underwater sound levels while pile driving is projected to significantly reduce the SPLs, and the extent of area where the accumulated SEL could potentially result in barotrauma if fish remain within that zone for an extended period of time. Pile driving activities could result in noise that may startle green sturgeon and result in temporary dispersion from the action area. Behavioral effects during impact hammer pile driving may extend up to 1585 meters. If green sturgeon were to react behaviorally to the sound produced by pile driving, adequate water depths and area within the adjacent open waters of Central San Francisco Bay are expected to provide fish sufficient area to disperse. This noise may discourage green sturgeon from utilizing the action area during pile driving, but this area represents a small portion of the Central San Francisco Bay and these habitat areas will become available again once the Project's pile driving is completed.

The action area is designated critical habitat for Southern DPS green sturgeon. Critical habitat is expected to be impacted through temporary degradation of water quality and temporary impacts to foraging habitat. Water quality may be degraded through increased turbidity and suspension of sediment-borne contaminants resulting from pile driving. Foraging habitat will be temporarily affected during Project activities through elevated SPLs, physical disturbance of benthic habitat, and the associated impacts to food resources. Temporary impacts from the small areas of benthic habitat disturbed by the placement of piles are expected to recover rapidly due to the small footprint of an individual pile.

Based on the above, a very small number of green sturgeon could be adversely affected by the Project's proposed pile driving activities. However, it is unlikely that the small potential loss of individuals as a result of the Project will impact future adult returns due to the proportionally large number of green sturgeon unaffected by the Project compared to the small number of sturgeon potentially affected by the Project. Due to the life history strategy of green sturgeon that spawn 60,000 to 140,000 eggs every 3-5 years over an adult lifespan of as much as 40 years (Moyle 2002), the few individuals potentially injured or killed during pile driving are likely to be replaced in subsequent generations of green sturgeon.

Regarding future climate change effects in the action area, California could be subject to higher average summer air temperatures and lower total precipitation levels. Reductions in the amount of snowfall and rainfall would reduce stream flow levels in Northern and Central Coastal rivers. Estuaries may also experience changes in productivity due to changes in freshwater flows, nutrient cycling, and sediment amounts. For this Project, in-water activities will occur in 2018 or 2019 at the Pier 31.5 site, and during a subsequent summer at the Fort Baker site, and the above effects of climate change are not likely to be detected within that time frame. If the effects of climate change are detected, they will likely materialize as moderate changes to the current climate conditions within the action area. These changes may place further stress on green sturgeon populations. The effects of the proposed action combined with moderate climate change effects may result in conditions similar to those produced by natural ocean-atmospheric variations (as described in the Environmental Baseline) and annual variations. The species is expected to persist throughout these phenomena, as they have in the past, even when concurrently exposed to the effects of similar projects.

2.8 Conclusion

After reviewing and analyzing the current status of the listed species and critical habitat, the environmental baseline within the action area, the effects of the proposed action, any effects of interrelated and interdependent activities, and cumulative effects, it is NMFS' opinion that the

NPS Alcatraz Ferry Embarkation Project is not likely to jeopardize the continued existence of threatened Southern DPS of American green sturgeon or destroy or adversely modify its designated critical habitat.

2.9 Incidental Take Statement

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

<u>2.9.1 Amount or Extent of Take</u>

In the opinion, NMFS concludes that incidental take is reasonably certain to occur as follows: NMFS anticipates that the take of threatened green sturgeon associated with NPS Alcatraz Ferry Embarkation Project at Pier 31.5 on the San Francisco waterfront and at Fort Baker in Horseshoe Cove in Marin County, California will be in the form of injury or mortality to green sturgeon caused by impact hammer pile driving over a period of up to ten days spread over two years.

