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

FEB - 6 2017

Refer to NMFS No: WCR-2015-3700

Rick M. Bottoms, Ph.D.
Chief, Regulatory Division
U.S. Department of the Army
San Francisco District, Corps of Engineers
1455 Market Street
San Francisco, California 94103-1398

Re: Endangered Species Act Section 7(a) (2) Biological Opinion for the Mare Island Maintenance Dredging and Dry Dock Operations in San Francisco Bay (Corps File No. 2008-00311), Reinitiation of Consultation

Dear Dr. Bottoms:

Thank you for the U.S. Army Corps of Engineers' (Corps) letter of October 27, 2015, requesting reinitiation 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 Corps' authorization of maintenance dredging at the Mare Island Dry Docks pursuant to Section 404 of the Clean Water Act of 1972, as amended (33 USC Section 1344 *et seq.*) and Section 10 of the Rivers and Harbors Act (RHA) of 1899, as amended (33 U.S.C. § 403 *et seq.*). The Corps has requested reinitiation of consultation with NMFS to address changes in dry dock operations and changes to the dredging work window. In addition, the Corps has requested NMFS assess in this reinitiation of consultation the one-time renewal of this 10-year permit. The existing Corps permit was issued on August 2, 2010, for a 10-year period. Thus, in approximately four years the existing Corps permit will expire and the Corps proposes to renew this permit in 2020 for an additional 10-year period.

Since the completion of the July 22, 2010, biological opinion issued by NMFS (PCTS No. 2010/1961), the dry dock facility has been acquired by Mare Island Dry Dock, LLC (MIDD) from Allied Defense Recycling. MIDD proposes to modify operation of the facility to include additional fish deterrent devices, expand operations at the dry dock facility, and perform maintenance dredging year-round in Mare Island Strait. The enclosed biological opinion replaces the original biological opinion issued by NMFS on July 22, 2010.

The enclosed biological opinion is based on our review of MIDD's proposed operation of the facility, including the proposed project modifications, and describes NMFS's analysis of potential effects on threatened southern distinct population segment (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 enclosed biological opinion, NMFS concludes the project is not likely to jeopardize the continued existence of the southern DPS of North American green sturgeon, threatened CCC steelhead, threatened Central Valley spring-run Chinook salmon, threatened California Central Valley steelhead, endangered Sacramento River winter-run Chinook salmon, nor designated critical habitat in accordance with section 7 of the ESA. However, NMFS anticipates take of the above listed species may occur as a result of the dry dock operations and, therefore, an incidental take statement with non-discretionary terms and conditions is included with the enclosed biological opinion.

Please contact Ms. Sara Azat at 707-575-6067, or sara.azat@noaa.gov if you have any questions concerning this section 7 consultation, or if you require additional information.

Sincerely,

Barry A. Thom
Regional Administrator

Enclosure

cc: Debra O'Leary, Corps Regulatory Branch, San Francisco, CA
Brenda Goeden, BCDC, San Francisco, CA
Kim Turner, USFWS, Sacramento, CA
Arn Aarreberg, CDFW, Santa Rosa, CA
Dan Chase, WRA Environmental Constants, San Rafael, CA
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Endangered Species Act (ESA) Section 7(a)(2) Biological Opinion

Mare Island Maintenance Dredging and Dry Dock Operations

NMFS Consultation Number: WCR-2015-3700

Action Agency: Army Corps of Engineers, San Francisco District

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	Yes	No	Yes	No
Central California Coast steelhead (*O. mykiss*)	Threatened	Yes	No	Yes	No
Sacramento River Winter-run Chinook (*O. tshawytscha*)	Endangered	Yes	No	Yes	No
Central Valley Spring-run Chinook (*O. tshawytscha*)	Threatened	Yes	No	Yes	No
North American Green Sturgeon (*Acipenser medirostris*)	Threatened	Yes	No	Yes	No

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

Issued By: [signature] for

Barry A. Thom
Regional Administrator

Date: FEB - 6 2017

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LIST OF ACRONYMS

BA	Biological Assessment
BCDC	Bay Conservation and Development Commission
BMP	Best Management Practices
BOR	Bureau of Reclamation
BRT	Biological Review Team
CCC	Central California Coast
CDFW	California Department of Fish and Wildlife
CSLC	California State Lands Commission
Corps	U.S. Army Corps of Engineers
CV	Central Valley
cy	cubic yards
cy/yr	cubic yards per year
dB	decibel
DDT	dichlorodiphenyltrichloroethane
DPS	distinct population segment
DWR	Department of Water Resources
DQA	Data Quality Act
EFH	essential fish habitat
EIS	Environmental Impact Statement
ESA	Endangered Species Act
ESU	evolutionary significant unit
FEIR	Final Environmental Impact Report
FMP	Fishery Management Plan
FRH	Feather River Hatchery
ft.	foot
FWS	United States Fish and Wildlife Service
GCID	Glenn Colusa Irrigation District
ITS	incidental take statement
MHHW	mean higher high water
MISP	Marine Invasive Species Program
MLLW	mean lower low water
mm	millimeter
MSA	Magnuson-Stevens Fishery Conservation and Management Act
MOTCO	Military Ocean Terminal
NMFS	National Marine Fisheries Service
NTU	nephlometric turbidity units
PCE	primary constituent element
PBF	physical or biological feature
RBDD	Red Bluff Diversion Dam
SFBRWQCB	San Francisco Bay Regional Water Quality Control Board
TL	total length
TMDL	Total Maximum Daily Load
USCG	United States Coast Guard
USFWS	United States Fish and Wildlife Service

1.0 INTRODUCTION

This Introduction section provides information relevant to the other sections of this document and is incorporated by reference into section 2 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 USC 1531 *et seq*.), and implementing regulations at 50 CFR 402. This biological opinion replaces the original biological opinion issued July 22, 2010 (PCTS No. SWR-2010-1961).

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

During late March 2010, representatives from NMFS and the U.S. Army Corps of Engineers (Corps) discussed by telephone and through email messages, Allied Defense Recycling's (ADR) proposal to re-activate the former U.S. Naval Shipyard at Mare Island. The Corps proposed to issue a 10-year permit to ADR for maintenance dredging in the Mare Island Strait adjacent to the shipyard. In order to access the dry docks for use, dredging was required to remove accumulated sediment. Following the initial dredging episode, ADR proposed to commerce shipyard operations at the dry dock facilities.

By letter dated April 12, 2010, the Corps initiated informal consultation with NMFS for ADR's proposed operation of the shipyard on Mare Island, Vallejo, Solano County, California. With the Corps' April 12, 2010 letter, two biological assessments were provided to NMFS. One biological assessment dated March 30, 2010, was prepared by ADR for the California Department of Fish and Wildlife (CDFW) and this assessment focused on state-listed longfin smelt (ADR 2010). The second biological assessment evaluated potential project impacts to Delta smelt, listed anadromous salmonids, and the southern distinct population segment (DPS) of North American green sturgeon. Based on information provided in the project's biological assessments and additional information provided by ADR, NMFS informed the Corps by letter dated May 14, 2010, that NMFS could not concur with the Corps' determination of "not likely to adversely affect" listed species and NMFS requested initiation of formal consultation for the project.

Beginning in late May 2010, representatives from NMFS, ADR, and the Corps worked together to develop measures to reduce the risk of fish entrainment during operation of the dry docks. Discussion centered on ways to reduce the rate of filling and, thereby, reduce intake water velocities to levels which wouldn't entrain fish as well as options for screening the water intake structures. In mid-July 2010, the agencies reached agreement on the following: (1) a fisheries monitoring plan; (2) a dredging work plan; (3) an operations plan and facilities description; and (4) a schedule for completing the ESA consultation and issuance of the Corps' permit. An exchange of email messages on July 16, 2010, confirmed which documents contain the final description of each project component and would serve as the basis for the NMFS/Corps formal consultation and resulting biological opinion.

Formal consultation with the Corps was concluded with NMFS' issuance of a biological opinion, on July 22, 2010, in which NMFS concluded that the proposed project was not likely to jeopardize the continued existence of threatened Central Valley steelhead (*Oncorhynchus mykiss*), threatened Central California Coast (CCC) steelhead (*O. mykiss*), threatened Central Valley spring-run Chinook salmon (*O. tshawytscha*), endangered Sacramento River winter-run Chinook salmon (*O. tshawytscha*), and the southern distinct population segment (DPS) of North American green sturgeon (*Acipenser medirostris)*, nor adversely modify designated critical habitat. However, NMFS anticipated potential injury or mortality of the above listed fish as a result of dredging and operation of the dry dock facilities. An incidental take statement with non-discretionary terms and conditions was included with the July 22, 2010 biological opinion.

The Corps issued a permit (Corps Permit No. 2008-0031N) on August 2, 2010, to ADR for maintenance dredging associated with dry dock operations at the Mare Island dry dock facilities in Solano County, California.

From November 2010 through April 2011, representatives from NMFS and ADR worked together to develop a fish exclusion device that could be installed on the dry dock water intakes during filling operations. On April 18, 2011, a meeting with representatives from NMFS and ADR was convened at the dry dock facility to evaluate the proposed exterior barrier net (referred to as the "dynamic barrier"). By letter dated April 25, 2011, NMFS informed the Corps that the dynamic barrier satisfied the requirements of terms and conditions 2(a) and 2(b) of the incidental take statement attached to the July 22, 2010 biological opinion.

In addition to the dynamic barrier, ADR installed an internal bubble curtain system in June 2012 that is located in front of the caisson doors of Dry Docks 2 and 3. The bubble curtain is operated as a behavioral deterrent to fish when the caisson doors are not in place. The system generates a constant stream of bubbles across the entire opening between the dry dock and Mare Island Strait. The use of the bubble curtain has resulted in a substantial reduction in the number of fish encountered during each fish salvage event when compared to salvage events conducted prior to implementation (see Environmental Baseline section of this opinion).

In 2013, Mare Island Dry Dock, LLC (MIDD) assumed control of the facility from ADR and changed the focus of operations from a ship dismantling facility to a ship repair and maintenance facility.

On February 13, 2014, representatives from NMFS, U.S. Fish and Wildlife Service (USFWS), CDFW, the Corps, and MIDD met to discuss requested changes in operations of the dry dock. MIDD proposed to change the number of annual evolutions (defined as a flooding/dewatering cycle) at the dry docks, and changes to the fish rescue and relocation procedures. By letter dated

June 17, 2014, MIDD submitted the proposed operational changes to NMFS, Corps, and USFWS for review.

By letter dated October 27, 2015, the Corps requested reinitiation of section 7 consultation with NMFS to modify the facility's Corps permit in a manner that would allow for the following: (1) an increase in the number of annual dry dock evolutions; (2) changes to the fish monitoring program; (3) changes to the fish exclusion measures; and (4) dredging year-round in Mare Island Strait. The Corps also provided a biological assessment dated July 2015 to NMFS with the request for reinitiation of consultation.

Conference calls were held on January 8 and 29, 2016, with representatives from NMFS, the Corps, and MIDD to discuss dredging volumes and time of year that dredging would be allowed under the revised Corps permit. The current Corps permit identifies a work window of August 1 through December 13 for annual dredge episodes. However, due to sedimentation rates higher than anticipated in the Mare Island Strait, additional maintenance dredging events are now proposed by MIDD to provide safe draft depths for accessing the dry docks year-round.

On September 6, 2016. NMFS and the Corps discussed the remaining time period of the current Corps authorization. The existing Corps permit expires in less than 4 years (August 2, 2020) and the Corps anticipates renewal of the permit for an additional 10-year period at the end of the existing permit. Subsequent to this conversation the Corps requested, via e-mail on October 6, 2016, that a one-time renewal of the ten-year permit be addressed in this consultation, thus making the time period 14 years, be considered in this new opinion. This new biological opinion replaces the original biological opinion of July 22, 2010.

1.3 Proposed Action

"Action" means all activities or programs of any kind authorized, funded, or carried out, in whole or in part, by Federal agencies (50 CFR 402.02). The Corps proposes to modify MIDD's existing authorization pursuant to Section 404 of the Clean Water Act (CWA) of 1972, as amended (33 U.S.C. § 1344 *et seq*.) and Section 10 of the Rivers and Harbors Act (RHA) of 1899, as amended (33 U.S.C. § 403 *et seq*.) to allow for maintenance dredging in Mare Island Strait to occur year-round. MIDD proposes to continue to operate the dry docks for the repair and maintenance of vessels. Provided MIDD remains in compliance with all permit requirements during the 4 years remaining on the existing permit, the Corps proposes to renew the permit in 2020 for an additional 10-year term.

1.3.1 Dredging

MIDD proposes to periodically dredge sediments from the channel in the immediately vicinity of the dry dock facility to provide vessel access to each of the four dry docks at the Mare Island Shipyard. Maintenance dredging would continue to be performed by a mechanical (clamshell) bucket dredge to create water depths of 28 to 32 feet below mean lower low water (MLLW) in Mare Island Strait immediately offshore from the shipyard (Figure 1). Over the life of the existing 10-year Corps permit which was issued in 2010, MIDD is authorized to remove a cumulative total of 610,000 cy of sediment from a 16.3 acre area in front of berths 11-16 and dry docks 1-4. To date, dredge operations under the Corps' permit have removed a total of 229,581 cy. The remaining 380,419 cy may be removed during the remaining 4 years of the Corps permit. The renewal of the Corps permit in 2020 would authorize like amounts over the next permit term; that is during the 10 year-period between 2020 to 2030, the Corps' authorization would permit MIDD to remove a cumulative total of 610,000 cy of sediment from a 16.3 acre area in front of berths 11-16 and dry docks 104.

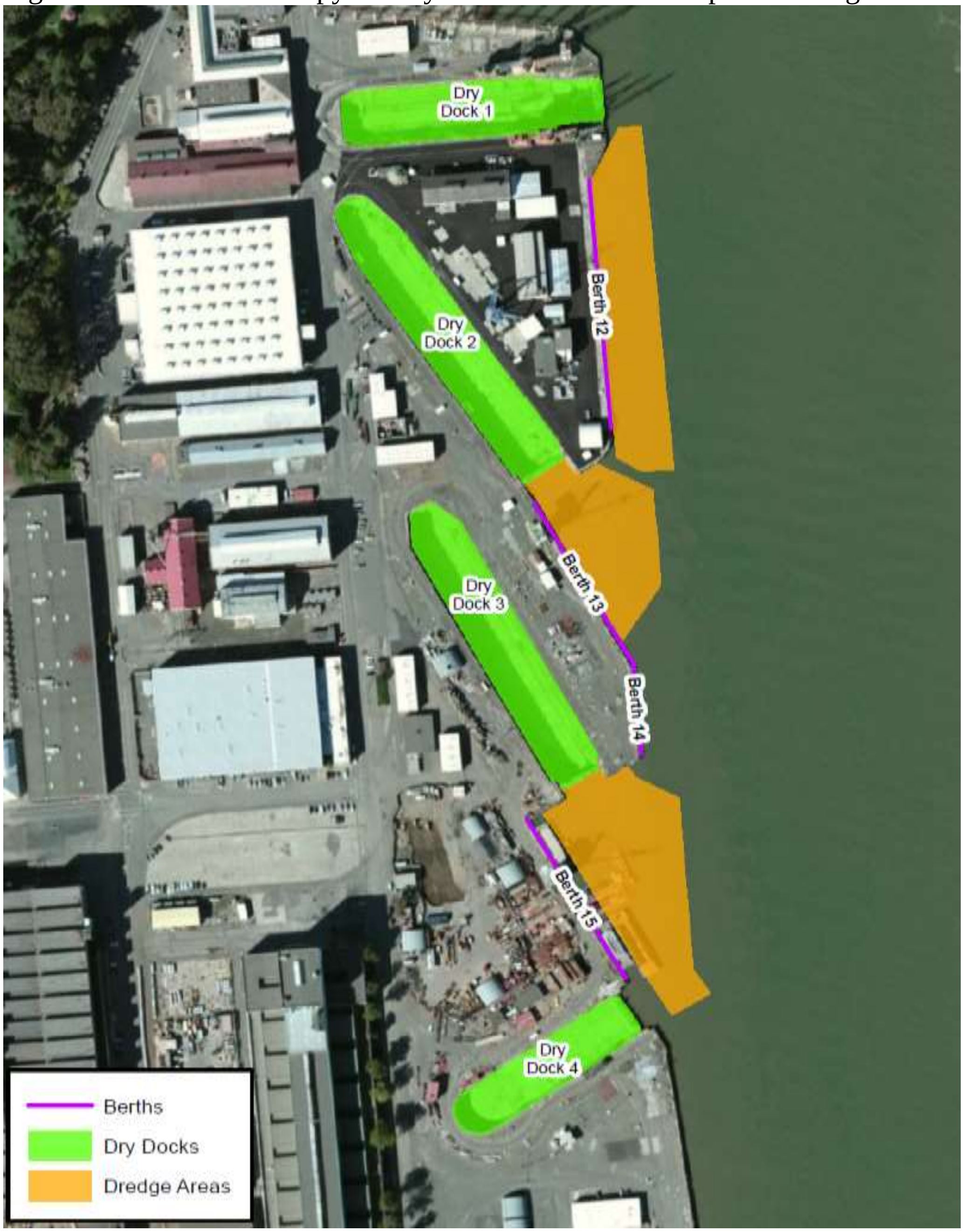
The proposed modifications to the remaining 4 years of the Corps permit, and the 2020 10-year permit renewal, would allow MIDD to conduct one dredge event annually that removes up to 80,000 cy between August 1 and October 15 and up to three additional dredge events per year with removal of up to 20,000 cy during a single event between October 16 and July 31.

