UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL MARINE FISHERIES SERVICE
West Coast Region
650 Capitol Mall, Suite 5-100
Sacramento, California 95814-4700

Refer to NMFS No: WCRO-2020-01201

September 25, 2020

Ms. Chandra Jenkins
Senior Project Manager
Delta Section, Regulatory Division
Department of the Army
United States Army Corps of Engineers
Sacramento District
1325 J Street
Sacramento, California 95814-2922

Re: Endangered Species Act Section 7(a)(2) Biological Opinion and Magnuson-Stevens Fishery Conservation and Management Act Essential Fish Habitat Response for the Lehigh Southwest Stockton Terminal Project within the Port of Stockton

Electronic transmittal only

Dear Ms. Jenkins:

Thank you for your letter of February 25, 2020, requesting initiation of consultation with NOAA's National Marine Fisheries Service (NMFS) pursuant to section 7 of the Endangered Species Act of 1973 (ESA) (16 U.S.C. 1531 et seq.) The U.S. Army Corps of Engineer (USACE) proposes to issue a Clean Water Act section 404 permit and a Rivers and Harbor section 10 permit to Lehigh Hanson for the Lehigh Southwest Stockton Terminal Project (Project). This consultation was conducted in accordance with the 2019 revised regulations that implement section 7 of the ESA (50 CFR 402, 84 FR 45016). NMFS requested additional information on March 10, 2020, and received this information on April 15, 2020. On May 14, 2020, NMFS responded to the USACE that we did not concur with the initial request for a concurrence with a not likely to adversely affect determination by the USACE for this Project, but that there was sufficient information available to proceed with a formal consultation under the ESA.

The enclosed biological opinion, based on the biological assessment, and best available scientific and commercial information, concludes that the Project is not likely to jeopardize the continued existence of the federally listed endangered Sacramento River winter-run Chinook salmon (*Oncorhynchus tshawytscha*) Evolutionarily Significant Unit (ESU), the threatened Central Valley (CV) spring-run Chinook salmon (*O. tshawytscha*) ESU, the threatened California Central Valley (CCV) steelhead (*O. mykiss*) Distinct Population Segment (DPS), and the threatened Southern DPS of North American green sturgeon (*Acipenser medirostris*). NMFS has also concluded that the Project is not likely to destroy or adversely modify the designated critical habitats for Sacramento River winter-run Chinook salmon, CV spring-run Chinook salmon, CCV steelhead, and sDPS green sturgeon that occur within the action area. NMFS has included an incidental take statement with reasonable and prudent measures and non-discretionary terms and conditions that are necessary or appropriate to minimize the impact of the amount or extent of incidental take of listed species associated with the Project.

Thank you, also, for your request for consultation pursuant to the essential fish habitat (EFH) provisions in Section 305(b) of the Magnuson-Stevens Fishery Conservation and Management Act (16 U.S.C. 1855(b)) for this action. NMFS also reviewed the likely effects of the proposed Project on EFH, pursuant to section 305(b) of the Magnuson-Stevens Fishery Conservation and Management Act (MSA, 16 U.S.C. 1855(b)), and concluded that the action would adversely affect the EFH of Pacific Coast Salmon and Pacific Coast groundfish. NMFS also determined that the action would not adversely affect the EFH of Coastal Pelagic Species. Therefore, we have included the results of that review in Section 3 of the enclosed document.

This letter also transmits NMFS' EFH conservation recommendations for Pacific salmon and Pacific Coast groundfish, as required by the MSA as amended (16 U.S.C. 1801 *et seq.*).

The EFH consultation adopts the ESA reasonable and prudent measures and associated terms and conditions from the biological opinion and includes additional conservation recommendations specific to the adverse effects to Pacific salmon EFH and Pacific Coast groundfish in the action area as described in Amendment 18 of the Pacific Coast Salmon Plan and in Appendix D of Amendment 19 for Pacific Coast groundfish.

The USACE has a statutory requirement under section 305(b)(4)(B) of the MSA to submit a detailed written response to NMFS within 30 days of receipt of these conservation recommendations, and 10 days in advance of any action, that includes a description of measures adopted by the USACE for avoiding, minimizing, or mitigating the impact of the Project on EFH (50 CFR 600.920(j)). If unable to complete a final response within 30 days, the USACE should provide an interim written response within 30 days before submitting its final response. In the case of a response that is inconsistent with our recommendations, the USACE must explain its reasons for not following the recommendations, including the scientific justification for any disagreements with NMFS over the anticipated effects of the Lehigh Southwest Stockton Terminal Project and the measures needed to avoid, minimize, or mitigate such effects.