Due to the relatively small area of potential effect and its location under water with low visibility, NMFS is not able to estimate the specific number of green sturgeon that may be present in the action area during the proposed action. Monitoring or measuring the number of listed fish actually injured or killed by elevated sound pressure levels during pile driving is also not feasible. Observation of injured or killed fish is unlikely because they may not float to the surface or may be carried away by the strong currents in and near the action area into the larger portions of Central San Francisco Bay. Due to the difficulty in quantifying the number of listed green sturgeon that could be affected by pile driving, a surrogate measure of take is necessary to establish a limit to the take exempted by this incidental take statement. For this action, compliance with the expected elevated underwater sound levels during pile driving is the best surrogate measure for incidental take associated with Project implementation. Therefore, NMFS will consider the extent of take exceeded if monitoring of elevated sound levels during pile driving indicates that accumulated sound exposure levels (cSEL) greater than 187 dB SEL extend beyond 215 meters during the installation of the twelve largest piles, the 36-inch diameter steel piles. This distance represents the maximum area where, if present for an extended period of several hours to a full day, green sturgeon injury or death is reasonably certain during impact hammer pile driving by this Project.

2.9.2 Effect of the Take

In the opinion, NMFS determined that the amount or extent of anticipated take, coupled with other effects of the proposed action, is not likely to result in jeopardy to the Southern DPS of American green sturgeon or destruction or adverse modification of critical habitat.

2.9.3 Reasonable and Prudent Measures

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

NMFS believes the following reasonable and prudent measures are necessary and appropriate to minimize take of green sturgeon:

1. NPS shall contract with an experienced and qualified professional to implement the NPS proposed plan for hydroacoustic monitoring of underwater sound pressure levels generated by Project pile driving activities in order to adequately evaluate the Project's effects on green sturgeon.

2. NPS shall ensure the Project's bubble curtain system is properly operated during all pile driving activities to maximize sound attenuation.

3. NPS shall prepare and submit reports regarding the two phases of construction of the Project at the two Project locations (at Pier 31.5 in San Francisco; and at Fort Baker Pier) and the results of the hydroacoustic monitoring program at each location.

2.9.4 Terms and Conditions

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

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

    a. At least four weeks prior to the initiation of construction, NPS shall submit to NMFS for review and approval a Statement of Qualifications for the contractor selected to carry out the proposed hydroacoustic monitoring plan.

    b. The NPS shall make available to NMFS data from the hydroacoustic monitoring program on a real-time basis (*i.e.*, daily monitoring data should be accessible to NMFS upon request).

c. The NPS and its contractors shall allow any NMFS employee(s) or any other person(s) designated by NMFS to accompany field personnel to visit the project site during the activities described in this opinion.

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

   a. A designated monitor shall be on-site daily while impact hammer pile driving is taking place to ensure that the bubble curtain system is operating efficiently. The NPS or its contractors shall be prepared to maintain and repair the bubble curtain system if the system is not functioning properly and fully.

   b. No pile driving will occur at times when the bubble curtain system is not functioning properly and fully.

3. The following terms and conditions implement reasonable and prudent measure 3:

   a. NPS shall provide a written report to NMFS within 120 days of the completion of each of the two phases of the Project (at Pier 31.5; and at Fort Baker Pier). The reports shall be submitted to NMFS North Central Coast Office, Attention: San Francisco Bay Branch Supervisor, 777 Sonoma Avenue, Room 325, Santa Rosa, California, 95404-6528. The reports must contain, at a minimum, the following information:

      i. Project related activities – The dates pile installation occurred and a description of any and all measures taken to minimize effects on green sturgeon (*e.g*., utilization of bubble curtain or wood or plastic pile driving cushion blocks).

      ii. Bubble curtain monitoring – a description of the methods used to monitor the functioning of the bubble curtain; a description of any events during which the bubble curtain was not functioning properly and fully, including times of excessive water currents; and a description of methods used to maintain or repair the bubble curtain, if undertaken.

      iii. Hydroacoustic monitoring – a description of the methods used to monitor underwater sound levels during impact hammer use; the locations (depths and distances of hydrophones placements from point of impact) where monitoring was conducted; the total number of pile strikes per pile; total number of strikes per day; the interval between strikes; the peak/SPL, RMS and SEL per strike; and accumulated SEL (cSEL) per day, and the radial extent of cSEL greater than 187 dB calculated for each of the three pile sizes installed with impact hammer (24, 30, and 36-inch diameter piles).