For dredging events performed between August 1 and October 15, disposal of sediment could occur at either in-bay disposal sites or beneficial reuse sites. For in-bay disposal, the site in eastern San Pablo Bay, known as the Carquinez Strait disposal site (SF-9), is the closest to the dry dock berths and the most likely site to be used; however, Corps may also authorize disposal at Alcatraz (SF-11) or San Pablo Bay (SF-10).

For dredging events between October 16 and July 31, MIDD has proposed several measures to minimize potential impacts to listed fish in Mare Island Strait. Measures include the following: (1) limiting the duration of each dredge event to two weeks or less; (2) placing all dredge material at a beneficial reuse site; and (3) monitoring water temperature and salinity one week prior to the event and during the dredge event. Temperature and salinity monitoring serves as a proxy for determining Delta smelt habitat suitability. Should the salinity drop to below 12 parts per thousand while the water temperature is between 7 and 25 degrees Celsius (ºC) dredging would be limited to deeper water (greater than -20 feet mean lower low water). For disposal of sediments dredged between October 16 and July 31, materials will only be placed at an upland, beneficial reuse site. For beneficial reuse and upland disposal sites, various sites may be available including Cullinan Ranch and Montezuma Wetlands. Prior to each dredging episode, the Dredge Material Management Office (DMMO) will evaluate the sediment to be dredged for disposal or reuse suitability.

All dredging would be performed on an as-needed basis. Based on past observation, the historic siltation rate is approximately 2 feet per month in the areas in front of the dry docks. In three months, the dry docks commonly encounter 6 feet of infill in the V-shaped area in front of Dry Docks 2 and 3. Dredging to the depth of 32 feet conducted prior to October 15, means that by late January the depths in front of the dry docks may be as shallow as 26 feet. MIDD has recently contracted services to have monthly hydrographic surveys and accretion rate analyses performed to assess rates of accretion.

Figure 1. Mare Island Shipyard Dry Docks and MIDD Proposed Dredge Areas



<u>1.3.2 Dry Dock Operations</u>

MIDD proposes to operate four dry docks in the shipyard: Dry Docks 1, 2, 3, and 4. Although every vessel service is different, typical operations within a dry dock include propeller removal, shaft removal, balancing, hull repairs, and renewal of antifouling bottom paints. When not in use, the dry docks do not contain water and are separated from the Mare Island Strait by steel barriers referred to as caissons. An "evolution" consists of a complete cycle up and down for a vessel. An evolution involves filling the dry dock with water, bringing a vessel into the dry dock, and dewatering the dry dock to perform the required service on the vessel. Future operations at the facility may result in as many as 104 total evolutions annually, using all dry docks. Prior to bringing in a ship to the dry dock for repairs, the dry dock is filled with water from Mare Island Strait by gravity flow through valve, piping, and tunnel systems. Intake systems to fill the docks are fitted with steel bar filter screens spaced at approximately 5 to 12 inches primarily for debris prevention.

MIDD proposes to use two primary measures to minimize fish entrainment during the flooding of the dry docks: a barrier net (the dynamic barrier) and a bubble curtain. The dynamic barrier net is deployed outside the caisson (in the Mare Island Strait), approximately 25 to 50 feet from the caisson. This barrier net has 1/4-inch mesh. Once the dry dock is filled, the caisson is removed, allowing vessel access into the dock. As the caisson doors are removed, a permanently installed internal bubble curtain deterrence system is activated. Piping to operate the bubble curtain is installed on the inside sill, on the dry dock side of the caisson. Air is pumped through the piping and discharged through holes in the pipe to create a “curtain of bubbles” which float from the bottom to the water surface. The curtain of bubbles is a behavioral method to deter aquatic species from entering the dry dock while the caisson is not in place.

When it is time for a vessel to enter dry dock, the dynamic barrier will be deployed and the valves will be opened to flood the dock. Prior to removing the caisson, the bubble curtain will be activated and the dynamic barrier will be removed so that a tug boat can remove the caisson. Once the vessel has entered a dry dock, the caisson is re-installed and seated. Water is then pumped from the enclosed dry dock back into Mare Island Strait, allowing the vessel to settle and set down on blocks on the floor of the dry dock. Fish that are entrapped in the dry dock are then collected and returned to Mare Island Strait. Fish collections are conducted during the final stages of dewatering.

Within the dewatered dry dock, ship maintenance and repairs are performed in a dry environment while the vessel is seated on the blocks. Once the repairs are finished, the process is repeated in reverse to float the vessel out of the dry dock. On occasion, when one vessel is removed from the dry dock, another is immediately brought in, which is referred to as a “wet to wet” docking. The docks are thoroughly cleaned prior to flooding. Specific information on each dry dock is provided below.

Dry Dock 1 is approximately 525 feet long and has a capacity of 11.7 million gallons depending on tidal levels. The elevation is -21.0 feet MLLW. Dry Dock 1 has not been used since the Navy rebuilt the caisson seals and reinstalled the caisson in 1995. Bay water is gravity fed to Dry Dock 1 by valves in the caisson door, and dewatering occurs through Pump House 1. Since the caisson has not been operated since 1995, some recommissioning of Dry Dock 1's infrastructure will likely be required prior to its use.

Dry Dock 2 is approximately 720 feet long and has a capacity of 14 to 18 million gallons depending on tidal levels. The elevation of Dry Dock 2 is -32 feet MLLW. The fill rate for Dry Dock 2 can be regulated by manipulating the number of valves opened on the caisson door. Four valves are located on the caisson door which allows the dry dock to fill. Low flow channels line the north and south side of the dry dock floor, and water drains on an angle from east to west through two wall-mounted drains.

Dry Dock 3 is approximately 680 feet long dry dock and has a capacity of 15 to 19 million gallons depending on tidal levels. The elevation of Dry Dock 3 is -32 feet MLLW. The fill rate for Dry Dock 3 can be regulated by two steel doors that cover the intake points for the dry dock. When the gates on the doors are lifted, water flows through a short concrete tunnel and into the dry dock. Dry Dock 3 drains to two central floor drains. Low flow channels line the north and south side of the dry dock floor, and become progressively deeper moving towards the central floor drains.

Dry Dock 4 is approximately 400 feet long dry dock and has a capacity of 9 to 13 million gallons depending on tidal levels. The elevation of Dry Dock 4 is -19 feet MLLW. The fill rate for Dry Dock 4 can be regulated by dockside gates and the dock drains to Pump House 2.

In addition to the above dry docks, MIDD has a secure berthing of up to 1,300 linear feet at Berths 12, 13, 14, and 15. Vessels are moored at this location along the shoreline of Mare Island Strait (Figure 1).

1.3.3 Fish Rescue and Relocation Plan

Since the Mare Island Shipyard re-opened in 2011, fish collections and relocations have been performed in the dry docks for each evolution. Based on this experience, MIDD proposes to continue this program with the revisions presented below. The proposed Fish Rescue and Relocation Plan is presented in Appendix F of the July 2015 biological assessment. The proposed plan incorporates measures outlined in the 2010 biological opinions from NMFS and USFWS, the CDFW Incidental Take Permit (ITP) amended in 2013, and additional CDFW recommendations. The following section presents a summary of the proposed fish collection and relocation procedures.

1.3.3.1 Notification and Monitoring

MIDD will notify the Resource Agencies (NMFS, USFWS and CDFW) at least one week prior to each fish salvage event in order to provide an opportunity for Resource Agency staff to observe the activities. In the event that an emergency evolution is required (*i.e.*. vessel taking on water and in need of repair), a one week notice will not be possible; however, notification of a fish salvage will be provide to Resource Agency staff to the as soon as practicable. The MIDD will allow any Resource Agency employee employee(s), or any other person(s) designated by the Resource Agencies, to visit the dry dock facilities during the fish salvage and related activities.

A designated representative will be on-site daily while dry dock operations are taking place to check for compliance with all minimization and avoidance measures. These inspections will be compiled into a Monthly Compliance report. The designated representative will record events of each fish salvage as described in the Fish Rescue and Relocation Plan.

1.3.3.2 Level I and II Fish Rescue

Level I fish rescue and relocation will occur during each dewatering event between December 1 and May 31. Level II fish rescue and relocation procedures will be performed between June 1 and November 30. Level I procedures differ from Level II in that a biologist will be on-site for the deployment of the dynamic barrier, operation of the bubble curtain, and all of the dewatering event. In addition, Level I procedures require the collection of all fish and relocation of all surviving individuals to Mare Island Strait. Level I includes the period when federally-listed and state-listed fish species are most likely to be encountered.

For Level I fish rescue (from December 1 through May 31), draining of the dry dock will be halted during the final stage of dewatering (last 16 to 24 inches within the dry dock). A fisheries biologist will then collect entrapped fish by netting in the dry dock. All fish will be identified to species, measured, and relocated back to Mare Island Strait.

During the Level II period (June 1 through November 30), a biologist will only be onsite to monitor the final stage (last 16 to 24 inches of draining the dry dock) of dewatering. If a large sturgeon (includes both white and green) or adult Chinook salmon or steelhead fish (over 18 inches) is identified in the dry dock, the biologist will conduct a targeted salvage effort for the individual fish. The fish will be netted, measured, and relocated back to Mare Island Strait. No additional fish salvage activity will occur during a Level II fish rescue. In the event that there is a malfunction of the dynamic barrier or the bubble curtain does not operate, a Level I fish salvage will occur.

For both Level I and Level II fish rescues, any special status species collected as deceased will be processed and preserved in accordance the NMFS, USFWS, and CDFW requirements. Carcasses of special status fish collected from the dry docks will be retained, placed in an appropriately sized sealable plastic bag, labeled with the species name, length, date and location of the collection, and will be frozen as soon as possible. Samples will be retained by the designated biologist for a period of at least one week or until specific instructions are approved by NMFS, whichever occurs first. MIDD will not transfer biological sample of NMFS-listed fish to anyone other than NMFS, USFWS, or CDFW representatives without obtaining prior written approval from the NMFS Santa Rosa Office.

Otolith and/or tissue samples will be collected from Chinook salmon and steelhead that are encountered in the dry dock during salvage activities. Salmonid otoliths will be only be collected from carcasses and sent to the appropriate laboratory designated by NMFS. For live individuals, fin tissue samples from adult salmonids will be collected prior to release back to Mare Island Strait. Fin tissue samples will only be collected in the event that the individual fish is in sufficient condition and the tissue sample is not anticipated to compromise the survival.

<u>1.3.3.3 Reporting</u>

For Level I fish salvage events, reports will be provided to NMFS, USFWS and CDFW. If the fish salvage occurs as part of a series (*i.e.*, a new vessel is brought into the dry dock directly following the removal of another without closing the caisson, resulting in two fish salvage events), a joint report will be prepared. A draft report will be provided to the Resource Agencies within 30 days following completion of a fish rescue and relocation event. A 30-day review period will be in effect for review by the Resource Agencies. After the 30-day review period, comments will be addressed and a final report will be submitted to the resource Agencies. The written report will include the number of fish collected by species, fish lengths, injuries, mortalities, and number of surviving fish relocated back to Mare Island Strait.

For Level II fish salvage events, summary reports via email will be provided to NMFS, USFWS, and CDFW. A brief memorandum will be prepared if one or more large fish are encountered. The memorandum will include information on the species(s), size, and survival. Additional information on abiotic conditions and methodology used for the salvage event will be included. For salvage events where no large native fish are encountered, no reporting summary will be prepared. Level II fish salvage reports will be provided to NMFS, USFWS and CDFW.

An annual summary of all Level I and Level II fish salvage events will be prepared and distributed to the Resource Agencies.

1.3.4 Avoidance, Minimization and Mitigation Measures

In addition to the minimization and monitoring measures presented above, MIDD has proposed the following measures associated with operation of the dry docks:

1) The dry dock will be cleaned and any silt will be removed prior to beginning work on a vessel. Fire hoses are used to flush sediments that come into the dock with the flooding water back to the suction side of the dry dock pumps so that the sediment can be returned to Mare Island Strait.
2) Best Management Practices (BMPs) for the dry docks will be implemented to prevent toxic or hazardous material from entering the Mare Island Strait during an evolution. Water that has the potential of coming into direct contact with any of the work materials will be pumped to a holding tank and held pending analyses. Upon receipt of acceptable analytical results, the water will be discarded to the Vallejo Sanitation and Flood Control District (VSFCD) for treatment.
3) Upon completion of the contracted work on a vessel, the dock will be thoroughly cleaned using dry techniques as much as possible. Again, any potentially contaminated water is held pending analysis and then either discharged to VSFCD or properly disposed at an offsite treatment facility.

2.0 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 habitats. If incidental take is reasonably certain to occur, section 7(b)(4) requires NMFS to provide an 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. This biological opinion replaces the original biological opinion issued by NMFS to the Corps on July 22, 2010.

2.1 Analytical Approach

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

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

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

- Identify the rangewide status of the species and critical habitat likely to be adversely affected by the proposed action.
- Describe the environmental baseline in the action area.
- Analyze the effects of the proposed action on both species and their habitat using an "exposure-response-risk" approach.
- Describe any cumulative effects in the action area.
- Integrate and synthesize the above factors 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 RPA to the proposed action.

2.1.1 Use of Best Available Scientific and Commercial Information

To conduct the assessment, NMFS examined an extensive amount of information from a variety of sources. Detailed background information on the biology and status of the listed species and critical habitat has been published in a number of documents including peer reviewed scientific journals, primary reference materials, and governmental and non-governmental reports. Additional information regarding the effects of the proposed dredging and dry dock operations 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, and the following:

(1) Section 7 Biological Assessment. Prepared by WRA Environmental Associates, July 2015.

(2) Mare Island Dry Dock Fish Rescue and Relocation Plan, Revised, Mare Island, Solano County, California. Prepared by WRA Environmental Associates, May 20, 2014.

(3) Technical Report for Mare Island Dry Dock Fish Salvage Data and Analysis, May 5, 2015.

Information was also provided in emails messages and telephone conversations between December 2015 and October 2016. For information that has been taken directly from published, citable documents, those citations have been referenced in the text and listed at the end of this document. A complete administrative record of this consultation is on file at the NMFS North-Central Coast Office (Administrative Record Number 151422SWR2010SR00178).

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 biological opinion analyzes the effects of the federal action on the following Federally-listed species (DPS or ESU) and designated critical habitats:

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

California Central Valley steelhead (*O. mykiss*) DPS
Threatened (71 FR 834; January 5, 2006);
Central Valley Spring-run Chinook salmon (*O. tshawytscha*) ESU
Threatened (70 FR 37160; June 28, 2005);
Sacramento River Winter-run Chinook salmon (*O. tshawytscha*) ESU
Endangered (70 FR 37160; June 28, 2005)
Critical habitat (58 FR 33212; June 16, 1993);
North American Green Sturgeon (*Acipenser medirostris*) southern DPS
Threatened (71 FR 17757; April 7, 2006)
Critical habitat (74 FR 52300; September 8, 2008).

Critical habitat for California Central Valley (CCV) steelhead and Central Valley (CV) spring-run Chinook salmon is not present in the action area.

2.2.1.1. CCV and CCC Steelhead General Life History

Steelhead are anadromous forms of *O. mykiss*, spending some time in both freshwater and saltwater. Unlike Pacific salmon, steelhead are iteroparous, or capable of spawning more than once before death (Busby *et al*. 1996). Although one-time spawners are the great majority, Shapovalov and Taft (1954) reported that repeat spawners are relatively numerous (17.2 percent) in California streams. Steelhead young usually rear in freshwater for 1 to 3 years before migrating to the ocean as smolts, but rearing periods of up to 7 years have been reported. Migration to the ocean usually occurs in the spring. Steelhead may remain in the ocean for 1 to 5 years (2 to 3 years is most common) before returning to their natal streams to spawn (Busby *et al.* 1996). The distribution of steelhead in the ocean is not well known. Interannual variations in climate, abundance of key prey items (*e.g.*, squid), and density dependent interactions with other salmonid species are key drivers of steelhead distribution and productivity in the marine environment (Atcheson *et al*. 2013; Atcheson *et al*. 2012). Recent information indicates that steelhead originating from central California use a cool, stable, thermal habitat window (ranging between 8-14 °C) in the marine environment characteristic of conditions in northern waters above the 40th parallel to the southern boundary of the Bering Sea (Hayes *et al*. 2012). Adult steelhead typically migrate from the ocean to freshwater between December and April, peaking in January and February (Fukushima and Lesh 1998).

Juvenile steelhead migrate as smolts to the ocean from January through May, with peak migration occurring in April and May (Fukushima and Lesh 1998). Barnhart (1986) reports steelhead smolts in California typically range in size from 140 to 210 millimeter (mm) (fork length). Steelhead of this size can withstand higher salinities than smaller fish (McCormick 1994), and are more likely to occur for longer periods in tidally influenced estuaries, such as San Francisco Bay. Steelhead smolts in most river systems must pass through estuaries prior to seawater entry.

2.2.1.2 Status of CCC Steelhead DPS and Critical Habitat

Historically, approximately 70 populations of steelhead are believed to have existed in the Central California Coast steelhead Distinct Population Segment (CCC steelhead DPS) (Spence *et* *al.* 2008). Many of these populations (approximately 37) were independent, or potentially independent, meaning they historically had a high likelihood of surviving for 100 or more years absent anthropogenic impacts (Bjorkstedt *et al.* 2005). The remaining populations were dependent upon immigration from nearby CCC steelhead DPS populations to ensure their persistence (McElhaney *et al.* 2000, Bjorkstedt *et al.* 2005).