Please contact Jeffrey Stuart in NMFS' West Coast Region, California Central Valley Office at (916) 930-3607 or via email at J.Stuart@noaa.gov if you have any questions concerning this section 7 consultation, or if you require additional information.

Sincerely,

A. Catherine Marcinkevage

Cathy Marcinkevage, PhD
Assistant Regional Administrator
California Central Valley Office

cc: Copy to File: 151422-WCR2020-SA00010

Electronic copy only:

Ms. Tin Lau, Lehigh Hanson, Tina.Lau@LehighHanson.com
Ms. Katie Chamberlin, Anchor QEA, LLC, KChamberlin@AnchorQEA.com

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

Lehigh Southwest Stockton Terminal Project

NMFS Consultation Number: 2020-01201

Action Agency: United States Army Corps of Engineers

Affected Species and NMFS' Determinations:

ESA-Listed Species	Status	Is Action Likely to Adversely Affect Species?	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
Sacramento River winter-run Chinook salmon (*O. tshawytscha*)	Endangered	Yes	No	Yes	No
Central Valley spring-run Chinook salmon (*O. tshawytscha*)	Threatened	Yes	No	Yes	No
Southern Distinct Population Segment of North American green sturgeon (*Acipenser medirostris*)	Threatened	Yes	No	Yes	No

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

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

Issued By: A. Catherine Marcinkevage

Cathy Marcinkevage, PhD.
Assistant Regional Administrator, California Central Valley Office

Date: *September 25, 2020*

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1 INTRODUCTION

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

1.1 Background

NOAA's National Marine Fisheries Service (NMFS) prepared the biological opinion (opinion) and incidental take statement (ITS) 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, as amended.

We also completed an essential fish habitat (EFH) consultation on the proposed Lehigh Southwest Stockton Terminal Project (Project), in accordance with section 305(b)(2) of the Magnuson-Stevens Fishery Conservation and Management Act (MSA) (16 U.S.C. 1801 et seq.) and implementing regulations at 50 CFR 600.920.

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 (DQA) (section 515 of the Treasury and General Government Appropriations Act for Fiscal Year 2001, Public Law 106-554). The document will be available within two weeks at the NOAA Library Institutional Repository [https://repository.library.noaa.gov/welcome]. A complete record of this consultation is on file at the California Central Valley Office.

1.2 Consultation History

The list below summarizes correspondence, meetings, and discussions between regulatory agencies, Lehigh Hanson (the applicant), and Anchor QEA (consultants for the applicant) that relate to potential effects of the Lehigh Southwest Stockton Terminal Project (Project) on species addressed in this document.

2/25/2020 Letter from the United States Army Corps of Engineers (USACE) transmitting the Biological Assessment (BA) (Anchor QEA 2019) and requesting informal consultation with NMFS for the issuance of permits for the Project and concurrence that the Project was "not likely to adversely affect" the federally listed threatened Central Valley (CV) spring-run Chinook salmon evolutionarily significant unit (ESU, *Oncorhynchus tshawytscha*), threatened California CV (CCV) steelhead distinct population segment (DPS, *O. mykiss*), and the threatened southern DPS (sDPS) of North American green sturgeon (*Acipenser medirostris*). The USACE also determined that the proposed Project would not result in the destruction or adverse modification of designated critical habitat for any of these species and may adversely affect EFH of Pacific Coast salmon under section 305(b)(2) of the MSA.

3/10/2020 NMFS sent an email to the USACE, indicating that there was insufficient information contained in the BA and the letter requesting the initiation of informal consultation, to determine whether NMFS could concur with the USACE's determination that the Project was "not likely to adversely affect" listed species or their designated critical habitat, or whether the EFH for Pacific Coast salmon may be adversely affected under the MSA. NMFS requested that additional information be provided to proceed with the consultation.

4/10/2020 NMFS issued a letter to the USACE indicating that the Lehigh Southwest Stockton Terminal consultation had been closed out due to inactivity.

4/13/2020 USACE responded via email that a response from the applicant was forthcoming regarding the request for additional information.

4/15/2020 USACE provided a letter from the applicant's consultant (Anchor QEA) providing the additional information requested by NMFS.