2.10 Conservation Recommendations

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

NMFS has the following conservation recommendation:

1. NPS should support the California Fish Tracking Consortium's effort to detect tagged salmonids and green sturgeon in the vicinity of Horseshoe Cove by funding the installation and maintenance of tag receiving monitors in and adjacent to the Fort Baker Pier in Horseshoe Cove. For information regarding the California Fish Tracking Consortium, see http://californiafishtracking.ucdavis.edu/.

2.11 Reinitiation of Consultation

This concludes formal consultation for the NPS Alcatraz Ferry Embarkation Project.

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

2.12 "Not Likely to Adversely Affect" Determinations

Under the ESA, "effects of the action" means the direct and indirect effects of an action on the listed species or critical habitat, together with the effects of other activities that are interrelated or interdependent with that action (50 CFR 402.02). The applicable standard to find that a proposed action is not likely to adversely affect listed species or critical habitat is that all of the effects of the action are expected to be discountable, insignificant, or completely beneficial. Discountable effects are those extremely unlikely to occur. Insignificant effects relate to the size of the impact and should never reach the scale where take occurs. Beneficial effects are contemporaneous positive effects without any adverse effects to the species or critical habitat.

NMFS does not anticipate the proposed action will adversely affect:

Sacramento River winter-run Chinook salmon (*Oncorhynchus tshawytscha*) **Evolutionarily Significant Unit (ESU)**
endangered (70 FR 37160; June 28, 2005)
critical habitat (58 FR 33212; June 16, 1993);
Central Valley spring-run Chinook salmon (*O. tshawytscha*) **ESU**
threatened (70 FR 37160; June 28, 2005);
Central California Coast steelhead (*O. mykiss*) **DPS**
threatened (71 FR 834; January 5, 2006)
critical habitat (70 FR 52488; September 2, 2005); and

California Central Valley steelhead (*O. mykiss*) **DPS**
threatened (71 FR 834; January 5, 2006).

The effects of the proposed action are reasonably likely to include elevated underwater sound levels during pile driving, temporary degradations to water quality, and habitat disturbance as described above. By restricting pile driving activities to the period between July 1st and October 1st at Fort Baker, and between July 1st and November 30th at Pier 31.5, the project avoids the primary migration seasons of adult and juvenile ESA-listed salmonids through Central San Francisco Bay, and the South Bay. Thus, NMFS anticipates ESA-listed salmonids are unlikely to be present in the action area during the Project's pile driving construction activities.

Use of an impact hammer to install steel piles is anticipated to generate elevated levels of underwater sound during construction of the Alcatraz Ferry Embarkation Project. The hydroacoustic effects of the Project's pile driving activities are described in Section 2.5.1.3 of this opinion. However, the effects on fish associated with elevated sound pressure levels only occur during the pile driving events and effects will cease when operation of the pile driving hammer is terminated. With the Project's pile driving work activities restricted to the period of July 1 through September 30th at the Fort Baker site, and July 1 through November 30th at the Pier 31.5 San Francisco waterfront site, listed salmonids will not likely be present in the action area to experience elevated underwater sound levels, and the temporary effects of pile driving will have concluded prior to the likely seasonal presence of listed anadromous salmonids in the action area.

Effects to water quality associated with Project activities are described in Section 2.5.1.4. As with elevated sound levels during pile driving, effects of degraded water quality are anticipated to cease prior to the seasonal occurrence of listed salmonids in the action area. Pile installation will likely create temporary increases in turbidity and may suspend sediment-associated contaminants into the adjacent water column. However, these effects to water quality are expected to rapidly dissipate with tidal circulation and not persist once the work is completed. With the Project's pile driving work activities restricted to the period of July 1st through September 30th at the Fort Baker site, and between July 1st and November 30th at the Pier 31.5 site, listed salmonids will not likely be present to experience degraded water quality conditions in the action area. Based on the above, the effects of the Project's construction activities on listed salmonids are anticipated to be discountable.