While historical and current data of abundance are limited, CCC steelhead DPS numbers are substantially reduced from historical levels. A total of 94,000 adult steelhead were estimated to spawn in the rivers of this DPS in the mid-1960s, including 50,000 fish in the Russian River – the largest population within the DPS (Busby *et al.* 1996). Near the end of the 20th century, McEwan (2001) estimated that the wild steelhead population in the Russian River watershed was between 1,700 and 7,000 fish. Abundance estimates for smaller coastal streams in the DPS indicate low but stable levels, with recent estimates for several streams (Lagunitas, Waddell, Scott, San Vicente, Soquel, and Aptos creeks) of individual run sizes of 500 fish or less (62 FR 43937). However, as noted in Williams *et al.* (2016) data for CCC steelhead populations remains scarce outside of Scott Creek, which is the only long-term dataset and shows a significant decline. Short-term records indicate the low but stable assessment of populations is reasonably accurate; however, it should be noted that there is no population data for any populations outside of the Santa Cruz Mountain stratum, other than hatchery data from the Russian River.

Although available time series data sets are too short for statistically robust analysis, the information available indicates CCC steelhead populations have likely experienced serious declines in abundance, and apparent long-term population trends suggest a negative growth rate. This would indicate the DPS may not be viable in the long term, and DPS populations that historically provided enough steelhead immigrants to support dependent populations may no longer be able to do so, placing dependent populations at increased risk of extirpation. However, because CCC steelhead have maintained a wide distribution throughout the DPS, roughly approximating the known historical distribution, CCC steelhead likely possess a resilience that could slow their decline relative to other salmonid DPSs or ESUs in worse condition. The 2005 status review concluded that steelhead in the CCC steelhead DPS remain "likely to become endangered in the foreseeable future" (Good *et al.* 2005), a conclusion that was consistent with a previous assessment (Busby *et al.* 1996) and supported by the NMFS Technical Recovery Team work (Spence *et al.* 2008). On January 5, 2006, NMFS issued a final determination that the CCC steelhead DPS is a threatened species, as previously listed (71 FR 834).

Although numbers did not decline further during 2007/08, the 2008/09 adult CCC steelhead return data indicated a significant decline in returning adults across their range. Escapement data from 2009/2010 indicated a slight increase; however, the returns were still well below numbers observed within recent decades (Jeffrey Jahn, NMFS, personal communication, 2010).

In the Russian River, analysis of genetic structure by Bjorkstedt *et al.* (2005) concluded previous among-basin transfers of stock, and local hatchery production in interior populations in the Russian River likely has altered the genetic structure of the Russian River populations. Depending on how "genetic diversity" is quantified, this may or may not constitute a loss of overall diversity. In San Francisco Bay streams, reduced population sizes and fragmentation of habitat has likely led to loss of genetic diversity in these populations. More detailed information on trends in CCC steelhead DPS abundance can be found in the following references: Busby *et al.* 1996, NMFS 1997, Good *et al.* 2005, and Spence *et al*. 2008.

The status review by Williams *et al.* published in 2011 concluded that steelhead in the CCC steelhead DPS remain "likely to become endangered in the foreseeable future" as new information released since Good *et al.* 2005 did not appear to suggest a change in extinction risk. The most recent status review (Williams *et al.* 2016) reached the same conclusion. On May 26, 2016, NMFS affirmed no change to the determination that the CCC steelhead DPS is a threatened species (81 FR 33468), as previously listed (76 FR 76386).

Critical habitat was designated for CCC steelhead on September 2, 2005 (70 FR 52488). For CCC steelhead, PBFs include estuarine areas free of obstruction and excessive predation with the following essential features: (1) water quality, water quantity and salinity conditions supporting juvenile and adult physiological transitions between fresh- and saltwater; (2) natural cover such as submerged and overhanging large wood, aquatic vegetation, large rocks and boulders, and side channels; and (3) juvenile and adult forage, including aquatic invertebrates and fishes, supporting growth and maturation (70 FR 52488).

The condition of CCC steelhead critical habitat, specifically its ability to provide for their conservation, has been degraded from conditions known to support viable salmonid populations. NMFS has determined that present depressed population conditions are, in part, the result of the following human-induced factors affecting critical habitat: logging, agricultural and mining activities, urbanization, stream channelization, dams, wetland loss, and water withdrawals, including unscreened diversions for irrigation. Impacts of concern include alteration of streambank and channel morphology, alteration of water temperatures, loss of spawning and rearing habitat, fragmentation of habitat, loss of downstream recruitment of spawning gravels and large woody debris, degradation of water quality, removal of riparian vegetation resulting in increased streambank erosion, loss of shade (higher water temperatures) and loss of nutrient inputs (Busby *et al.* 1996, 70 FR 52488). Water development has drastically altered natural hydrologic cycles in many of the streams in the DPS. Alteration of flows results in migration delays, loss of suitable habitat due to dewatering and blockage; stranding of fish from rapid flow fluctuations; entrainment of juveniles into poorly screened or unscreened diversions, and increased water temperatures harmful to salmonids. NMFS (2016) has identified threats that impair conditions and decrease survival of CCC steelhead in San Francisco Bay. These threats include, but are limited to, urbanization and channelization, which are described below in section 2.4.2. Overall, current condition of CCC steelhead critical habitat is degraded, and does not provide the full extent of conservation value necessary for the recovery of the species.

<u>2.2.1.3 Status of the CCV Steelhead DPS</u>

CCV steelhead historically were well-distributed throughout the Sacramento and San Joaquin rivers (Busby *et al.* 1996). Although it appears CCV steelhead remain widely distributed in Sacramento River tributaries, the vast majority of historical spawning areas are currently above impassable dams. At present, all CCV steelhead are considered winter-run steelhead (McEwan and Jackson 1996), although there are indications that summer steelhead were present in the

Sacramento River system prior to the commencement of large-scale dam construction in the 1940s (IEP 1999). McEwan and Jackson (1996) reported that wild steelhead stocks appear to be mostly confined to upper Sacramento River tributaries such as Antelope, Deer, and Mill creeks and the Yuba River. However, naturally spawning populations are also known to occur in Butte Creek, and the upper Sacramento mainstem, Feather, American, Mokelumne, and Stanislaus rivers (CALFED 2000). It is possible that other small populations of naturally spawning steelhead exist in Central Valley streams, but are undetected due to lack of sufficient monitoring and research programs; increases in fisheries monitoring efforts led to the discovery of steelhead populations in streams such as Auburn Ravine and Dry Creek (IEP 1999).

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

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

CCV steelhead have been extirpated from most of their historical range in this region. Habitat concerns in this DPS, identified in the California Central Valley Salmon and Steelhead Recovery Plan (NMFS 2014), focus on the widespread degradation, destruction, and blockage of freshwater habitat within the region, and water allocation problems. Habitat degradation and freshwater flow are discussed below in section 2.4.2. Widespread hatchery production of introduced steelhead within this DPS also raises concerns about the potential ecological interactions between introduced and native stocks. Because the CCV steelhead population has been fragmented into smaller isolated tributaries without any large source population, and the remaining habitat continues to be degraded by water diversions, the species was listed as a threatened population in 2006 (71 FR 834).

NMFS has completed three 5-year reviews of the status of the CCV steelhead DPS. The 2005 status review (Good *et al*. 2005) concluded that the DPS was in danger of extinction. The 2010 assessment considered new information available since Good *et al*. (2005) which indicated the viability of the CCV steelhead DPS had worsened since the 2005 status review and concluded the DPS was in danger of extinction (Williams *et al*. 2011). The 2015 status review (Williams *et* *al.* 2016) reported the viability of the CCV-steelhead DPS appears to have slightly improved since the 2010 assessment. This modest improvement is driven by the increase in adult returns to hatcheries from their recent lows, but the state of the naturally produced fish remains poor. As in previous assessments (Good *et al.* 2005; Williams *et al*. 2011), the 2015 assessment concluded the CCV steelhead DPS continues to be at a high risk of extinction (Williams *et al.* 2016).

2.2.1.4 CV Spring-run and Sacramento River Winter-run Chinook Salmon General Life History

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

Sacramento River winter-run Chinook salmon spawn primarily from mid-April to mid-August, peaking in May and June, in the Sacramento River reach between Keswick Dam and the Red Bluff Diversion Dam. CV spring-run Chinook salmon typically spawn between September and October depending on water temperatures. Chinook salmon generally spawn in waters with moderate gradient and gravel and cobble substrates. Eggs are deposited within the gravel where incubation, hatching, and subsequent emergence take place. The upper preferred water temperature for spawning adult Chinook salmon is 13ºC (Chambers 1956) to 14 ºC (Reiser and Bjornn 1979). The length of time required for eggs to develop and hatch is dependent on water temperature, and quite variable.

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

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

2.2.1.5 Status of the CV Spring-run Chinook Salmon

Historically, CV spring-run Chinook salmon were the second most abundant salmon run in the Central Valley and one of the largest on the west coast (CDFG 1998). Extensive construction of dams throughout the Sacramento-San Joaquin basin has reduced the CV spring-run Chinook salmon run to only a small portion of its historical distribution. The Central Valley drainage as a whole is estimated to have supported CV spring-run Chinook salmon runs as large as 600,000 fish between the late 1880s and 1940s (CDFG 1998). Some of the most important stressors affecting the viability of CV spring-run Chinook include reduced instream flows, high water temperatures, altered stream and delta hydrology, barriers to historic habitat, and wide-spread loss of tidal marsh, riparian and floodplain habitat (NMFS 2014).

CV spring-run Chinook salmon were originally listed as threatened on September 16, 1999 (64 FR 50394). This ESU consists of spring-run salmon occurring in the Sacramento River basin. The Feather River Fish Hatchery (FRFH) spring-run population has been included as part of the spring-run ESU in the most recent spring-run listing decision (70 FR 37160, June 28, 2005). Although the FRFH spring-run production is included in the ESU, these fish do not have a section 9 take prohibition.

Since the independent populations in Butte, Deer and Mill creeks are the best trend indicators for ESU viability, NMFS can evaluate risk of extinction based on Viable Salmonid Population (VSP) parameters in these watersheds. Lindley *et al.* (2007) indicated that the spring-run Chinook salmon populations in the Central Valley had a low risk of extinction in Butte and Deer creeks, according to their population viability analysis (PVA) model and other population viability criteria (*i.e.*, population size, population decline, catastrophic events, and hatchery influence, which correlate with VSP parameters abundance, productivity, spatial structure, and diversity). The Mill Creek population of spring-run Chinook salmon was at moderate extinction risk according to the PVA model, but appeared to satisfy the other viability criteria for low-risk status. However, the CV spring-run Chinook salmon ESU failed to meet the “representation and redundancy rule” since there are only demonstrably viable populations in one diversity group (northern Sierra Nevada) out of the three diversity groups that historically contained them, or out of the four diversity groups as described in the NMFS Central Valley Salmon and Steelhead Recovery Plan. Over the long term, these three remaining populations are considered to be vulnerable to catastrophic events, such as volcanic eruptions from Mount Lassen or large forest fires due to the close proximity of their headwaters to each other. Drought is also considered to pose a significant threat to the viability of the spring-run Chinook salmon populations in these three watersheds due to their close proximity to each other. One large event could eliminate all three populations.

In the 2011 NMFS status review of the CV spring-run Chinook salmon ESU, the authors concluded that the ESU status had likely deteriorated on balance since the 2005 status review and the Lindley *et al*. (2007) assessment, with two of the three extant independent populations (Deer and Mill Creeks) of spring-run Chinook salmon slipping from low or moderate extinction risk to high extinction risk. Additionally, Butte Creek remained at low risk, although it was on the verge of moving towards high risk, due to the rate of population decline. In contrast, spring-run Chinook salmon in Battle and Clear creeks had increased in abundance since 1998, reaching levels of abundance that place these populations at moderate extinction risk. Both of these populations have likely increased at least in part due to extensive habitat restoration. The Southwest Fisheries Science Center (SWFSC) concluded in their viability report (Williams *et al.* 2011) that the status of CV spring-run Chinook salmon ESU has probably deteriorated since the 2005 status review and that its extinction risk has increased. The degradation in status of the three formerly low- or moderate-risk independent populations is cause for concern.

In the 2016 status review, the authors found, with a few exceptions, CV spring-run Chinook salmon populations have increased through 2014 returns since the last status review (2010/2011), which has moved the Mill and Deer creek populations from the high extinction risk category, to moderate, and Butte Creek has remained in the low risk of extinction category. Additionally, the Battle Creek and Clear Creek populations have continued to show stable or increasing numbers during the last five years, putting them at moderate risk of extinction based on abundance. Overall, the SWFSC concluded in their viability report that the status of CV spring-run Chinook salmon (through 2014) has probably improved since the 2010/2011 status review and that the ESU's extinction risk may have decreased, however the ESU is still facing significant extinction risk, and that risk is likely to increase over at least the next few years as the full effects of the recent drought are realized (Williams *et al*. 2016).

The 2015 adult CV spring-run Chinook salmon returns were very low. Those that did return experienced high pre-spawn mortality. Juvenile survival during the 2012 to 2015 drought has likely been impacted, and will be fully realized over the next several years.

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

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

Sacramento River winter-run Chinook salmon ESU, currently listed as endangered, was listed as a threatened species under emergency provisions of the ESA on August 4, 1989 (54 FR 32085), and formally listed as a threatened species in November 1990 (55 FR 46515). On January 4, 1994, NMFS reclassified the ESU as an endangered species due to several factors, including: (1) the continued decline and increased variability of run sizes since its listing as a threatened species in 1989; (2) the expectation of weak returns in coming years as the result of two small year classes (1991 and 1993); and (3) continuing threats to the species.

On June 28, 2005, NMFS concluded that the winter-run Chinook ESU was "in danger of extinction" due to risks to the ESU's diversity and spatial structure and, therefore, continues to warrant listing as an endangered species under the ESA (70 FR 37160). In August 2011, NMFS completed a 5-year status review and determined that the species status should remain as "endangered" (August 15, 2011, 76 FR 50447). The 2011 status review concluded that although the listing remained unchanged since the 2005 review, the status of the population had declined over the past five years (2005-2010). As with CV spring-run Chinook, some of the most important stressors affecting the viability of winter-run Chinook include reduced instream flows, high water temperatures, altered stream and delta hydrology, barriers to historic habitat, and wide-spread loss of tidal marsh, riparian and floodplain habitat (NMFS 2014).

The winter-run Chinook salmon population currently consists of only one population that is confined to the upper Sacramento River (spawning below Shasta and Keswick dams) in California's Central Valley. In addition, an artificial conservation program at the Livingston-Stone National Fish Hatchery produces winter-run salmon that are considered to be part of this ESA (June 28, 2005, 70 FR 37160).

Critical habitat was designated for the Sacramento River winter-run Chinook salmon on June 16, 1993. PBFs that are essential for the conservation of Sacramento winter-run Chinook salmon, based on the best available information, include: (1) access from the Pacific Ocean to appropriate spawning areas in the upper Sacramento River; (2) the availability of clean gravel for spawning substrate; (3) adequate river flows for successful spawning, incubation of eggs, fry development and emergence, and downstream transport of juveniles; (4) water temperatures between 6 and 14˚C for successful spawning, egg incubation, and fry development; (5) habitat areas and adequate prey that are not contaminated; (6) riparian areas that provide for successful juvenile development and survival; and (7) access downstream so that juveniles can migrate from the spawning grounds to San Francisco Bay and the Pacific Ocean (58 FR 33212).

Designated critical habitat for Sacramento River winter-run Chinook salmon includes the Sacramento River from Keswick Dam, Shasta County (River Mile 302) to Chipps Island (River Mile 0), all waters from Chipps Island westward to Carquinez Bridge, all waters of San Pablo Bay, and all water of San Francisco Bay (north of the San Francisco /Oakland Bay Bridge).

Winter-run Chinook salmon critical habitat has been degraded over its historical conditions. It does not provide the full extent of conservation values necessary for the recovery of the species, particularly the upstream riverine habitat of the Sacramento River. Within the Sacramento River, essential features of critical habitat (*i.e.*, migration corridor, adequate temperature, flows) have been impacted by human activities, substantially altering the historical river characteristic in which winter-run ESU evolved. In the Delta, the man-made alterations may have a strong impact on the survival and recruitment of juvenile winter-run due to changes in migration routes and their dependence of migration cues like high flows and increased turbidity.

The most recent NMFS status review was completed in 2016 and concluded the overall viability of the Sacramento winter-run has declined since the 2010 viability assessment, with the single spawning population on the mainstem Sacramento River (Williams *et al*. 2016). New information available since Williams *et al*. (2011) indicates an increased risk of extinction. The larger influence of the hatchery broodstock in addition to the rate of decline in abundance over the past decade has placed the population at an increased risk of extinction (Williams *et al*. 2016).

2.2.1.7 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 2 meters 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 is the most marine-oriented species of sturgeon (Moyle 2002). Along the West Coast of North America, they range in nearshore waters from Mexico to the Bering Sea (Adams *et al*. 2002), with a general tendency to head north after their out-migration from freshwater (Lindley *et al*. 2011). While in the ocean, archival tagging indicates that green sturgeon occur in waters between 0 and 200 meters depth, but spend most of their time in waters between 20–80 meters and temperatures of 9.5–16.0°C (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 60–80 mm total length (TL). After hatching larvae migrate downstream and metamorphose into juveniles. Juveniles spend their first few years in the Sacramento-San Joaquin Delta (Delta) and San Francisco Estuary before entering the marine environment as subadults. Juvenile green sturgeon salvaged at the State and Federal water export facilities in the southern Delta are generally between 200 mm and 400 mm TL (Adams *et al*. 2002) which suggests southern DPS green sturgeon spend several months to a year rearing in freshwater before entering the Delta and San Francisco Estuary. Laboratory studies conducted by Allen and Cech (2007) indicated juveniles approximately 6-month old were tolerant of saltwater, but approximately 1.5-year old green sturgeon appeared more capable of successful osmoregulation in salt water.

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

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

Green sturgeon feed on benthic invertebrates and fish (Adams *et al*. 2002). Radtke (1966) 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 (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.