5/14/2020 NMFS issued a letter to the USACE indicating that it did not concur with their "not likely to adversely affect" determination for the Project. NMFS, however, concluded that there was sufficient information contained in the BA and supplementary information to initiate formal consultation with the USACE on this Project. NMFS informed the USACE that a biological opinion will be completed on or before August 28, 2020.

8/18/2020 NMFS requested from the USACE a 2-week extension to the due date until September 11, 2020, which was granted by the USACE via email.

9/4/2020 NMFS requested from the USACE an additional extension to the due date until September 28, 2020, which was granted by the USACE via email.

1.3 Proposed Federal Action

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

1.3.1 *Federal Authorities*

The proposed action for the USACE is to make a combined permit decision on the Project under the authority of Section 404 of the Clean Water Act (33 USC 1344) and Section 10 of the Rivers and Harbors Act of 1899 (33 USC 403) for placement of fill into jurisdictional waters of the United States by Lehigh Hanson (applicant) to implement the Lehigh Southwest Stockton Terminal Project.

1.3.2 *Project Location*

The Project is located on Berth 2 in the Port of Stockton (Port), which is located in the City of Stockton, San Joaquin County, approximately 75 miles east of San Francisco and 40 miles southeast of Sacramento (Figure 1). The Port is bisected by the San Joaquin River and subsequently divided into the following two areas along the Stockton Deep Water Ship Channel

(DWSC): the East Complex and the West Complex (Rough and Ready Island). The East Complex encompasses approximately 680 acres bounded to the north by the Stockton DWSC and turning basin; to the east and south by the Port's Public Beltline Railroad main lead and Atchison, Topeka, and Santa Fe Railroads; and to the west by the San Joaquin River. The East Complex includes Docks 2 through 13 and the West Complex includes Docks 14 through 20.

1.3.3 *Project Purpose and Objectives*

The purpose of the proposed Project is to upgrade the existing Lehigh Hanson cement facility and the associated Port facilities (including the dock and adjacent upland rail areas) in order to handle a heavier replacement unloader and improve rail and truck loading and unloading systems in anticipation of an increased future cementitious materials supply and market demand (Anchor QEA 2019). The proposed new ship unloader would be supplied with a longer arm for greater reach that allows operations at a higher capacity, thereby minimizing the possibility of dust emissions, reducing berthing time, and allowing greater dock utilization and shipping volume. In addition, the new longer arm will accommodate longer and wider vessels at the berth, increasing the current berth's vessel capacity. Because the new unloader would be significantly heavier, the existing rail support beams and narrow rail gauge would not be adequate to support its weight and must be replaced. In order to accommodate the new ship unloader, the underlying dock structure would need to be rehabilitated as well, including installation of new concrete pilings with greater load bearing capacities. In addition, a new fender system on the outboard side of the dock would be installed to provide additional protection to the dock and its pilings from ships moored at the berth (Anchor QEA 2019).

The existing wooden rail trestle immediately east of Berth 2 was built in the 1930s, and it lacks the structural integrity needed to support fully loaded rail cars and engines at the berth. Repair and replacement of the rail trestle is needed to accommodate the movement of fully loaded rail cars and engines required for full and optimal operations of the berthing facility. Upland improvements to the storage facilities, rail, and truck systems are also needed to handle cementitious material more efficiently at the Lehigh Hanson facility, but are not part of the USACE's permit proposal (Anchor QEA 2019).

1.3.4 Construction Actions Related to the Project Elements

1.3.4.1 Berth 2 Rehabilitation

In order to achieve the greater weight bearing requirements needed to support the new ship unloader, a maximum of one hundred and forty-four 18-inch octagonal concrete piles would be driven under the current Berth 2 structure to support the ship unloader gantry rail beams, and an additional twenty 14-inch-square concrete piles would be driven on the waterside of the Berth 2 structure to support the replacement fender system. Where the location of new piles are under the dock's concrete deck, slots would be cut through the deck of Berth 2 to accommodate piles being driven through the structure. Installation of the new piles would use a single impact hammer mounted on a crawler crane operating atop the Berth 2 deck. If the existing dock structure cannot support this type of crane, a floating derrick barge crane would be used. In addition to the new fender piles, the replacement fender system would include four 5-foot by 10-foot floats fixed to the outboard dock face. Table 1 identifies the proposed pile and float quantities and overwater coverage impacts from Berth 2 rehabilitation (Anchor QEA 2019). The locations of the proposed Berth 2 beam support piles, fender piles, and fender floats are depicted in Figure 2 (and pages 5 and 6, Appendix A, Anchor QEA 2019).