The action area is designated as critical habitat for CCC steelhead and Sacramento winter-run Chinook salmon. The PBFs essential for the conservation of Sacramento River winter-run Chinook salmon are: (1) access from the Pacific Ocean to appropriate areas in the upper Sacramento river, (2) availability of clean gravel for spawning substrate, (3) adequate river flows for spawning, incubation of eggs, fry development and emergence, and downstream transport of juveniles, (4) water temperatures between 42.5 and 57.5 °F (5.8 and 14.1 °C) for successful spawning, egg incubation, and fry development, (5) habitat areas and adequate prey that are not contaminated, (6) riparian habitat that provides for successful juvenile development and survival, and (7) access downstream so that juveniles can migrate from spawning grounds to San Francisco Bay and the Pacific Ocean. The PBFs of designated critical habitat for CCC steelhead include estuarine areas free of obstruction with water quality, water quantity, and salinity conditions supporting juvenile and adult physiological transitions between fresh- and saltwater; natural cover such as submerged and overhanging large wood, aquatic vegetation, large rocks and boulders, and side channels; and juvenile and adult forage, including aquatic invertebrates and fishes, supporting growth and maturation.

The Project's installation of pilings will disturb bottom sediments and the associated benthic community in a small portion of the Project's action area (approximately 117 square feet). This disturbance may injure or kill benthic organisms, some of which may be prey for listed salmonids. However, once construction activities are completed, the benthic community in disturbed areas is expected to recover rapidly due to the small footprint of each pile. Collie *et al.* (2000) reported some aquatic invertebrates re-colonize areas within a few months of a disturbance activity. In addition, salmonids are unlikely to forage at water depths of -35 to -40 feet MLLW at the pile driving locations under the San Francisco waterfront. Because of the location and small size of disturbed areas, NMFS expects that the effects of disturbance to the benthic community from this Project's pile driving will be minor and not affect foraging by listed salmonids. Based on the above, effects of benthic disturbance on foraging by listed salmonids within the action area are expected to be insignificant. For the above reasons, the potential effects of the Project are considered insignificant or discountable and are not expected to result in either a net change to existing habitat values in the action area or result in adverse impacts to designated critical habitat for listed salmonids.

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

Section 305(b) of the MSA directs Federal agencies to consult with NMFS on all actions or proposed actions that may adversely affect EFH. The MSA (section 3) defines EFH as "those waters and substrate necessary to fish for spawning, breeding, feeding, or growth to maturity." Adverse effect means any impact that reduces quality or quantity of EFH, and may include direct or indirect physical, chemical, or biological alteration of the waters or substrate and loss of (or injury to) benthic organisms, prey species and their habitat, and other ecosystem components, if such modifications reduce the quality or quantity of EFH. Adverse effects on EFH may result from actions occurring within EFH or outside of it and may include site-specific or EFH-wide impacts, including individual, cumulative, or synergistic consequences of actions (50 CFR 600.810). Section 305(b) also requires NMFS to recommend measures that can be taken by the action agency to conserve EFH.

This analysis is based, in part, on the EFH assessment provided by the NPS and descriptions of EFH for Pacific Coast Groundfish (Pacific Fishery Management Council [PFMC] 2005), Coastal Pelagic Species (PFMC 1998), and Pacific Coast Salmon (PFMC 1999) contained in the fishery management plans developed by the PFMC and approved by the Secretary of Commerce.

3.1 Essential Fish Habitat Affected by the Project

Effects of the proposed Project will impact EFH for various federally managed fish species within the Pacific Coast Groundfish (PFMC 2005), Pacific Coast Salmon (PFMC 1999), and

Coastal Pelagic Species (PFMC 1998) FMPs. Furthermore, the Project area is located in an estuary Habitat Areas of Particular Concern for various federally managed fish species within the Pacific Coast Groundfish FMP.

3.2 Adverse Effects on Essential Fish Habitat

Adverse effects to EFH will occur through (1) increased turbidity in the water column, (2) suspension of sediment-associated contaminants, and (3) disturbance of benthic habitat. EFH will also be temporarily impacted by elevated underwater sound levels during pile driving.

Turbidity
In-water work activities (*i.e*., pile installation) may result in elevated levels of turbidity and suspended sediment in the water column (Section 2.5.1.4 in the above opinion). The finer grain sediments, silts and clays, are more readily suspended and settle out slower than coarse sediments, such as sand and gravel. In-water work in areas with fine sediments are likely to have greater turbidity impacts than in areas with coarse sediments (Sabol *et al.* 2005). The action area construction sites are expected to have primarily fine grain sediments with only a minimal amount of sand and gravel.