2.2.1.8 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 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 population. By comparing ratios of white sturgeon to green sturgeon captures, estimates of southern DPS green sturgeon abundance can be calculated. Estimated abundance of green sturgeon between 1954 and 2001 ranged from 175 fish to more than 8,000 per year and averaged 1,509 fish per year. Unfortunately, there are many biases and errors associated with these data, and CDFG 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 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; 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; 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). 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 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, mitigation 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 PBFs 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 Additional Threats to CCC Steelhead, CCV steelhead, CV spring-run Chinook salmon, Sacramento River winter-run Chinook salmon and Southern DPS of Green Sturgeon

One factor affecting the rangewide status of threatened Southern DPS of North American green sturgeon, threatened CCV steelhead, threatened CCC steelhead, threatened CV spring-run Chinook salmon, endangered Sacramento River winter-run Chinook salmon, and aquatic habitat at large 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). Listed salmonids may have already experienced some detrimental impacts from climate change. NMFS believes the impacts on listed salmonids to date are likely fairly minor because natural, and local climate factors likely still drive most of the climate conditions salmonids experience, and many of these factors have much less influence on salmonid abundance and distribution than human disturbance across the landscape.

The threat to listed salmonids 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; critically dry years may increase (Lindley *et al.* 2007; Schneider 2007; Moser *et al.* 2012). Wildfires are expected to increase in frequency and magnitude (Westerling *et al.* 2011, 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 salmonids and 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 salmonids and sturgeon are likely to experience changes in temperatures, circulation, water chemistry, and food supplies (Brewer and Barry 2008, Feely 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

The action area is defined as all areas affected directly or indirectly by the Federal action and not merely the immediate area involved (50 CFR 402.02). The action area for this project includes the Mare Island dry docks, berths, adjacent waterfront area identified for dredging, and an approximately 1,500 foot (ft.) radius around the dredge footprint area. The action area also includes the dredge material disposal sites at Carquinez (SF-9), San Pablo Bay (SF-10), Alcatraz (SF-11), and beneficial reuse disposal sites in the San Francisco Bay Area.

Mare Island Strait separates Mare Island from the mainland at Vallejo, California, and connects the Napa River with San Pablo Bay. Within Mare Island Strait, the action area includes approximately 140 acres of aquatic habitat immediately adjacent to the Mare Island Shipyard that will be subject to periodic dredging. For disposal of sediment dredged during the period between August 1 and October 16, three in-bay sites may be used: Carquinez Strait (SF-9), San Pablo Bay (SF-10), and Alcatraz (SF-11). The Carquinez Strait placement site is a 1,000-foot by 2,000-foot rectangle, approximately 10 to 55 feet deep, 0.9 mile west of the entrance to Mare Island Strait in eastern San Pablo Bay in Solano County. The San Pablo Bay placement site is a 1,500-foot by 3,000-foot rectangle, approximately 30 to 45 feet deep, 3.0 miles northeast of Point San Pedro in southern San Pablo Bay in Marin County. The Alcatraz placement site is a 1,000-foot-radius circular area, approximately 40 to 70 feet deep, approximately 0.3 mile south of Alcatraz Island in the Central Bay. During the period between December 1 and July 31, various beneficial reuse sites will be used for disposal of dredged materials. These sites are confined in diked nearshore areas or upland areas and, therefore, dredged materials do not come in direct contact with aquatic environs with listed fish species.

Figure 2. MIDD Action Area

2.4 Environmental Baseline

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

The Mare Island Dry Docks are located along the western shore of Mare Island Strait across from the City of Vallejo. The shipyard is the former Mare Island Naval Shipyard which has been operated since 1854. Mare Island Strait forms the connection between the lower Napa River and San Pablo Bay. The Napa River watershed is the largest watershed in the northern San Francisco Bay region, with 48 major tributaries, and draining an area of approximately 426 square miles. The Napa River watershed provides spawning and juvenile rearing habitat for threatened CCC steelhead. For the purposes of this consultation, the Mare Island Strait portion of the action area consists of the water column, substrate, and shoreline in a 140-acre area at the shipyard and the adjacent waterfront area. The water depth in Mare Island Strait in the action area ranges from -5 to -32 feet MLLW depending on the amount of sediment accumulation. The project proposes to create water depths -28 to -32 feet MLLW upon completion of dredging. The sediment in Mare Island Strait is primarily composed of fine-grain silt and clay. The shoreline of Mare Island Strait in the action area has been entirely modified by the construction of piers, wharves, bulkheads, and landfill. Strong tidal influence occurs within Mare Island Strait with average current speeds of 2.3 knots on the ebb tide and 1.6 knots on the flood (NOS 2015).

The three in-bay disposal sites for dredged material are located in two sub-embayments of San Francisco Bay. Carquinez (SF-11) and San Pablo (SF-10) are located in San Pablo Bay, while Alcatraz (SF-9) is located in the Central Bay. Although San Pablo Bay is primarily shallow water habitat, the Carquinez Strait placement site is located in waters approximately 10 to 55 feet deep and the San Pablo Bay placement site is 30 to 45 feet deep. The Alcatraz placement site is located waters approximately 40 to 70 feet deep in the Central Bay. These three in-bay disposal site are considered dispersive in that the material is expected to be dispersed either during placement of dredged sediments or eroded from the bottom over time and transported away from the disposal site by currents. During the period between December 1 and July 31, various beneficial reuse sites will be used for disposal of dredged materials. These sites are confined in diked nearshore areas, and therefore dredged materials do not come in direct contact with aquatic environs with listed fish species.

2.4.1 Status of Species and Critical Habitat in the Action Area

The following sections provide a brief summary of the population and critical habitat status of each listed species within the action area.

2.4.1.1 CCC Steelhead, CCV Steelhead, CV Spring-Run Chinook Salmon, and Sacramento River Winter-Run Chinook Salmon

Available information indicates the action area is used primarily as a migration corridor by listed CCC steelhead, CCV steelhead, CV spring-run Chinook salmon and Sacramento River winter-run Chinook salmon. Adult salmonids migrate from the Pacific Ocean through the San Francisco Bay estuary as they seek the upstream spawning grounds of their natal streams. Adult CCV steelhead migration through the Bay typically begins in fall and winter (McEwan and Jackson 1996). Adult CCC steelhead typically migrate through San Francisco Bay to their natal streams from December through April. Adult Sacramento River winter-run Chinook migrate through San Francisco Bay between December and May. Based on time of entry to natal tributaries in the Central Valley, adult CV spring-run Chinook salmon enter the San Francisco Bay from the ocean for their upstream migration between February and April.

During the spring months, juvenile CCC steelhead (smolts) from the Napa River watershed migrate downstream through Mare Island Strait to reach San Francisco Bay and the Pacific Ocean. Adult CCC steelhead migrate upstream to the Napa River watershed through the Mare Island Strait from December through March. All Napa River CCC steelhead pass through the Mare Island Strait portion of the action area. Additionally, Mare Island Strait is commonly used by downstream migrating Central Valley salmonid juveniles. The results of acoustic tagging studies conducted from 2007 through 2012 indicate it is common for Central Valley salmonid smolts to detour for short periods into Mare Island Strait during their downstream migration to the Pacific Ocean. Tagging studies of late-fall run Chinook salmon and CCV steelhead in 2007 and 2008 detected several Chinook salmon and steelhead smolts traveling north in the Mare Island Strait as far as the Vallejo Marina prior to exiting San Francisco Bay at the Golden Gate (Chapman *et al*. 2009). During a three-year study (2010-2012) of acoustic tagged salmonids in the lower Napa River, ECORP Consulting Inc. (2013) reports Central Valley Chinook smolts were detected in the lower Napa River as far north as Fagan Slough which is over 10 miles from the San Pablo Bay. Residence time for individual fish was also recorded by ECORP Consulting Inc. (2013) at the 13 acoustic receiver stations in the lower Napa River. Results indicate that the residence times of both Central Valley Chinook smolts and Napa River-origin steelhead smolts in the Strait was generally short and typically measured in hours. With strong tidal currents through the Carquinez Strait, Mare Island Strait likely offers a low velocity refuge for the Central Valley salmonid smolts as they navigate their way through the San Francisco Estuary to the Pacific Ocean.

Due to the location of the Carquinez Strait Disposal Site, SF-9, most Central Valley adult and juvenile salmonids likely pass through or near it. The disposal site is located immediately south of Mare Island within an area of deep water and strong currents at the western end of the Carquinez Strait. Napa River CCC steelhead are also likely to pass through the Carquinez Strait Disposal Site due to its location offshore the southern tip of Mare Island and the west of Mare Island Strait.

To assess juvenile salmonid outmigration behavior and timing, a series of studies were performed from 2006 through 2010 with Central Valley late fall-run Chinook salmon and CCV steelhead smolts. Smolt-sized juveniles originating from Coleman National Fish Hatchery were tagged with acoustic transmitters and released in the Sacramento River to monitor their downstream movement to ocean-entry at the Golden Gate. Results showed that smolts generally transited the Bay rapidly in 2 to 4 days, yet also made repeated upstream movements, coinciding with incoming tidal flows (Hearn *et al.* 2013). Most Chinook and steelhead smolts were detected by acoustic receivers located over deep, channelized portions of the Bay (Hearn *et al.* 2013). Smolts detected at nearshore, shallow sites such as marinas, or up tributaries generally returned to the main channel to finish their migration (Hearn *et al.* 2013).

Although the work of Hearn *et al.* (2013) indicates listed anadromous salmonids originating from the Central Valley are rapidly migrating through San Francisco Bay, some juvenile listed salmon and steelhead may utilize the estuary for seasonal rearing during the course of their downstream migration. Historically, the tidal marshes of San Francisco Bay likely provided a highly productive estuarine environment for native fish species, including juvenile anadromous salmonids. However, loss of tidal wetlands, changes in prey communities, and water-flow alterations by regulated rivers have degraded habitat in the estuary and likely limit the ability of the Bay to support juvenile salmonid rearing. MacFarlane and Norton (2002) found that fall-run Chinook experienced little growth, depleted condition, and no accumulation of lipid energy reserves during the relatively limited time the fish spent transiting the 40-mile length of the estuary. Sandstrom *et al*. (2013) found that CCC steelhead smolts emigrated more rapidly through the Bay than the Napa River and the ocean.

In contrast to demersal fish that are associated with the channel bottom, salmonids are pelagic fish and, as such, primarily occupy the water column and near surface when over deeper waters (Mari-Gold Environmental and Novo Aquatic Sciences 2009). Within the action area, listed salmon and steelhead are thought to typically display a preferential use of the middle and upper water column. Studies by Kjelson *et al.* (1982) in the Sacramento-San Joaquin Delta concluded juvenile Chinook salmon appear to prefer shallow water habitats near the shore and the upper portion of the water column (less than 10 feet deep).

2.4.1.2 CCC Steelhead and Sacramento River Winter-Run Chinook Salmon Critical Habitat

Designated critical habitat for CCC steelhead and Sacramento River winter-run Chinook salmon includes both the Mare Island Strait portion of the action area and the three in-bay dredge disposal sites: Carquinez Strait (SF-9); Alcatraz (SF-11); and San Pablo Bay (SF-10). PBF's essential for the conservation of CCC steelhead include estuarine areas free of obstruction and excessive predation with: (1) water quality, water quantity and salinity conditions supporting juvenile and adult physiological transitions between fresh- and saltwater; (2) natural cover such as submerged and overhanging large wood, aquatic vegetation, large rocks and boulders, and side channels; and (3) juvenile and adult forage, including aquatic invertebrates and fishes, supporting growth and maturation (70 FR 52488).

Essential features of designated critical habitat for CCC steelhead in the action area include the estuarine water column, benthic foraging habitat, and food resources used by steelhead as part of their juvenile downstream migration and adult upstream migration. These essential features of estuarine PBFs of designated critical habitat within the action area are partially degraded and limited due to altered and diminished freshwater inflow, shoreline development, shoreline stabilization, non-native invasive species, discharge and accumulation of contaminants, loss of tidal wetlands, and periodic dredging for navigation.

Features of designated critical habitat for winter-run Chinook salmon in the action area essential for their conservation are habitat areas and adequate prey that are uncontaminated. These PBFs of designated critical habitat within the action area are degraded and limited. Habitat degradation in the action area is primarily due to altered and diminished freshwater inflow, shoreline development, shoreline stabilization, non-native invasive species, discharge and accumulation of contaminants, loss of tidal wetlands, and periodic dredging for navigation.

2.4.1.3 Green Sturgeon

Green sturgeon are iteroparous[1], 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 the bay after spawning in the Sacramento River in the spring and early summer for months prior to emigrating into 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 action area year-round.

Little is known about green sturgeon distribution and abundance in the Bay, and what influences their movements (Kelly *et al*. 2007). Tracking of green sturgeon movements in the Bay indicate

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

that sub-adults typically remain in shallower depths (less than 30 feet) and show no preference for temperature, salinity, dissolved oxygen, or light levels (Kelly *et al*. 2007). Observations also suggest that there are two main types of movements of sub-adult green sturgeon: directional and non-directional (Kelly *et al*. 2007). Tracking data suggests that directional movements typically occur near the surface of the water, while non-directional movements were associated with the bottom at depths up to 42 feet, indicating foraging behavior (Kelly *et al*. 2007) since green sturgeon are known to feed on benthic invertebrates and fish (Adams *et al*. 2002). Within the San Francisco Estuary, green sturgeon are encountered by recreational anglers and during sampling by CDFW in the shallow waters of San Pablo Bay. These fish are likely foraging on benthic prey and fish commonly found in soft-bottom habitats (ghost shrimp, crab, crangonid shrimp, and thalassinid shrimp) (Dumbauld *et al*. 2008).

As a demersal fish, green sturgeon are commonly associated with the channel bottom. Kelly *et al*. (2007) tracked the movements of several individual green sturgeon through the San Francisco Bay Estuary with ultrasonic telemetry. These observations concluded that non-directional movements, accounting for 63.4% of observations, were closely associated with the bottom, with individuals moving slowly while making frequent changes in direction and swim speed, or not moving at all. These non-direction movements recorded sturgeon swimming at bottom depths ranging from one foot to 80 feet; however, over 70% of sturgeon remained in shallow regions of the estuary less than 30 feet deep, and it was uncommon for sturgeon to swim at depths greater than 52 feet (Kelly *et al*. 2007). Directional movements, accounting for 36.6% of total observations, were typified by continuous and active swimming while holding a steady course for long periods of time. When all depth records from directional movements were grouped, Kelly *et al*. (2007) concluded that green sturgeon make directional movements near the water surface (in the upper 6 feet of the water column) and rarely ventured below 15 feet, despite the depth of the bottom exceeding 60 feet in depth.

The CDFW conducts regular surveys to estimate sturgeon (white and green) abundance, relative abundance, harvest rate, and survival rate in San Francisco Bay and the delta. They collect information from recreational and commercial fisherman as well as conduct annual sampling in Suisun and San Pablo bays. Data from 2012 and 2013 show that green sturgeon abundance is low in Suisun and San Pablo bays relative to white sturgeon abundance. Green sturgeon make up approximately 2-5 percent of the total reported sturgeon caught in the greater Bay and lower delta. Green sturgeon catches were highest in Suisun Bay and San Pablo Bay, with very few green sturgeon reported in Central San Francisco Bay. However, this may be due to variances in fishing efforts in different locations in the Bay. Nonetheless, based on the available data, NMFS believes green sturgeon abundance in the action area is low.

2.4.1.4 Green Sturgeon Critical Habitat

Mare Island Strait and the three dredged material disposal sites are 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 sturgeon critical habitat in the action area are degraded. Habitat degradation in the action area is primarily due to altered and diminished freshwater inflow, shoreline development, shoreline stabilization, non-native invasive species, discharge and accumulation of contaminants, loss of tidal wetlands, and periodic dredging for navigation.

2.4.2 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. Each of these drivers is considered a stressor that continues to affect the viability of anadromous fish in San Francisco Bay (NMFS 2016). Responses to these drivers in the Bay include shifts in the timing and extent of freshwater inflow and salinity intrusion, restructuring of plankton communities, nutrient enrichment and metal contamination of biota, and large-scale food web changes (Cloern and Jassby 2012). Major factors affecting the species environment in the Bay are described below:

2.4.2.1 Reduced Amount and Altered Timing of Freshwater Flow

Following the gold rush of the mid 1800s, population growth and economic development in California required a stable water supply. Large water projects were developed to capture and transport runoff from wet regions to drier regions for agriculture and residential supplies (Nichols *et al*. 1986). Approximately 60 percent of runoff from the Delta and upstream watersheds reach the Bay (Cloern and Jassby 2012). Water exports from the Delta increased from 5 percent to 30 percent of the total runoff from the Delta between 1956 and 2003 (Cloern and Jassby 2012). Researchers have identified several biological impacts of reduced inflow from the Delta to the Bay and altered salinity gradients in the North Bay, namely, large-scale population declines of native aquatic biota across trophic levels from phytoplankton (Alpine and Cloern 1992) to zooplankton (Winder *et al*. 2011) to pelagic fish (Sommer *et al*. 1997), and large shifts in biological communities (Winder and Jassby 2011).

2.4.2.2 Changes to Sediment Supply

Major historical changes to the estuary were driven by extensive hydraulic mining in the western foothills of the Sierra Nevada Mountain Range between 1850 and 1900, when over 850 million cubic meters (m^3) of sediment was discharged into watersheds that drain to the Bay (Gilbert 1917). Sediment influxes into the Bay from hydraulic mining resulted in ecosystem alterations, including the development of extensive intertidal flats and tidal marshes (*i.e.*, centennial marshes) (Jaffe *et al*. 2007), and widespread mercury contamination (David *et al*. 2009). Logging, urbanization, agriculture, and grazing within Bay Area watersheds since the 1850s have also lead to increased sediment yields and pollution in the Bay. At the same time, the construction of dams, reservoirs, flood control structures, and bank protection in watersheds draining to the Bay in the 20th century have concurrently trapped and/or reduced the transport of sediment to the Bay and reduced peak flows that transport sediment to the Bay (Barnard *et al*. 2013).