Table 1. Berth 2 Rehabilitation Pile Quantities and Overwater Coverage

Project Component	Pile or Fender Type/ Size	Number of Piles or Float Quantity	Total Area (square feet)	Total Volume (Mudline to MHHW) (cubic yards)	Overwater Coverage (net square feet)
Seaside Rail Support Piles	18-inch Octagonal Concrete	72	134 ft^2	203.48 yds^3	0 (Piles beneath existing dock)
Landside Rail Support Piles	18-inch Octagonal Concrete	72	134 ft^2	104.22 yds^3	0 (Piles beneath existing dock)
Floating Fender Piles	14-inch Square Concrete	20	27 ft^2	41.34 yds^3	27 ft^2
Fender Floats	5-feet by 10 feet	5	250 ft^2	0 yds^3	250 ft^2

Additional Berth 2 rehabilitation activities would occur above the mean higher high water (MHHW) line, including installation of new concrete beams, new gantry rails, and repairs to existing structural concrete. New concrete beams would be installed with below-deck ties to the existing dock structure, and new gantry rails would be installed at the appropriate rail gauge. Similar to the support piles, these features would be constructed using slots cut into the existing concrete deck of Berth 2. The slots in the concrete deck would be formed and filled with concrete to complete the deck surface. Forms would be supported by the new piling and the existing concrete structure. A hydraulic crane would be used to support the forming and placement of the reinforced cast-in-place beams. Concrete repairs would be completed to provide structural integrity, including repair of damage to existing concrete columns, spalled concrete on beams, and to the underside of the deck.

1.3.4.2 Rail Trestle Replacement

Rail trestle replacement would include removal of the 180-foot wooden rail trestle deck, partial removal of wooden support piles, installation of replacement concrete piles, and installation of replacement decking (composed of concrete beams, track, and access walkways) with a reduced overwater footprint (pages 3 and 4, Appendix B, Anchor QEA 2019). Construction would begin with demolition of existing wooden rail trestle components. Fifty-six in-water 14-inch creosote-treated wood piles would be cut off at the mudline and the remainder left in place below the surface of the substrate. Fifteen 14-inch creosote-treated wood piles located on the bank slope (10 above MHHW and 5 below MHHW) would be removed, and the void space caused by the removal would be filled. Table 2 identifies the overwater coverage and fill values for the existing wooden rail trestle components planned for demolition. The existing gantry rail support beams, including fifty 17-inch timber support piles, would remain in place and would be integrated with the replacement rail trestle design (pages 8 and 9 of Appendix A, Anchor QEA 2019).

Table 2. Existing wooden rail trestle overwater coverage and pile quantities for demolition.

Pile or Feature Location	Pile Type	Above or Below MHHW	Method for Proposed Removal	Pile Quantity	Total Area (square feet)	Total Volume (Mudline to MHHW) (cubic yards)
In-water	14-inch Creosote-treated Wood	Below	Cut at mudline	56	59.92 ft^2	55.48 yds^3
Bank Slope	14-inch Creosote-treated Wood	Below	Pulled with excavator	10	10.7 ft^2	2.34 yds^3
Bank Slope	14-inch Creosote-treated Wood	Above	Pulled with excavator	5	5.35 ft^2	0 yds^3
Trestle Deck	NA	Above	Remove all decking; keep gantry rail and supporting beams	NA	4,800 ft^2	NA

Following rail trestle demolition, a maximum of thirty 18-inch octagonal concrete support piles would be installed beneath MHHW. Piles would be installed using an impact hammer operating from a floating derrick barge crane set-up. Once piles have been installed, the contractor would construct forms atop the piles, place reinforcement, then cast in place concrete beams and structural ties, constituting the replacement trestle. After this portion of the installation is complete, new track would be installed, as well as an access walkway alongside the rail. These improvements would be constructed above the MHHW. The replacement deck would have a smaller overwater coverage area compared to the existing wooden rail trestle, as the portion southeast of the gantry rails would be narrower. Table 3 identifies overwater coverage and pile fill values for the proposed rail trestle replacement structure.

Table 3. Proposed rail trestle overwater coverage and pile quantities.