The frequency and duration of elevated turbidity generally depends upon the size and quality of the bottom sediments and the frequency and duration of the activity. Elevated levels of turbidity are expected during pile installation activities. However, pile driving at each action area will occur for not more than four days at Fort Baker, and no more than six days at Pier 31.5, and the two areas of Project activities where increased turbidity will occur are small. Therefore, in-water work is expected to have localized and short-term periods of elevated turbidity that dissipate rapidly with tidal circulation.

Release of Contaminants
The suspension of contaminated sediments during pile installation presents the potential for release of contaminants to the water column, and for the uptake of contaminants by organisms contacting re-suspended material (Section 2.5.1.4 in the above opinion). However, most contaminants are tightly bound in the sediments and are not easily released during short-term resuspension (USACE 2004).

This Project does not include any activities that will disturb large surface areas on the bay substrate. This will avoid the creation of newly exposed surface layers of sediment that allow for contaminants to be made available to organisms and assimilation into the food chain. Furthermore, the potential for suspension of contaminated sediment is low with this Project as the area of disturbed sediment is small.

Benthic disturbance
Pile installation is expected to disturb the benthic community in the action area (Section 2.5.1.5 in the above opinion). This disturbance will impact forage species, such as infaunal and bottom-dwelling organisms like polychaete worms and crustaceans, by directly contacting or burying these organisms (Van der Veer *et al.* 1985, Newell *et al.* 1998). Recolonization studies suggest that recovery may not be linear, and can be regulated by physical factors including particle size

distribution, currents, and compaction/stabilization processes following disturbance. Rates of recovery listed in the literature range from several months to several years for estuarine muds (Oliver *et al.* 1977, Currie and Parry 1996, Tuck *et al.* 1998, Watling *et al.* 2001) and can take up to 1 to 3 years in areas of strong currents (Oliver *et al.* 1977). At the Pier 31.5 and Fort Baker Pier construction sites, benthic organisms are expected to recover rapidly at disturbed sites due to the small footprint of each pile. Collie *et al.* (2000) reported some aquatic invertebrates re-colonize areas within a few months of a disturbance activity. Because of the small size of disturbed areas (directly under and adjacent to pilings installed), NMFS expects that the effects of disturbance to the benthic community from this Project's pile installation will be minor.

<u>Elevated Underwater Sound Levels</u>
Pile driving will increase underwater sound pressures and will effect open water column habitat for fishes (Section 2.5.1.3 of the above opinion). Approximately 580 acres of the Horseshoe Cove and adjacent San Francisco Bay at the Fort Baker Pier site will be impacted for up to four days, and 425 acres near the San Francisco City waterfront at the Pier 31.5 will be impacted for between four to six days by the installation steel piles. However, it is expected that fish will utilize other adjacent habitats during pile driving activities and the elevated sound pressure levels will have no permanent impact on EFH.

3.3 Essential Fish Habitat Conservation Recommendations

There are no practical EFH Conservation Recommendations to provide because impacts to EFH are expected to minor, temporary, localized, or addressed through proposed mitigation.

3.4 Supplemental Consultation

The NPS must reinitiate EFH consultation with NMFS if the proposed action is substantially revised in a way that may adversely affect EFH, or if new information becomes available that affects the basis for NMFS' EFH Conservation Recommendations (50 CFR 600.920(l)).

4. DATA QUALITY ACT DOCUMENTATION AND PRE-DISSEMINATION REVIEW

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

4.1 Utility

Utility principally refers to ensuring that the information contained in this consultation is helpful, serviceable, and beneficial to the intended users. The intended users of this opinion are NPS and USACE. Other interested users could include the U.S. Fish and Wildlife Service, San Francisco Bay Conservation and Development Commission, the California Department of Fish and Wildlife, the San Francisco Bay Regional Water Quality Control Board, and the State Water Quality Control Board. Individual copies of this opinion were provided to the NPS. This opinion will be posted on the Public Consultation Tracking System web site (https://pcts.nmfs.noaa.gov/ pcts-web/homepage.pcts). The format and naming adheres to conventional standards for style.

4.2 Integrity

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

4.3 Objectivity

Information Product Category: Natural Resource Plan.

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

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

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

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

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