The three dredge material disposal sites receive sediment from dredging projects throughout the greater San Francisco Bay. Dredged materials are typically transported by barge to the sites and materials dropped into the open water. These three in-bay disposal site are considered dispersive in that the material is expected to be dispersed either during placement of dredged sediments or eroded from the bottom over time and transported away from the disposal site by currents.

2.4.2.3 Contaminants

Sediments within the Bay contain a substantial amount of contaminants from historical point and non-point sources. Contaminants often times are bound to sediments, and thus their distribution within the environment is driven by sediment dynamics in the Bay. In some areas of the Bay, contaminated sediments are being buried by cleaner sediments; in other areas, contaminated sediments or clean sediments overlying contaminated sediments are eroding. Remobilization of buried contaminants can occur through erosion of sediments, which can lead to contamination of the surface of the sediment layer and the water column. This is of particular concern for many legacy contaminants (*e.g.*, the pesticide DDT) that no longer are supplied to an estuary in large quantities, compared to historic inputs, but continue to persist because the bottom sediment acts as a source, as in the case of San Francisco Bay (Cloern and Jassby 2012).

2.4.2.4 Invasive Species and Ballast Water Effects

San Francisco Bay is considered one of the most invaded estuaries in the world (Cohen and Carlton 1998). Invasive species contribute up to 99 percent of the biomass of some of the communities in the Bay (Cloern and Jassby 2012). Invasive species can disrupt ecosystems that support native populations. While there have been numerous invasions in the Bay, the best documented and studied invasive is the non-native overbite clam *Corbula amurensis*. It is a small clam native to rivers and estuaries of East Asia that is believed to be introduced in the ballast waters of ships entering the Bay in the late 1980s. *C. amurensis* can utilize a broad suite of food resources and withstand a wide range of salinities, including a tolerance of salinities less than 1 ppt (Nichols *et al*. 1990). Its introduction has corresponded with a decline in phytoplankton and zooplankton abundance due to grazing by *C. amurensis* (Kimmerer *et al*. 1994). Prior to its introduction, phytoplankton biomass in the Bay was approximately three times what it is today (Cloern 1996; Cloern and Jassby 2012), and the zooplankton community has changed from one having large abundances of mysid shrimp, rotifers, and calanoid copepods to one dominated by copepods indigenous to East Asia (Winder and Jassby 2011).

The discharge of ballast water from large vessels (*i.e.*, container ships) is the major pathway for the introduction of invasive species in the San Francisco Estuary. Ballast water is taken on by a vessel to increase water draft, change the trim, regulate stability or maintain stress loads. When the ship reaches its destination, it commonly discharges ballast water containing the larvae of nonindigenous organisms. Under the Nonindigenous Aquatic Nuisance Prevention and Control Act of 1990 as reauthorized and amended in the National Invasive Species Act of 1996, the United States Coast Guard (USCG) is the lead federal agency in implementing regulations to reduce or prevent the introduction of nonindigenous species via shipping activities in United States waters. On March 23, 2012 the USCG publish in the Federal Register standards for living organisms in ship's ballast water discharged in U.S. waters. This standard which took effect in 2013 establishes an allowable concentration of living organisms in ship's ballast water discharges for the purpose of preventing or reducing the introduction of nonindigenous species. The USCG's program also requires vessel operators to maintain records and report their discharges. USCG has the ability to board vessels to ensure vessel operators are treating and discharging ballast water in compliance with all requirements.

The State of California has also adopted regulations to prevent and reduce the release of nonindigenous species from commercial vessels to California waters. The Marine Invasive Species Act of 2003 requires vessels to adopt a ballast water management plan and maintain ballast water activity records. California's multi-agency Marine Invasive Species Program (MISP) is comprised of the State Lands Commission, CDFW, State Water Resources Control Board and the Board of Equalization. The policy and regulations developed for the California by the MISP include the action area of this consultation and are considered by the State to be the most practicably achievable standards for avoiding the discharge of nonindigenous species. Although the recently adopted USCG and State of California ballast water discharge standards are likely effective in preventing and reducing the harmful introduction of new nonindigenous species, the current suite of exotic plants and aquatic animals living in San Francisco Bay persist.

2.4.2.5 Natural Ocean-Atmosphere Variations

Research indicates that the Bay is significantly influenced by ocean-atmosphere variations (*i.e.*, the North Pacific Gyre Oscillation and the Pacific Decadal Oscillation). For example, following a strong El Nino event in 1997-1998 and an equally strong La Nina event in 1999, the ocean waters adjacent to San Francisco Bay cooled and upwelling intensity increased. Major changes in the Bay ensued, with record high populations of fish species that migrate from the ocean to the Bay (*e.g.* English sole, Dungeness crab). The increase in abundance of predators to the Bay led to large-scale trophic cascades in the Bay characteristic of a cool, high-production regime (Cloern and Jassby 2012). Such climate shifts occur at various intervals and have widespread implication on the annual mean abundance of biota in the Bay (see Figure 16: Cloern and Jassby 2012).

2.4.2.6 Operation of the Mare Island Shipyard

At Mare Island Strait, the action area was impacted by the U.S. Navy's operation of the Mare Island Shipyard from 1854 to 1996. Contaminants originating from the shipyard and other U.S. Navy activities on Mare Island degraded water quality and contaminants accumulated in the sediments of Mare Island Strait. In the past, the area in front of the shipyard was regularly dredged to provide access for large ships into the berths and dry docks. Adjacent to the shipyard, the Corps periodically dredged the Mare Island Strait Federal Navigation Channel. Corps dredging of the area immediately in front of the shipyard likely collected and removed from Mare Island Strait a high percentage of the sediments laden with contaminants. There are also several marinas and piers along the Mare Island Strait that are periodically dredged for navigation purposes. Within the action area, and directly across Mare Island Strait from MIDD, Vallejo Ferry Terminal is dredged, approximately, every 4-5 years.

Since February 2011, operations at the Mare Island dry docks have resumed. Flood-up of the dry docks result in the entrainment fish from Mare Island Strait and many of these fish are subsequently entrapped when the dry dock caisson doors are closed. To reduce the level of impact associated with dry dock operations, entrapped fish are collected and relocated to Mare

Island Strait, but not all fish survive the collection/relocation process. Initially, ADR solely utilized the dynamic barrier net to reduce the number of fish entrained into the dry docks during filling. In June 2012, ADR added an internal bubble curtain system that is located in front of the caisson doors of Dry Docks 2 and 3. The bubble curtain is operated as a behavioral deterrent to fish when the caisson doors are not in place. The system generates a constant stream of bubbles across the entire opening between the dry dock and Mare Island Strait. The use of the bubble curtain has resulted in a substantial reduction in the number of fish encountered during each fish salvage event when compared to salvage events conducted prior to implementation (Table 1).

Table 1. Average number of fish encountered per salvage before and after installation of the bubble curtain at Mare Island Dry Docks 2 and 3.

	Prior to installation of bubble curtain (February 2011- May 2012)	After installation of bubble curtain (June 2012 – September 2013)
Longfin Smelt	27	1
Other* Species of Native Fish	55	11
Total Fish	210	55

*Species of native fish other than longfin smelt.

The number of salmonids and sturgeon entrained into the dry docks has been significantly reduced since the deployment of the bubble curtain deterrence system. Prior to deployment, moderate numbers of hatchery-origin Chinook salmon smolts were found during evolutions occurring in the spring (March through May), and since deployment only ten salmonid smolts have been encountered (July 2012 – December 2016) in total. No green sturgeon have ever been encountered during fish salvage activity, however, the non-listed white sturgeon (*Acipenser medirostris*) have been encountered in low numbers. Prior to deployment of the bubble curtain, white sturgeon were encountered in 50% of the salvages. With implementation of the bubble curtain, the frequency of encountering white sturgeon has been reduced to 19% of the salvages. Other fish protection measures in use since 2011 include decreasing the amount of time the caisson is removed to allow vessel transfer. The effects of dry dock operations on listed fish is discussed further in the "Effects" section of this opinion.

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

Pursuant to section 7 of the ESA, NMFS has conducted multiple interagency consultations in action area. These consultations were primarily related to dredging, wetland restoration, shoreline stabilization, and maintenance of existing infrastructure along the shoreline (*i.e.* repair of wharves, docks and piers). For most of these projects NMFS determined that they were not likely to adversely affect listed salmonids or green sturgeon or their critical habitat. For those projects with adverse effects on listed salmonids and green sturgeon and/or critical habitat, NMFS determined that they were not likely to jeopardize the continued existence of listed salmonids or adversely modify critical habitat. Adverse effects that resulted from these projects are not anticipated to affect the current population status of listed salmonids or green sturgeon.

Research and enhancement projects resulting from NMFS' section 10(a)(1)(A) research and enhancement permits and section 4(d) limits or exceptions could potentially occur in the action area. Salmonid and sturgeon monitoring approved under these programs includes juvenile and adult net surveys and tagging studies. In general, these activities are closely monitored and require measures to minimize take during the research activities. As of October 2016, 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 species status section of this opinion indicates that listed salmonids and 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 salmonids and 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. During the next 14 years, these impacts are unlikely to be as evident or severe as those projected for the end of this century. However some local effects, such as the recent drought in California, and global effects, such as sea level rise, may be evident in this 14-year time frame. Reduced freshwater flows could affect the salinity gradient in the action area, *e.g.* salinity could increase locally with less freshwater outflow. Estimates of sea level rise are approximately 3.2 mm per year (Merrifield *et al.* 2015); if this trend continues, sea level rise in 14 years would be approximately 4.5 cm.

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 biological opinion, our approach 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, that salmonids and green sturgeon are likely to be exposed to. Next, we evaluated the likely response of salmonids and 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 salmonids, sturgeon, and their critical habitat, were limited or not available, our assessment of effects focused mostly on qualitative identification of likely stressors and responses.

Proposed project activities that are expected to affect listed anadromous salmonids, green sturgeon and designated critical habitat are dredging, disposal of dredged materials, and dry dock operations.

2.5.1 Dredging and Disposal of Dredged Materials

MIDD proposes to remove approximately 80,000 cy of material during the period between August 1 to October 15, and as many as three additional dredging events of up to 20,000 cy each, if needed, during the period between October 16 to July 31. The proposed modifications to the Corps permit would expand the annual time period in which dredging and disposal could occur. Dredged materials will be placed on a barge for transport to the disposal site. During the period between December 1 and July 31, various beneficial reuse sites will be used for disposal of dredged materials. These sites are confined in diked nearshore areas, and therefore dredged materials do not come in direct contact with aquatic environs with listed fish species. Dredging conducted between August 1 and November 30, may dispose of materials at three in-bay disposal sites: Carquinez Strait (SF-11) and San Pablo (SF-10) are located in San Pablo Bay, while Alcatraz (SF-9) is located in Central San Francisco Bay.

Dredging and disposal of dredged materials by this project has the potential to directly affect listed salmonids, green sturgeon, and critical habitat though degradation of water quality, exposure to re-suspended contaminants, and physical entrainment of fish by the clamshell dredge bucket.

2.5.1.1 Water Quality During Dredging

At the dredging site in front of the shipyard, the primary concerns for listed fish are exposure to elevated levels of suspended sediments, exposure to natural and anthropogenic contaminants re-suspended by dredging activities, and entrainment by the clamshell dredge. As the clamshell dredge collects material from the bottom of Mare Island Strait, disturbance of the substrate and movement of the bucket introduces bottom materials into the water column. Sediment resuspension caused by dredging is defined as those sediment particles suspended into the water column during dredging that do not rapidly settle out of the water column (Hayes and Engler 1986). Sediment resuspension when a clamshell dredge is used is generated primarily from four sources: 1) when the bucket contacts the sediment bed, closes, and is pulled off the bottom; 2) sediment loss from the bucket as it is raised or lowered through the water column; 3) sediment loss when the bucket breaks the water surface; and 4) sediment-laden water leaking through the openings between the jaws of the bucket during hoisting and swinging from water to the barge (Herbich and Brahme 1991). The degree of resuspension of sediments from dredging and disposal depends on certain variables (Herbich and Brahme 1991, Pennekamp and Quaak 1990, Johnson and Parchure 2000, Thackston and Palermo 2000), such as sediment grain size, dredge and disposal site characteristics (*i.e.* salinity and hydrodynamic forces), and nature of the dredging operation (*i.e.* dredge type/size, and production rate), the “tightness” of the bucket, and the proficiency of the operator.

Field and laboratory analysis examining the dispersion of dredged material indicates that sediment suspended during dredging or open-water disposal either remains suspended in the upper water column at relatively low concentrations or forms high concentrations suspended near the bottom (Barnard 1978). The degree of suspended sediment concentrations at the dredge and disposal sites largely depends on the size of the sediment particles (Herbich 2000). Fine-grain sediments, such as the clay and silt material found in Mare Island Strait, have a tendency to quickly go into suspension during the dredging process, typically within 2-3 hours (Rich 2010).

This resuspended fine-grain sediment at the dredge site can remain in suspension for an extended period of time in the upper water column where listed salmonid smolts are likely to inhabit, although strong currents present at the site will help disperse suspended sediment.

Studies have been conducted at the Port of Oakland in San Francisco Bay to characterize the suspended sediment plume associated with the use of clamshell dredges (MEC Analytical Systems, Inc. & U.S. Army Engineer Research and Development Center 2004, Clarke *et al.* 2005). Turbidity plumes generated during the use of a mechanical clamshell dredge can extend as far as 1,500 ft. near the substrate when using ineffective equipment, however, plumes remain closer to dredging activities when more effective equipment is used (MEC Analytical Systems, Inc. & U.S. Army Engineer Research and Development Center 2004). Clarke *et al.* (2005) reported pulses of elevated suspended sediment concentrations coincided with repetitive cycles of a 12 cy bucket impact with the substrate. The highest concentrations of suspended sediment measured with an acoustic Doppler current profiler by Clarke *et al.* (2005) extended up to 500 feet from the source and concentrations ranged from 200 to 275 mg/l in this area. With increasing distance concentrations greater than 100 mg/l were observed only in relatively small pockets of water that dispersed along the bottom (Clarke *et al.* (2005). Background suspended sediment concentrations in the San Francisco estuary vary depending on location, but typically can range from 25 and 200 mg/l (Buchanan and Schoellhamer 1996). Based on these findings, the degradation of water quality is anticipated to be limited to the periods when the dredge is actually in operation and may extend up to 1,500 ft. near the substrate. In the middle and upper portions of the water column, the extent of the turbidity plume is anticipated to generally extend 500 to 1,000 ft. based on observations by Clark *et al*. (2005). Elevated turbidity levels and concentrations of suspended sediment are expected to return to background levels when dredging ceases due to strong tidal currents in Mare Island Strait.

In addition to the resuspension of sediment, there is potential in Mare Island Strait for the resuspension of contaminants. Past industrial operations along the waterfront of Mare Island Strait have resulted in the delivery of contaminants to the Strait and some have likely accumulated in bottom sediments. Thus, suspended sediments in the water column likely include both natural and anthropogenic contaminants. Removal of sediment with clamshell equipment can result in the resuspension of contaminated sediment and increase levels of toxicity in the water column during dredging operations.

The potential short-term effects of degraded water quality on fish include acute toxicity, subacute toxicity, and biological and other indirect effects such as avoidance (Jabusch *et al*. 2008). Potential long-term effects are associated with bioaccumulation of contaminants. Due to the year-round residency of juveniles in San Francisco Bay and their long life span, green sturgeon are subject to a higher risk of exposure and potential bioaccumulation. Due to their short period of residency in the action area, listed salmonids are significantly less vulnerable to impacts associated with contaminants released by dredging and disposal activities.

Dredged materials distributed throughout the water column can change the chemistry and the physical characteristics of the receiving water by introducing chemical constituents in suspended or dissolved form. Heavy metals (Cd, Cu, Hg, Ni, Pb, Zn, Ag, Cr, As), and organic contaminants (PAHs, PCBs, pesticides) are of particular concern. Additionally, dredge plumes have the potential to cause short-term changes in dissolved oxygen (DO), pH, hydrogen sulfide (H_2S), and ammonia. The rapid conversion to sulfates and nitrate can lead to drops in DO. The introduction of nutrients or organic material to the water column as a result of the discharge can lead to a high biochemical oxygen demand (BOD), which in turn can also lead to reduced dissolved oxygen, thereby potentially affecting the survival of many aquatic organisms. Increases in nutrients can favor one group of organisms such as polychaetes or algae to the detriment of other types.

Contaminants in an aquatic environment typically become available to fish via gill uptake or ingestion with food. The potential short-term effects of contaminant uptake on fish are primarily a function of the fish species, type of contaminant, its concentration in the sediment, the environmental conditions at the time of dredging (*e.g.*, low oxygen or reducing environments), and the duration of the exposure (Jabusch *et al.* 2008).

The response of salmonids to suspended sediments varies among life stages, and is a function of particle size, particle shape, water velocities, suspended sediment concentrations, contaminants, dissolved oxygen levels, and exposure duration (O'Conner 1991). High concentrations of suspended sediment can adversely affect fish through reduced feeding and growth, damage to gill rakers and gill filaments, modification of movements and migration patterns, and reduction in the abundance of prey items (Hanson 2003). Sigler *et al.* (1984) exposed juvenile coho salmon and steelhead to suspended sediment concentrations ranging from 260 to 380 mg/l for periods of up to 336 hours. Although survival rates were close to 100%, there was some reduction in growth rate for both species. Also, given the opportunity, both species would migrate to clearer water. There was also no readily discernible gill damage until after at least 3-5 days of exposure. Newcombe and Mac Donald (1991) conducted a thorough survey of the literature on the impacts of suspended sediments to aquatic systems, with a focus on anadromous salmonids. They concluded that concentration alone is a relatively poor indicator of impact. Among the research cited by the authors included Noggle (1978), who found a 45% reduction in feeding rate for coho salmon at 100 mg/l, and a 90% reduction in feeding rate at 250 mg/l. Noggle (1978) also found that histological damage to Chinook salmon gills at concentrations of 1,547 mg/l over 96 hours, and 50% mortality of juvenile coho salmon when exposed to 1,200 mg/l over 96 hours.