Project Component	Pile Type	Above or Below MHHW	Number of Piles	Total Area (square feet)	Total Volume (cubic yards)
Row 1 (Closer to channel side)	18-inch Octagonal Concrete	Below	15	28 ft^2 (below trestle decking)	25.85 yds^3
Row 2 (Closer to Bankside)	18-inch Octagonal Concrete	Below	15	28 ft^2 (below trestle decking)	25.85 yds^3
Trestle Deck	NA	Above	NA	3,800 ft^2	NA

1.3.4.3 Ship Unloader Replacement

The existing ship unloader would be replaced with a new ship unloader inclusive of a completely enclosed conveying system. The new ship unloader will have a capacity of 1,700 metric tons per hour, which is greater than the existing equipment. The ship unloader components would be delivered to the site by ship from various international locations in large pre-assembled pieces and multiple shipping containers. A designated area of the dock would be used for assembling the unloader upon the new gantry rails. Only one vessel trip is expected to be needed to bring in all of the pieces of the new ship unloader. The delivery of this equipment will occur later in the phased construction schedule when the berth is ready to accept it for installation (Anchor QEA 2020).

1.3.4.4 Upland Construction and Facility Improvements

Proposed Project improvements that would occur entirely in upland areas (page 3 of Appendix A, Anchor QEA 2019) include the following:

- Replacement of Bunker 7 with a monolithically constructed concrete storage dome to handle Portland cement or other cementitious materials more efficiently. The new storage dome would have a storage capacity of 40,000 metric tons and would include air pollution control devices to minimize or eliminate dust emissions.
- Upgrades to existing bunkers and addition of dust filter systems.
- Modifications to the existing truck loading stations, including more efficient and higher capacity truck loading systems.
- Rail loading station to allow more efficient and greater throughput of rail car shipping of cementitious materials.

1.3.4.5 Construction Schedule

All in-water construction work is scheduled to occur annually between July 1 and November 30. Installation of piles will occur between the hours of 0700 and 1900 hours (sunrise to sunset, total duration not to exceed 12 hours per day) during the in-water work periods. The applicant anticipates that no more than 6 piles will be installed per day, with each pile installed sequentially (no overlapping pile driving activities). Pile driving activities are not expected to exceed 35 days in total, but may occur over multiple seasons (Anchor QEA 2019).

The overall Project construction schedule is anticipated to take from 2020 to 2025 to complete, with a total of 5 phases of construction. Phases 2, 3, and 4 include in-water and overwater activities. Several portions of the phases will overlap and occur concurrently. Table 4 provides a more detailed accounting of the phase elements and their timing (Anchor QEA 2020).

Table 4. Schedule of Construction Phases and Elements

Phase and Work Elements	Years and Duration[1]
Phase 1: Upland Improvements • Demolition • Upgrade Rail Track and Rail Loading • Upgrade Transport System and Receiving Dust Filter System • Structural Installation	**2020 to 2021** (4 months total construction)

Phase and Work Elements	Years and Duration[1]
Phase 2: Waterfront Berth 2 Structure • Demolition • Test Pile Program • Fender System • New Support Piles and Pile Caps • Dock Repairs • Pile Caps, Grade Beams, Work Slabs Structural Installation	**2020 to 2021** (8 months total construction)
Phase 3: Ship Unloader • Demolition Equipment Delivery • Mechanical and Electrical Installation	**2021 to 2023** (4 months total construction)
Phase 4: Rail Loadout and Rail Trestle • Excavation • Pile Installation (Extended Foundations) Pile Caps, Grade Beams, Work Slabs • Backfill and Compaction • Track Installation, Structural, Equipment and Electrical Installation	**2022 to 2024** (8 months total construction)
Phase 5: Storage Dome and Material Handling Equipment • Demolition • Excavation • Pile Installation Pile Caps, Grade Beams, Work Slabs • Backfill and Compaction • Dome Structural, Equipment and Electrical Installation	**2023 to 2025** (18 months total construction)

1. Because of fiscal implications of the COVID-19 response, construction years for the various phases may shift by 1 year or more.

1.3.4.6 Avoidance and Minimization Measures

Construction of the in-water and out-of-water improvements described above would occur in compliance with established best management practices (BMPs). The following BMPs are considered an integral part of the proposed Project and would be implemented by Lehigh Hanson or its contractors prior to, during, or after the execution of the proposed Project (Anchor QEA 2019):

- General BMPs are as follows:
  - The contractor would fully understand and adhere to the terms and conditions of approvals and permits obtained, as well as all Project BMPs.
  - All construction activities would occur within the designated Project footprint.
- Debris-related BMPs are as follows:
  - Closed debris containment booms, floating debris screens, and/or absorbent booms would be positioned beneath and alongside work areas whenever possible.