Based on water quality monitoring at other dredging projects in San Francisco Bay, the suspended sediment concentrations anticipated to occur during dredging by this project are between 100 and 300 mg/l. These concentrations may impede visual foraging, but are not at levels that have been observed to produce the acute effects (1,200 mg/l over 96 hours) to salmonids discussed above. This is especially true given the short duration of exposure during dredging and the ability of the fish to access adjacent areas of clearer water in Mare Island Strait. However, elevated levels of suspended sediment within the plume may interfere with visual foraging and lead to an increased susceptibility for predation. Short-term pulses of suspended sediments can disrupt feeding behavior and lead to physiological stress such as increased cough reflexes, reduced swimming activity, and gill flaring. Suspended sediment also reduces the avoidance response of juvenile Chinook salmon to bird and fish predators (Gregory 1993) and induces a surfacing response in juvenile coho salmon, which potentially increases their vulnerability to predation (Servizi 1990, Servizi and Martens 1992). In contrast, Gregory and Northcote (1993) found that elevated suspended sediment concentrations may reduce the risk of predation while foraging, and result in increased foraging rates, as was observed for juvenile Chinook salmon.

Green sturgeon are well adapted to forage in fine sediment and can tolerate the concentration levels of suspended sediment anticipated to occur during dredging by this project. Green sturgeon seek soft sediment areas for foraging upon benthic prey organisms. Sediment likely enters the mouth of green sturgeon as they forge along the bottom of the estuary. Green sturgeon's sensory systems likely aid in their navigation through areas when suspended sediment creates a visual impairment. Therefore, the localized areas of suspended sediment associated with this project's clamshell dredging operations are not expected to impair or harm green sturgeon.

To determine the potential level of contaminants and associated risks to aquatic organisms during dredging, individual sediment core samples from the Mare Island Strait dredge area were submitted by ADR for chemical analysis and composite sample were submitted for biological testing in 2009. All analytical chemistry results were generally within or below San Francisco Bay background levels. Results from the amphipod and polychaete solid-phase bioassays showed no evidence of increased mortality in test sediments compared to the Carquinez Strait reference sediment (Pacific EcoRisk and ADR 2009). Overall, the results showed the dredged materials are suitable for in-bay aquatic disposal and would not result in increased toxicity to aquatic organisms.

Additionally, maintenance dredging has been performed in the action area since 2010, and with the exception of dredging at Berth 12 in 2014, chemical and physical sediment results for dredging events have been comparable to the reference site samples (*i.e.*, Carquinez Strait and Cullinan Ranch Restoration Site) and below Bay ambient levels. Benthic testing results determined that sediments dredged from areas in front of the dry docks show no significant benthic toxicity based on survival exhibited by the marine amphipods and polychaetes (CLE Engineering 2016). As a result of elevated levels of arsenic and PAHs at Berth 14 detected in 2014, half the material was placed at Winter Island and half was placed at Cullinan Ranch Restoration Site for that dredging event.

For future dredging episodes at MIDD conducted under the Corps permit, the DMMO process requires sediment testing prior to dredging episodes for the purpose of determining potential contaminant levels in dredged materials and selection of appropriate disposal sites. Based on sediment test results, the DMMO may impose measures at the dredge site as well as restrict disposal placement locations. This DMMO process is expected to continue to minimize the potential for water quality degradation and release of hazardous materials into the water column during maintenance dredging events.

Based on the above, adverse effects due to contaminants and suspended sediments released by dredging activities conducted by the MIDD are anticipated to be minor on listed anadromous salmonids and green sturgeon. This is due to: 1) the small area affected by dredging activities in Mare Island Strait, 2) the anticipated low concentrations of suspended sediments, 3) water volume and tidal circulation in Mare Island Strait, and 4) sediment testing and evaluation which ensures no in-Bay disposal of sediments that exceed bioaccumulation trigger values. These factors either minimize or avoid the chance of exposure and dilute toxic materials to such small amounts that even if exposure were to occur, effects to listed salmonids or green sturgeon would be negligible.

2.5.1.2 Entrainment by Clamshell Bucket

Although remote, there is a potential for listed species to be collected by the bucket on a clamshell dredge operated at the MIDD. The risk of entrainment is difficult to determine as there are little data available regarding fish densities in this area and little information regarding incidences of fish entrainment by a clamshell dredge. Because green sturgeon is a benthic species, its exposure to this potential impact is greater than for salmonids, which primarily inhabit the upper water column. Although juvenile salmonids may be present during the dredge events conducted from December 1 through May 31, as mentioned above, they are likely to be in the upper water column thus avoiding the clamshell bucket gathering sediments from the bottom. Adult and juvenile salmonids are not benthic and it is very unlikely that they would be present on the soft sediment bottom of Mare Island Strait in water depths of 25 to 30 feet. In addition, the excellent swimming ability of adult and juvenile salmonids makes it unlikely that they would be entrained by an operating clamshell dredge.

For green sturgeon, tagging studies conducted by the California Fish Tagging Consortium have shown that adults during their migration runs and “summer resident” adult and subadults are most frequently in the Mare Island Strait during the winter, spring, and early summer months. Juvenile sturgeon may be in the area during late summer (UC Davis, 2014). Although no data are available to quantify the risk of capture by the dredge bucket, NMFS believes the potential risk of capture is very low because the noise and water pressure waves generated by the dredge bucket lowering and raising through the water column will be detected by the green sturgeon. Fish within the action area would be expected to disperse with this intrusion. Overall, the chance of entraining a green sturgeon or listed salmonid in the clamshell bucket is considered remote and risk is small. Fish in the vicinity of the project may be startled by the operation of the dredging equipment, but these activities should not result in more than minimal disturbance to them and the open water of adjacent Mare Island Strait and San Pablo Bay offers adequate opportunity to avoid the area of disturbance.

2.5.1.3 Disposal of Dredge Materials

For disposal of dredged materials during the August 1 to October 15 work window, MIDD proposes to use either in-bay disposal sites or beneficial reuse sites. For in-bay disposal, the Carquinez Strait disposal site (SF-9) in eastern San Pablo Bay is the closest to MIDD and the most likely site to be used; however, Corps may also authorize disposal at Alcatraz (SF-11) or San Pablo Bay (SF-10). The period of August 1 to October 15 avoids the primary migration seasons of listed anadromous salmonids. Thus, in-bay disposal events will be limited to periods when listed salmonids are unlikely to be present in the action area and the chance of exposure to the short-term effects of disposal is miniscule for listed anadromous salmonids. Green sturgeon may be present in the action area year-round and potentially exposed to the effects of in-bay disposal. All material dredged during the period between October 16 and July 31 will be disposed at a beneficial reuse site such as Cullinan Ranch or Montezuma Wetlands Restoration site.

For threatened green sturgeon, disposal of dredged materials at the in-bay disposal sites is expected to create short-term elevated levels of suspended sediment in the water column and impacts similar to that presented above for dredging. Barges will transport dredged material from the Mare Island Strait portion of the action area to one of three designated sites where the sediments will be dropped into bay waters. Deep water conditions (-30 to -60 ft. MLLW) and swift tidal currents (3 to 4 knots current) at the disposal site are expected to disperse the dredged materials.

As part of a Corps permit to dispose of dredge material from the Larkspur Ferry Landing project, the Golden Gate Bridge Highway and Transportation District conducted a monitoring program that consisted of sediment plume tracking, water quality assessment, and a fish avoidance assessment at the Alcatraz Island Disposal Site (SF-11) between May 1 and May 9, 1990 (MEC 1990). Results of the plume tracking and water quality assessment showed that concentrations during disposal of dredge materials were generally very low with sulfide values ranging from less than 0.001 mg/l to) 0.014 mg/l. Results of the fish avoidance observation indicated that fish occupied the site prior to sediment disposal, but were not present during and, in general, did not occupy the site again until two hours after sediment disposal. However, avoidance was reported to be associated more with the physical act of disposal than with water quality impacts (MEC 1990).

As presented above for dredging, elevated concentrations of suspended sediments can lead to a host of impacts and physiological stress for fishes. However, the disposal events performed by this project at the Carquinez Strait Disposal Site and other in-bay disposal sites are anticipated to result in minor, localized and short-term increases in suspended sediments. Based on conditions at the disposal sites and the results of past water quality monitoring, elevated suspended sediment levels created by this project are expected to be considerably less than the thresholds commonly cited as the cause of physical impacts to fish. Although green sturgeon may encounter elevated levels of suspended sediment during an in-bay disposal event, the anticipated levels are not expected to adversely affect because sturgeon are adapted to living in estuaries with fine sediment bottoms and are tolerant of high levels of turbidity; specifically, they are tolerant of levels of turbidity that exceed levels expected to result from the proposed activities.

During the period between October 16 and July 31, disposal of dredged materials will be limited to beneficial reuse sites. Beneficial reuse sites typically consist of placement in a diked former bayland areas under conversion to wetlands or levees requiring maintenance. These disposal sites, as well as other beneficial reuse sites, are not located in the open waters of the San Francisco Bay and isolated from tidally-influence areas where listed fish may be present. Thus, no effects to listed salmonids nor green sturgeon are anticipated from the disposal of dredged materials during the period from October 16 through July 31.

2.5.2 Dry Dock Operations

MIDD has operated the dry docks at the Mare Island Shipyard since 2013, providing services for ship maintenance, repair, overhaul, and ship dismantling. Prior to MIDD, ADR operated the dry docks during 2011 and 2012. Ships are tied up along berths for internal work while the dry docks are used primarily for external ship repairs. The potential impact to listed fish associated with operations at the shipyard pertains to the filling of these dry docks with water from Mare Island Strait. A dry dock “evolution” consists of a complete cycle up and down for a vessel, which involves bringing a vessel into the dry dock, performing the required service, and removing the vessel from the dry dock. MIDD may conduct as many as 104 evolutions total annually at all dry docks at the Mare Island Shipyard.

For a ship to enter or exit the dry docks, water from Mare Island Strait will be allowed to flow by gravity through a series of valves, pipes, and tunnels to fill the dry dock. There is potential for listed fish to be diverted from Mare Island Strait into the dry dock water intake system during a filling event. The four dry docks at the shipyard vary in capacity from 9 to 19 million gallons of water and the system is designed to fill the dock in a period of approximately 90 minutes. To flood a dry dock in a 90-minute period, the rate of flow into and through the dry docks filling system is initially very high. Velocities are expected to range as high as 5.25 ft. per second at the intake structure. This flow rate can exceed the swimming ability of small fish, including juvenile salmonid smolts. Fish in the vicinity of the dry dock filling tunnel can be involuntarily pulled from Mare Island Strait with the fill water into the dry dock’s water system.

After the dry dock is filled with water by the intake system described above, the flooded dry dock is opened to Mare Island Strait for the movement of ships into and out of the facility. The dry docks are opened by pumping water out of the caissons, which causes them to float. The floating caissons are moved aside and a vessel is winched into the dry dock at high tide with the assistance of tug boats. After the vessel is inside the dry dock, the caisson is pushed back into place and filled with water, thus forming a tight seal. This procedure for removal and replacement of the caisson, and bringing a vessel in or out of the dry dock takes about three hours. While the caisson is removed, there is an opportunity for listed salmonids and green sturgeon from Mare Island Strait to enter the water-filled dry dock. If fish enter the dry dock and do not exit prior to the replacement of the caisson, they would be trapped and potentially stranded or killed as the dry dock is dewatered for ship repairs. These three hours of open caisson will occur during each of the dry dock evolutions. During this period, it is likely that some fish, including listed salmonids and green sturgeon, will enter the dry dock. Listed salmonids will only be vulnerable to entrapment during evolution events that overlap with their winter and spring migration periods. Green sturgeon abundance in Mare Island Strait appears to peak in the spring months, but some green sturgeon may be present and vulnerable to entrapment in the dry docks year-round.

As described above, MIDD has implemented avoidance and minimization measures to minimize the number of fish entrained during the filling of the dry dock and during the period the caissons are open. The use of the dynamic barrier net and the bubble curtain are proposed specifically to minimize entrainment. For each evolution, the dynamic barrier net is deployed prior to filling the dry dock and remains in place until the dock is filled with water. The dynamic barrier net is removed once the caisson is moved so that a vessel may enter/exit the dry dock. Used in place of intake structure fish screens, the dynamic barrier net serves as a physical barrier to fish entering the dry docks when water is allowed to fill the dry dock. After the dry dock has been filled with water, MIDD operates the bubble curtain deterrent system. This system generates a constant stream of bubbles across the opening of the dry dock while the caisson doors are removed and the vessel is entering or exiting the dry dock.

In addition to the implementation of the dynamic barrier net and the bubble curtain deterrent system, fish salvage operations have been performed at the dry docks since 2011 to assess fish entrainment. The MIDD procedure for fish monitoring during a Level I dry dock evolution involves lowering the water depth within the dry dock to approximately 16-24 inches. Block nets are placed in the central portion of the dry dock to prevent fish from moving freely toward the floor drains where there is the potential for impingement during the final stages of dewatering. Seine nets are used to corral and capture fish. Captured fish are then relocated to aerated coolers; native and listed species are separated from non-native species. After all portions of the dry dock have been salvaged, water within the dry dock is drawn down to approximately six inches in an effort to concentrate any remaining fish. Fish are collected by dip net and placed in the appropriate cooler. Remaining water is then pumped out and the entire dry dock is surveyed several times for any stranded fish. All fish are identified, numerated and measured. Native and listed species, and then non-native species, are processed and released back to Mare Island Strait.

Level II fish rescue will be performed during the period between June 1 and November 30. During this period, monitoring and fish rescue operations will target fish larger than 18 inches. Although fish smaller than 18 inches may not be detected during Level II procedures, this level of fish rescue is anticipated to be effective for listed anadromous salmonids and green sturgeon during this time period. This is because all green sturgeon and adult listed salmonids at this location are expected to be larger than 18 inches, and juvenile listed salmonids, which are smaller than 18 inches, are unlikely to be present in Mare Island Strait in the summer and fall months when Level II fish sampling is conducted. Fish salvage reports will continue to be provided for each fish salvage operation and an annual summary provided for each year of dry dock operation. MIDD proposes to continue fish rescue and relocation operations as described in Section 1.3.3.2 of this opinion.

As described in section 1.2 and Table 1 of this opinion, the number of fish encountered per salvage event has decreased since the combined deployment of the dynamic barrier and the bubble curtain deterrent system in June of 2012. Fish salvage reports indicate that the average number of total fish and non-native fish species encountered during fish salvage has been reduced by over 75 percent with the use of the bubble curtain.

2.5.2.1 Salmonid Entrainment

Salmonids have been found during salvage events since reporting began in 2011. Since the implementation of the bubble curtain (2012-2016), a total of 18 adult salmonids and 10 smolts have been reported and, of those, there were one smolt and three adult mortalities. Due to the size of the fish at the time of the salvage, and subsequent otolith analysis of deceased fish, 17 of the adult salmonids were assumed to be fall-run Chinook salmon, and one was identified as an adult steelhead with a clipped adipose fin. The adipose fin clip indicates this steelhead individual originated from one of four Central Valley hatcheries; CCV steelhead from the Coleman National Fish Hatchery and Feather River Hatchery are included in the listed DPS, while steelhead from the Nimbus Hatchery and Mokelumne River Hatchery are currently excluded from the DPS. All steelhead produced at Central Valley hatcheries since 1998 have been marked with an adipose fin clip (Williams *et al.* 2016).

Based on data from fish salvage operations, the number of salmonid smolts entrained into the dry docks has been reduced substantially since the implementation of the bubble curtain deterrent system. In the spring of 2011 and 2012, 286 and 66 salmonid smolts, respectively, were found during fish salvage operations. Following the deployment of the bubble curtain system in July 2012, salvage events in 2013, 2014, 2015, and 2016 yielded zero, seven, one, and two Chinook smolts, respectively. It should be noted that out-migrant trapping of salmonid smolts from the Napa River by the Napa County Resource Conservation District (NCRCD) also detected a reduction in the number juvenile Chinook salmon and steelhead entering Mare Island Strait during some of this time period (NCRCD 2014). The reduced number of smolts collected during MIDD fish rescue and relocation may be, in part, a result of reduced numbers of juvenile salmonids present within the Mare Island Strait during these years, however the significant reduction in number of all fish species collected within the dry docks likely indicates a behavioral inclination to avoid entrainment with use of the bubble curtain. All salmonid smolts found during fish salvage events have been identified as Chinook salmon.

Given the procedure for moving ships in and out of the dry dock occurs during slack tide, fish would have to actively swim into the dry docks to become trapped. The dry dock consists of concrete walls and floor, so there are no food resources to attract listed fish into the dry dock. Noise and disturbance generated by the presence of tug boats and the ship entering the dry dock may induce listed salmonids and green sturgeon to leave this area of human activity and further reduce their potential vulnerability to entrainment within the dry dock.

Based on the results of fish salvage events since the implementation of the bubble curtain deterrence system, the numbers of adult and juvenile listed salmonids entrained by the MIDD in future years can be estimated. Reports provided by ADR and MIDD indicate a total of 78 fish salvage events have occurred with the bubble curtain in place between July 2012 and November 2016. During this period, steelhead collections have been limited to one hatchery-origin adult fish and no juveniles/smolts. For Chinook salmon, a total of 17 adults have been collected and 10 juveniles/smolts during the previous 78 salvage events. For future dry dock operations at Mare Island Shipyard, the number of listed salmonids entrained is likely to depend on a number of variables including the timing of the dry dock filling events and the year class strength of each ESU/DPS.

For steelhead, entrainment in the dry docks would be rare based on the results of fish salvage monitoring to date and the behavior of CCC steelhead in the lower Napa River. Sandstrom *et al.* (2013) reports that tagged CCC steelhead moved at relatively high rates through the Napa River and spent little time exploring off-channel habitat. Similar behavior by CCV steelhead smolts in Carquinez Strait, Mare Island Strait, and San Pablo Bay is expected. NMFS utilized the results of past entrainment monitoring to calculate the average number of steelhead entrained per evolution and concluded from this analysis that no adult or juvenile steelhead will be entrained during most dry dock evolutions. However, some listed steelhead may be entrained during the 14-year term of this project because there is the potential for a maximum number of 104 evolutions annually, the inter-annual variation of steelhead abundance, and the potential for an evolution event to coincide with the presence of a school of migrating juvenile or adult steelhead in Mare Island Strait. Considering these various factors, in NMFS' judgement up to two adult and four juvenile CCC steelhead individuals may be entrained annually. Similarly, NMFS expects up to two adult and four juvenile CCV steelhead may be entrained annually. The expected numbers of steelhead entrainment associated with dry dock operations are presented in Table 2.

For Chinook salmon, NMFS also utilized the results of fish salvage monitoring to date to estimate the average number of Chinook that may be entrained per evolution. Based on the collection of 17 adult Chinook over 78 evolutions (0.22 adult Chinook/evolution), approximately 23 adult Chinook are likely to be collected if 104 evolutions are conducted. For juvenile Chinook, 10 individuals were collected over 78 evolutions (0.13 juvenile Chinook/evolution); thus, it is likely that 13 individuals would be collected if 104 evolutions are conducted. However, it is important to note here that NMFS expects the majority of Chinook will be non-listed Central Valley fall-run Chinook. Considering the very large number of Central Valley fall-run Chinook salmon in relation to the abundance of endangered winter-run Chinook and threatened CV spring-run Chinook, NMFS expects no adult or juvenile/smolt listed Chinook salmon will be entrained during most dry dock evolutions. As stated above for steelhead, it remains likely that some listed Chinook salmon will be entrained during the 14-year term of this project because there is a potential maximum number of 104 evolutions annually, the inter-annual variation of Chinook salmon abundance, and the potential for an evolution event to coincide with the presence of a school of migrating juvenile or adult listed Chinook in Mare Island Strait. Considering these various factors, in NMFS' judgement, up to two adult and four juvenile Sacramento River winter-run Chinook may be entrained annually. Similarly, NMFS estimates up to two adult and four juvenile Central Valley spring-run Chinook may be entrained annually. The expected numbers of Chinook entrainment associated with dry dock operations are presented in Table 2.

Although the salvage program has shown that a high percentage of trapped fish are collected and relocated successfully, some fish may be killed during dewatering and collection. Fish in the dry dock have been found to commonly hide within the grid of wooden blocks used to support the ship; fish that elude capture will die following dewatering. As stated above, few salmonids are found during fish salvage operations to date; thus, it is likely that most evolution events will result in no collection and no mortalities of listed salmonids. However, some mortality is anticipated to occur based on past salvage events. During the past 78 fish salvage events, approximately 18 percent of the adult salmonids entrained have been killed. With an adult mortality rate of approximately 18 percent, up to one adult listed winter-run Chinook and one CV spring-run Chinook could be lost to mortality every other year over the 14-year term of the Corps' authorization due to dry dock operations. Although there has only been one adult steelhead collected to date and this fish was successfully released alive, it is assumed that this species would be subject to a similar rate of salvage mortality. Using a mortality rate of approximately 18 percent for steelhead, one adult listed CCC steelhead and one CCV steelhead could be lost to mortality every other year over the 14-year term of the Corps' authorization. The expected numbers of adult steelhead and Chinook mortality associated with dry dock and fish salvage operations are presented in Table 2.

For juvenile salmonids, the mortality rate observed in past salvages events has been approximately 10 percent. Similar to the expected mortalities associated with adult listed salmonids, no juvenile listed salmonids will be killed in some years and the number lost in the other years is anticipated to be very low. It is expected that mortality rates will be one juvenile listed winter-run Chinook and one CV spring-run Chinook every other year over the 14-year term of the Corps' authorization due to dry dock operations. For steelhead, one juvenile listed CCC steelhead and one CCV steelhead will be lost to mortality every other year over the 14-year term of the Corps' authorization. The expected numbers of juvenile steelhead and Chinook mortality associated with dry dock operations are presented in Table 2.

Table 2. Cumulative estimates of fish entrainment and mortality associated with dry dock operations over the 14-year permit term, with a maximum of 104 evolutions per year.

	Entrained		Mortality[1]	
	Juvenile/Smolt	Adult	Juvenile/Smolt	Adult
CCV Steelhead	56	28	7	7
CCC Steelhead	56	28	7	7
Winter-run Chinook	56	28	7	7
Spring-run Chinook	56	28	7	7
Green Sturgeon	n/a	28[2]	n/a	7[2]

[1]Mortalities are based on a percentage of individuals entrained and do not represent additional individuals.
[2]Represents both adult and sub-adult green sturgeon.

Relocation of adult and juvenile salmonids imposes inherent risks of injury, stress, disease transmission, and/or subsequent mortality, but these risks vary widely depending on methodology, environmental conditions, and expertise of the collector. For those listed salmonids that are collected and released alive, NMFS anticipates these individuals will be subject to very low post-release mortality rates. This assumption is based on the techniques employed at the dry dock for fish capture and relocation, and by the expertise of qualified fisheries biologist conducting the fish salvage operations. Data on fish relocation efforts by CDFW shows most mortality rates are below three percent for anadromous salmonids (Collins 2004, CDFG 2005, 2006, 2007, 2008, 2009, 2010a, 2010b). Based on information from other relocation efforts, NMFS estimates post-release delayed mortalities would be less than three percent of those salmonids that are relocated.

2.5.2.2 Green Sturgeon Entrainment

White sturgeon have been reported during fish salvage operations, but no green sturgeon have been encountered. A total of 15 white sturgeon have been collected within the dry docks since the implementation of the bubble curtain deterrent system. Three of the 15 white sturgeon were reported as mortalities.

Although green sturgeon have never been encountered during a salvage event, MIDD proposes to increase the number of evolutions conducted each year which will increase the chance of entraining green sturgeon. Collections of white sturgeon during fish salvage events combined with CDFW sturgeon fishery data provide a means to estimate the potential entrainment and mortality of green sturgeon over the 14-year term of the Corps' permit authorization. Research and monitoring of sturgeon in San Francisco Bay is performed by the CDFW, and catch estimates of green sturgeon relative to white sturgeon range from 2 to 5 percent. Preliminary data from the 2015 CDFW Sturgeon Report Card shows that green sturgeon made up approximatley 2.3 percent of the overall catch in 2015 (Dubois and Harris, 2016). Based on the results of fish salvage events since implementation of the bubble curtain in 2012, a white sturgeon is entrained, on average, in one of five dry dock dewatering events. Of those entrained, mortality has been approximately 20 percent. Based on these past results, 104 evolutions per year could result in the entrainment of 20 white sturgeon annually and the mortality of four of the 20 sturgeon entrained. If green sturgeon abundance ranges from 2 to 5 percent of white sturgeon abundance, NMFS expects in most years no green sturgeon will be collected by this program. However, green sturgeon may be entrained by future dry dock operations due to the increased number of evolutions and the potential for fish to be in the vicinity during a dry dock filling event. Green sturgeon are known to inhabit San Pablo Bay throughout much of the year (Heublein *et al*. 2009) which is in close proximately to Mare Island Strait. Considering that there may be as many as 104 dry dock evolutions per year and the potential for an evolution event to coincide with the presence of migrating or rearing juvenile or adult threatened green sturgeon in Mare Island Strait., NMFS expects up to two green sturgeon may be entrained annually and one of these individuals may be subject to mortality every other year during a salvage event. The expected numbers of total green sturgeon entrainment and mortality associated with dry dock operations over the 14-year period of Corps authorization are presented in Table 2.

Relocation of green sturgeon imposes inherent risks of injury, stress, disease transmission, and/or subsequent mortality, but these risks vary widely depending on methodology, environmental conditions and expertise. For those threatened green sturgeon that are collected and released alive, NMFS anticipates these individuals will successfully survive. This assumption is based on the techniques employed at the dry dock for fish capture and relocation, and by the expertise of qualified fisheries biologist conducting the fish salvage operations.

2.5.3 Effects on Designated Critical Habitat

Designated critical habitat for Southern DPS green sturgeon, CCC steelhead, and Sacramento River winter-run Chinook salmon occurs in the action area. Dry dock evolutions are not expected to degrade water quality or adversely affect designated critical habitat. To protect water quality in Mare Island Strait, all debris and sediment in the dry dock associated with ship repairs and demolitions will be disposed of properly through the dry docks internal drain system and not allowed to enter the waters of Mare Island Strait. Wastewater, including stormwater, which enters the dry dock while a ship is being worked on will be collected in the dry dock sumps and pumped to a wastewater treatment facility. These measures are expected to effectively protect water quality and designated critical habitat in Mare Island Strait.

Dredging and disposal activities may impact designated critical habitat for green sturgeon, winter-run Chinook salmon and CCC steelhead by altering water quality, foraging habitat, and sediment quality.

Water Quality. The effects of dredging and disposal on water quality were discussed above in section 2.4.2.1 of this biological opinion and also apply to the critical habitat within the action area. As described above, the effects of the proposed project may result in increased levels of turbidity and the re-suspension of sediment-associated contaminants during dredging and in-bay disposal. NMFS does not expect the impacts on water quality will adversely affect or PBFs of designated critical habitat for Chinook salmon, steelhead, or green sturgeon because contaminants within the action area are not found at concentrations harmful to these species, or their prey. As presented in section 2.5.1.1 of this opinion, increases in turbidity levels are anticipated to be temporary and water quality is expected to improve within 2-3 hours following individual dredging and disposal events.

Foraging Habitat. Dredging results in the removal of the top layer soft or sandy bottom habitat and removal of invertebrate prey species in that layer. Empirical research suggests that even in dynamic environments, anthropogenic disturbance to the biological community, combined with the physical alteration of habitat, results in a loss of ecological function over varying timescales (Oliver *et al*. 1977; Reish 1961; Thrush *et al*. 1995; Watling *et al*. 2001). Recovery of the disturbed habitat could take months to years (Gilkinson *et al*. 2005), or never return its pre-disturbed state (McConnaughey *et al*. 2000). Recovery time depends on the frequency of disturbance, sediment characteristics, and the level of environmental disturbance by waves and currents at the site.

Within the 16.3-acre area subject to dredging by this project, the frequent schedule of sediment removal is expected to preclude the full recovery of the benthic community. As many as four dredge events per year may be performed and this level of continuous disturbance will result in the removal of benthic organisms at a rate that is likely faster than their re-colonization of the site. However, sediment removal by this project will occur in water depths of 28 to 32 feet and these depths typically support fewer benthic prey organisms for fish than sediments in shallower water depths. The following presents the anticipated effects of sediment removal on prey organisms and foraging opportunities for listed fish.

As described in section 2.4.1 of this opinion, research indicates that most juvenile salmonids use the estuary only during outmigration, and pass through the estuary rapidly. Subyearling fall-run Chinook salmon are more likely to rear for extended periods in the estuary than the listed Chinook and steelhead species. Research on juvenile fall-run Chinook salmon indicates they prefer shallow water habitats near the shore and within the upper portion of the water column (less than 10 feet deep) for foraging (Kjelson *et al*. 1982). Foraging behavior by juvenile listed Chinook and steelhead in the estuary is expected to be similar because they will generally be selecting same prey items as fall-run Chinook. Adult salmonids migrating upstream through the estuary are typically not foraging during the immigration to their natal streams. Since the MIDD dredge site is located in waters greater than the typical forage depths of listed salmonids, dredging by this project is unlikely to adversely affect PBFs related to forage for listed Chinook salmon and steelhead.

Little is known about green sturgeon feeding and prey resources in San Francisco Bay, but it is likely that they prey on demersal fish (*e.g.*, sand lance) and benthic invertebrates similar to those that green sturgeon are known to prey upon in estuaries of Washington and Oregon (Dumbauld *et al*. 2008). Research indicates that San Francisco Bay is an important area for juvenile green sturgeon rearing and residence, although, the distribution of green sturgeon and their movements in the bay are not well known. Green sturgeon are known to be generalist feeders and may feed opportunistically on a variety of benthic species encountered. For example, the invasive overbite clam, *C. amurensis,* has become the most common food of white sturgeon, and for the green sturgeon that have been examined to date (CDFG 2002). The periodic disturbance created by dredging activities may facilitate the establishment of invasive species, such as the overbite clam, in dredged areas and elsewhere in the bay. The act of removing mud and sandy-bottom habitat and the associated biotic assemblages during dredging creates an area of disturbance that is susceptible to recolonization by invasive species, often resulting in the displacement of native species.

The results of research conducted by Dumbauld *et al*. (2008), Kelly and Klimley (2012) and Kelly *et al.* (2007) suggest green sturgeon may hold in deep holes and channels in coastal estuaries, but foraging generally occurs within shallow areas with soft sediments. Dumbauld *et al.* (2008) reports green sturgeon in estuaries of the Pacific Northwest move into tidal flats areas, particularly at night, to feed. Movements by adult southern DPS green sturgeon were tracked by ship in the San Francisco Estuary (Kelly and Klimley 2012; Kelly *et al.* 2007) and individuals were reported to occupy the flats during low flows and moved within the channels during high flows, generally swimming near the bottom. The prey species typically associated with sturgeon include crangonid shrimp, callianassid shrimp, burrowing thalassinidean shrimp, amphipods, isopods, clams, annelid worms, crabs, sand lances, and anchovies. These prey species are commonly found in soft sediments of shallow waters in coastal estuaries and many of these prey species occur in association with eelgrass and other submerged aquatic vegetation in waters less than 15 feet in depth. At the Mare Island dry docks, benthic habitat disturbance by dredging will be limited to waters approximately 30 feet in depth which is deeper than typical forage depths of green sturgeon.

At the in-bay disposal sites, benthic organisms which may serve as prey for listed salmonids and green sturgeon are buried by the periodic placement of dredged materials. Both the Alcatraz and San Pablo Bay in-bay disposal sites bottom depths exceed 30 feet and listed salmonids are not known to forage for prey at these depths. As discussed above, green sturgeon are also unlikely to forage at these depths. However, the Carquinez in-bay disposal site is located in waters 10 to 55 feet deep. At this site, periodic disposal of dredged materials by the project may reduce the number and availability of forage prey organisms for listed salmonids and green sturgeon due to burial.

While effects on benthic habitats and prey resources for green sturgeon and listed salmonids are unclear, due to several factors NMFS does not expect dredging and dredged material disposal by this project will prevent listed fish from finding suitable forage at the quantities and quality necessary for normal behavior (*e.g.*, maintenance, growth, reproduction). Green sturgeon are generalist feeders and the reduction of certain prey species by dredging at dry docks and berths is unlikely to affect availability of prey resources for green sturgeon in shallower waters where most foraging likely occurs. Listed salmonids are known to forage at depths considerably shallower than the dredge and disposal sites of this project. Based on this information, NMFS concludes that dredging and disposal conducted for the dry dock and berth operations at Mare Island will not result in new adverse effects to critical habitat, but will adversely affect green sturgeon and listed salmonid critical habitat in the action area by continuing to preclude improvement in the quality of foraging habitat PBFs in the action area.

Sediment Quality. Sediments within Mare Island Strait likely contain a substantial amount of contaminants which originated from historic U.S. Navy operations at the dry dock facilities. From 1854 to 1996, ship building and naval operations at the shipyard resulted in the discharge of point and non-point source contaminants. Contaminants bound to sediments are thought to be present in buried sediments adjacent to the dry docks, but these contaminated sediments are overlain by recently deposited cleaner sediments. Remobilization of buried contaminants can occur during dredging, which can lead to contamination of the surface of the sediment layer and the water column.

As presented above in section 2.5.1.1 of this opinion, the results of sediment core samples from previous dredging events in the action area showed analytical chemistry results that were generally within or below San Francisco Bay background levels. Dredged materials from past episodes were judged as suitable for in-bay aquatic disposal and would not result in increased toxicity to aquatic organisms. For future dredging episodes at MIDD conducted under this Corps permit, the DMMO process requires sediment testing prior to dredging episodes for the purpose of determining potential contaminant levels in dredged materials and selection of appropriate disposal sites. This DMMO process is expected to continue to minimize the potential for water quality degradation and release of hazardous materials into the water column during maintenance dredging events. For these reasons, dredging and disposal activities by this project are not expected to degrade sediment quality PBFs of critical habitat in the action area.

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).

NMFS does not anticipate any cumulative effects in the action area other than those ongoing actions already described in the Environmental Baseline above, and resulting from climate change. Given current baseline conditions and trends, NMFS does not expect to see significant improvement in habitat conditions during the next 14 years due to existing land and maritime development in Mare Island Strait. In the long term, climate change may produce temperature, precipitation, and sea level changes that may adversely affect listed anadromous salmonids and green sturgeon habitat in the action area. Freshwater rearing and migratory habitat are most at risk to climate change. However, productivity in the San Francisco Bay is also likely to change based on changes in freshwater flows, nutrient cycling, and sediment amounts (Scavia *et al*. 2002). This may result in altered trophic level interactions, introduction or survival of invasive species, emergence of harmful algal blooms, changes in timing of ecological events, all of which may cause decreases (or increases) in abundance of green sturgeon and salmonids as well as of their predators and competitors.

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 biological opinion as to whether the proposed action is likely to: (1) Reduce appreciably the likelihood of both the survival and recovery of a listed species in the wild by reducing its numbers, reproduction, or distribution; or (2) appreciably diminishes the value of designated or proposed critical habitat for the conservation of the species.

CCC and CCV steelhead, CV spring-run Chinook salmon, Sacramento River winter-run Chinook salmon, and southern DPS green sturgeon have experienced serious declines in abundance, and long-term population trends 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, the effects of shoreline development, industrialization, and urbanization are evident. These activities have introduced non-native species, degraded water quality, contaminated sediment, and altered the hydrology of streams and the estuary in the action area.

The continued operation of the dry docks at the Mare Island Shipyard will involve maintenance dredging by clamshell dredge in Mare Island Strait immediately in front of the facility. Periodic dredging episodes over the next 14 years will impact an area of up to 16.3 acres of designated critical habitat for green sturgeon, CCC steelhead, and Sacramento River winter-run Chinook salmon. Dredging and in-water disposal of dredged materials are expected to degrade water quality and disturb benthic habitat in Mare Island Strait and at the three in-bay dredged material disposal sites.

Operation of the dry docks is expected to entrain listed salmonids and green sturgeon. To reduce the risk of fish entrainment during dry dock filling events, MIDD proposes to continue to use both the dynamic barrier placed outside of the dry dock and bubble curtain deterrence system used during the opening of the caisson. These two mechanisms work to physically and behaviorally minimize the amount of fish entrained during a dry dock evolution. MIDD's proposed program for fish collection within the sealed dry dock is expected to rescue the trapped fish during dewatering operations. Listed anadromous salmonids and green sturgeon will be collected by biologists from inside the dry dock and returned to Mare Island Strait.

Listed fish collected and relocated to Mare Island Strait will undergo stress, and potential injury and mortality. The amount of unintentional injury and mortality attributable to fish capture varies widely depending on the methods used, ambient conditions, and the experience of the field crew. Since fish relocation activities will be conducted by qualified fisheries biologists, mortality of juvenile salmonids and green sturgeon during capture and relation is expected to be minimized. The expected rate of mortality associated with fish relocation activities is incorporated into the mortality estimates presented below.

Based on the results of fish salvage events since 2012, the number of listed fish entrained and lost in future MIDD dry dock operations can be estimated. With MIDD's proposed 104 evolutions per year, NMFS estimates that up to two green sturgeon may be entrained annually. Green sturgeon collected alive will be relocated to Mare Island Strait. Of those white sturgeon entrained in past fish salvage events, mortality has been approximately 20 percent. Applying this mortality rate to green sturgeon, suggests that mortality will not exceed one green sturgeon every other year and a maximum mortality level of seven green sturgeon over the 14-year term.

For listed anadromous salmonids, NMFS' expects up to two adult salmonids of each of the following ESUs and DPSs may be entrained annually: CCC steelhead, CV steelhead, CV spring-run Chinook, winter-run Chinook. With an adult salmonid mortality rate of 18 percent, one adult listed winter-run Chinook and one CV spring-run Chinook will be lost to mortality on average every other year over the 14-year term of the Corps' authorization due to dry dock operations (maximum mortality level of seven adult winter-run chinook and seven adult CV spring-run Chinook over the 14-year term). For steelhead, one adult listed CCC steelhead and one CCV steelhead will be lost to mortality every other year over the 14-year term of the Corps' authorization (maximum mortality level of seven adult CCC steelhead and seven adult CCV steelhead over the 14-year term).

For juvenile listed anadromous salmonids, NMFS' expects up to four individuals of each of the following ESUs and DPSs may be entrained annually: CCC steelhead, CV steelhead, CV spring-run Chinook, winter-run Chinook. With a juvenile mortality rate of 10 percent, it is expected that one juvenile winter-run Chinook, one juvenile CV spring-run Chinook, one juvenile CCC steelhead, and one juvenile CV steelhead will be lost to mortality every other year over the 14-year term of the Corps' authorization due to dry dock operations (maximum mortality level of seven juvenile winter-run Chinook, seven spring-run Chinook, seven juvenile CCC steelhead, and seven juvenile CCV steelhead over the 14-year term).

PBFs of designated critical habitat for listed winter-run Chinook salmon and CCC steelhead in the action area include water quality and quantity, foraging habitat, natural cover including large substrate and aquatic vegetation, and migratory corridors free of obstructions. PBFs for green sturgeon critical habitat in estuarine areas include food resources, water flow, water quality, migratory corridor, water depth, and sediment quality. Potential effects to designated critical habitat are short-term impacts to water quality during dredging and disposal, and disturbance of the Mare Island Strait benthic habitat by dredging. Localized impacts to water quality may occur in the form of increased levels of suspended sediment, but these effects are expected to be localized and return to background levels when dredging and disposal activities cease. Removal of sediment from the bottom of Mare Island Strait will result in the loss of prey items for green sturgeon; however, the dredge site is located in water depths of approximately 30 feet and prey organisms preferred by green sturgeon typically occur in shallow mudflats and eelgrass beds. Foraging by listed anadromous salmonids, which feed primarily at the surface or within the water column, are not likely to be impacted by periodic dredging disturbance of benthic habitat in water depths of approximately -30 feet below MLLW. In-water disposal of dredged materials is expected to maintain the existing disturbed condition of benthic habitat at disposal sites by periodically burying benthic organisms with dredged material. Portions of the Carquinez Strait disposal site are relatively shallow (approximately -10 feet below MLLW) and burial of benthic organisms is likely to reduce prey items for listed salmon and sturgeon at this location. With dredging episodes of up to four times per year and in-water disposal episodes of up to three times per year, full recovery of the benthic community in the 16.3-acre dredge site and in-water disposal sites is not expected to occur. Due to multiple episodes of dredging and disposal throughout the year, the project is expected to adversely affect green sturgeon and listed salmonid critical habitat by continuing to preclude improvement in the quality of foraging habitat PBFs at the dredge site and in-bay disposal sites.

Regarding climate change, the anticipated impacts of the proposed project are limited to estuarine areas and the effects of climate change on fish habitat in the San Francisco Estuary are most likely to be associated with changes in freshwater flows, nutrient cycling, sediment delivery, sea level rise, and storm surges. Within estuarine and marine ecosystems, aquatic productivity may be altered with changes in water temperature, water circulation, water chemistry, and food supplies (Brewer and Barry 2008, Feely 2004, Osgood 2008, Turley 2008, Abdul-Aziz *et al*. 2011, Doney *et al*. 2012). In the action area of this project environmental conditions in San Francisco Bay and Mare Island Strait, including those related to climate change, will influence the distribution and foraging behavior of listed fish, and thereby, influence the potential vulnerability of salmonids and green sturgeon to entrainment during dry dock operations. However, the uncertainty stemming from natural variability over the short term of this Corps authorization (*i.e.*, 14 years) will have a large influence on the expected signal from climate change. Because we anticipate only small changes in environmental conditions related to climate change may be evident during the next 14 years (see section 2.4 of this opinion), we expect these changes are unlikely to combine with project effects to produce additional adverse effects to listed salmonids, green sturgeon, or their critical habitat.

Based on the above, a small number of CCC steelhead, CCV steelhead, CV spring-run Chinook, Sacramento River winter-run Chinook, and green sturgeon are expected to be adversely affected by MIDD's proposed maintenance dredging and dry dock operations. NMFS believes that, for the reasons stated herein, the potential level of injury and mortality to listed anadromous salmonids and green sturgeon by the proposed activities is very low. It is unlikely that the small potential loss of individuals as a result of dry dock operations conducted during the next 14 years will impact future adult returns, due to the small number of salmonids and green sturgeon affected by the project relative to the size of the population. Due to the relatively large number of juveniles produced by each spawning pair, adult salmonids and sturgeon in future years are expected to produce enough juveniles to replace the small number of individuals injured or killed by dry dock operations.

2.8 Conclusion

After reviewing the best available scientific and commercial data, the current status of listed anadromous salmonids and green sturgeon, the environmental baseline for the action area, the effects of the proposed action, and the cumulative effects, it is NMFS' biological opinion that MIDD's proposed maintenance dredging and operational activities at the Mare Island dry docks are not likely to jeopardize the continued existence of threatened CCC steelhead, threatened CCV steelhead, threatened CV spring-run Chinook salmon, endangered Sacramento River winter-run Chinook salmon, and threatened southern DPS green sturgeon, and the action is not likely to adversely modify or destroy critical habitat for CCC steelhead, Sacramento River winter-run Chinook salmon, and southern DPS green sturgeon.

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.

2.9.1 Amount or Extent of Take

In the biological opinion, NMFS determined that incidental take would occur in association with the operation of the Mare Island dry docks. Incidental take of adult and juvenile threatened CCC steelhead, threatened CCV steelhead, threatened CV spring-run Chinook salmon, endangered Sacramento River winter-run Chinook salmon, and threatened southern DPS green sturgeon is anticipated in the form of entrainment into the dry docks and the subsequent collection and relocation of listed fish from the dry docks. Fish entrainment is expected when the dry docks are filled with water from Mare Island Strait and during periods when the caisson doors are open for vessels to pass in and out of the docks. Listed fish will be entrapped within the dry docks when the caisson doors are sealed. As the docks are drained, listed fish will be collected by qualified fisheries biologists and surviving fish will be relocated to Mare Island Strait. Fish will be subject to stress by entrainment and during fish collection/relocation. Some mortality of adult and juvenile threatened CCC steelhead, threatened CCV steelhead, threatened CV spring-run Chinook salmon, endangered Sacramento River winter-run Chinook salmon, and threatened southern DPS green sturgeon is expected during entrainment, fish salvage operations, and post-release delayed mortality.

Based on the previous five years of fish rescue and relocation activities at the Mare Island dry docks, NMFS has estimated the numbers of listed fish that may be entrained and released, or entrained and killed with up to 104 dry dock evolutions conducted each year. For listed anadromous salmonids, NMFS' expects up to two adult salmonids of each of the following ESUs and DPSs may be entrained annually: CCC steelhead, CV steelhead, CV spring-run Chinook, winter-run Chinook. With an adult salmonid mortality rate of 18 percent, one adult listed winter-run Chinook and one CV spring-run Chinook will be lost to mortality on average every other year over the 14-year term of the Corps' authorization due to dry dock operations (maximum mortality level of seven adult winter-run chinook and seven adult CV spring-run Chinook over the 14-year term). For steelhead, one adult listed CCC steelhead and one CCV steelhead will be lost to mortality every other year over the 14-year term of the Corps' authorization (maximum mortality level of seven adult CCC steelhead and seven adult CCV steelhead over the 14-year term). Expected levels of entrainment and mortality of adult listed salmonids over the 14-year term of the Corps' dredging authorization are presented in Table 3.

For juvenile listed anadromous salmonids, NMFS' expects up to four individuals of each of the following ESUs and DPSs may be entrained annually: CCC steelhead, CV steelhead, CV spring-run Chinook, winter-run Chinook. With a juvenile mortality rate of 10 percent, it is expected that one juvenile winter-run Chinook, one juvenile CV spring-run Chinook, one juvenile CCC steelhead, and one juvenile CV steelhead will be lost to mortality every other year over the 14-year term of the Corps' authorization due to dry dock operations (maximum mortality level of seven juvenile winter-run Chinook, seven spring-run Chinook, seven juvenile CCC steelhead, and seven juvenile CCV steelhead over the 14-year term). Expected levels of entrainment and mortality of juvenile listed salmonids over the 14-year term of the Corps' dredging authorization are presented in Table 3.

For green sturgeon, NMFS expects that up to two green sturgeon may be entrained annually. Based on the observed mortality rate of entrained white sturgeon, NMFS expects approximately 20 percent of the green sturgeon entrained will be killed. Thus, it is expected that mortality will not exceed one green sturgeon every other year and the maximum mortality of seven green sturgeon could occur over the 14-year term of the Corps authorization. Expected levels of entrainment and mortality of green sturgeon over the 14-year term of the Corps' dredging authorization are presented in Table 3.

Table 3. Cumulative estimates of fish entrainment and mortality associated with dry dock operations over the 14-year permit term, with a maximum of 104 evolutions per year.

	Entrained		Mortality[1]	
	Juvenile/Smolt	Adult	Juvenile/Smolt	Adult
CCV Steelhead	56	28	7	7
CCC Steelhead	56	28	7	7
Winter-run Chinook	56	28	7	7
Spring-run Chinook	56	28	7	7
Green Sturgeon	n/a	28[2]	n/a	7[2]

[1]Mortalities are based on a percentage of individuals entrained and do not represent additional individuals.
[2]Represents both adult and sub-adult green sturgeon.

2.9.2 Effect of the Take

In the biological opinion, NMFS determined that the amount or extent of anticipated take, coupled with other effects of the proposed action, is not likely to result in jeopardy to the species 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 CCC steelhead, CCV steelhead, CV spring-run Chinook salmon, and Sacramento River winter-run Chinook salmon:

1. Undertake measures to ensure that harm and mortality to listed salmonids and green sturgeon resulting from dry dock dewatering and fish relocation activities are low.

2. Ensure the project's dynamic barrier and bubble curtain deterrence system are properly operated to minimize the amount of fish entrainment.

3. Monitor incidental take associated with dry dock operations by means of real-time genetic identification of collected salmonids to distinguish runs of listed Chinook salmon and steelhead.

4. Prepare and submit reports regarding the project's dry dock operations and the results of the fish monitoring and relocation program.

2.9.4 Terms and Conditions

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

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

a. For all fish collection and relocation activities, the Corps or any applicant shall retain qualified biologists with expertise in fisheries biology, including handling, collecting, and relocating salmonids and sturgeon.

b. Carcasses of fish collected from the dry docks shall be retained, placed in an appropriately-sized sealable plastic bag, labeled with the date and location of collection, fork length, and be frozen as soon as possible. Frozen samples shall be retained by the permittee for a period of at least one week or until specific instructions are provided by NMFS, whichever occurs first. The permittee may not transfer biological samples to anyone other than the NMFS, U.S. Fish and Wildlife Service (USFWS), or the California Department of Fish and Wildlife (CDFW) without obtaining prior written approval from the NMFS Santa Rosa Office.

c. The Corps and any applicant shall allow any NMFS employee(s) or any other person(s) designated by NMFS to accompany field personnel to visit the dry dock facilities during the activities described in this opinion.

The following terms and conditions implements reasonable and prudent measure 2:

a. A designated representative shall be on-site daily while dry dock operations are taking place to ensure that the dynamic barrier net, bubble curtain deterrence system are operating efficiently, and that all avoidance and minimization measures are in compliance. Inspections by the designated representative shall be compiled into a Monthly Compliance Report.

b. The bubble curtain deterrence system will be operated at all times that the caisson doors are not in place. The bubble curtain will be used on all dry docks and no evolutions will occur without its use.

The following terms and conditions implements reasonable and prudent measure 3:

a. Tissue samples (typically from a fin) for DNA analysis shall be collected from all salmon and steelhead individuals collected during Level I and Level II fish rescues.

b. Tissue samples shall be provided to a qualified laboratory, approved by NMFS, for genetic run determination. Genetic analysis shall be sufficient to distinguish the following Central Valley Chinook races: Central Valley fall-run Chinook salmon; Central Valley spring-run Chinook salmon; and Sacramento River winter-run Chinook salmon. Genetic analysis shall be sufficient to distinguish the following steelhead races: California Central Valley steelhead, and Central California Coast steelhead.

c. Results of genetic analyses with run determinations shall be provided by written report to NMFS within 90 days of tissue sample collection. 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 following terms and conditions implements reasonable and prudent measure 4:

a. The Corps or any applicant shall provide a written report to NMFS for each dry dock evolution event within 30 days of the activity. The report shall include the number of listed anadromous salmonids and green sturgeon collected by species, fish lengths, injuries, mortalities, and number of surviving fish relocated to Mare Island Strait. The report 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.

b. The Corps or any applicant shall provide an annual summary for all Level I and Level II fish collection and relocation events to NMFS. The annual summary shall include a table listing the date of each salvage event, the number of level of each salvage event and the number of listed salmonids and/or green sturgeon encountered. The report 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.

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. The number of dry dock evolutions and dredging events that occur during the peak period of the anadromous salmonid juvenile outmigration (February – May) should be minimized to reduce exposure of listed salmonid smolts to entrainment and degraded water quality.
2. Assist in California Fish Tracking Consortium’s effort to detect tagged salmonids and green sturgeon in the vicinity of the Mare Island dry docks by funding the installation and maintenance of tag receiving monitors in the Napa River, Mare Island Strait and San Pablo Bay.

2.11 Reinitiation Notice

This concludes formal consultation for maintenance dredging and dry dock operations by MIDD, L.L.C. at the Mare Island Shipyard in Solano County, California.

As 50 CFR 402.16 states, reinitiation of formal consultation is required where discretionary Federal agency involvement or control over the action has been retained or is authorized by law and if: (1) the amount or extent of incidental taking specified in the 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.

3.0 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.

3.1 Utility

Utility principally refers to ensuring that the information contained in this consultation is helpful, serviceable, and beneficial to the intended users. The intended users of this opinion are the Corps and the applicant, Mare Island Dry Dock, LLC. Other interested users could include the U.S. Department of Fish and Wildlife, the California Department of Fish and Wildlife, and the San Francisco Bay Conservation and Development Commission. Individual copies of this opinion were provided to the Corps and the Applicant. 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.

3.2 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.

3.3 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.,

Best Available Information: This consultation and supporting documents use the best scientific and commercial data available, as referenced in the References section. The analyses in this opinion 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 the ESA, and reviewed in accordance with West Coast Region ESA quality control and assurance processes.

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