During construction, the barges performing the work would be moored in a position to capture and contain the debris generated during any sub-structure or in-water work. Care would be taken to minimize debris falling into the water.

  - In the event that debris reaches the water, personnel in workboats would immediately retrieve the debris for proper handling and disposal. For small-scale overwater repairs and maintenance, tarps, tubs, or vacuums would be used as appropriate to catch sawdust, debris, or drips.
  - All debris and trash would be regularly collected and disposed of in appropriate waste containers. Discharge of hazardous materials into the Project site would be prohibited.
- Stormwater BMPs are as follows:
  - Construction material that could wash or blow away would be covered every night and during any rainfall event.
  - Construction materials would be stored in an area that does not freely drain to the water, is free from standing water and wet soil, and protected from rain. If necessary, materials would be stored on skids or support timbers to keep them off the ground.
  - Adequate erosion control supplies would be kept on site and during all construction activities to ensure materials are kept out of waterbodies.
- Spill prevention and response BMPs are as follows:
  - All construction-related equipment would be inspected daily and maintained in good working order to minimize the potential for hazardous waste spills. Current hazardous material spill prevention and cleanup plans would be maintained on site. Hammers and other hydraulic attachments would be placed on plywood and covered prior to the onset of rain to prevent run-on and runoff.
- Special status species and habitat BMPs are as follows:
  - Pile driving would only occur between July 1 and November 30.
  - The contractor would be required to bring all impact hammer pile driving equipment online slowly (employ a "soft-start") to allow fish to move out of the construction area impacted by the pile driving.

1.3.5 Additional Project-Related Activities

We considered, under the ESA, whether or not the proposed Project would cause any other activities and determined that it would cause the following activities:

Increased Commercial Navigational Traffic

As part of the stated purpose of the Project, the capacity of the Berth 2 facilities will be increased to allow faster unloading of commercial vessels calling on the Lehigh Hanson facilities as well as servicing larger and wider commercial vessels than is currently possible with the existing ship unloader. The greater capacity to unload vessels will facilitate a faster turn-around time for vessels, resulting in shorter docking stays at the facility. Lehigh Hanson anticipates that this will increase the number of vessels visiting the Berth 2 facilities.

The Port of Stockton accommodated 252 ship calls in 2018, the last year that data are available. Visits to the Port of Stockton do not follow any particular seasonal pattern, but are market driven and, therefore, vary over time. Berth 2 had an annual throughput of nine ship calls in 2018, and this generally represents the baseline throughput for the berth (2019 data have not yet been published). The applicant anticipates that with construction and operation of the proposed Project, ship calls to the facility could double within approximately 5 years after construction (for an annual total of 18 ship calls) and could potentially increase beyond that amount in the future if market conditions are favorable. Accordingly, it is possible that between one and three vessels could ultimately call on Berth 2 each month, although the applicant anticipates that there would be fewer vessels monthly over the first 5 years than 10 years from now. Lehigh Hanson also reported that there is not a seasonal component to when the berth would be used for operations, based on past usage (Anchor QEA 2020).

Each visit of an ocean-going commercial vessel requires two transits of the navigational ship channels leading from the Golden Gate Bridge to the Port of Stockton, a distance of approximately 145 kilometers (~90 miles). Therefore, each round trip commercial vessel visit to the Lehigh Hanson facility requires approximately 290 kilometers (180 miles) of travel through the waters of northern San Francisco Bay, San Pablo Bay, Suisun Bay (collectively the San Francisco estuary), and the San Joaquin River (*i.e.,* Stockton DWSC). During each transit, listed species and the aquatic habitat of the San Francisco estuary and the Sacramento - San Joaquin Delta are exposed to shipping noise, ship wakes and turbulence, altered flow fields, changes in water quality, and the potential for ship strikes and propeller entrainment.

2 ENDANGERED SPECIES ACT: BIOLOGICAL OPINION AND INCIDENTAL TAKE STATEMENT

The ESA establishes a national program for conserving threatened and endangered species of fish, wildlife, plants, and the habitat upon which they depend. As required by section 7(a)(2) of the ESA, each Federal agency must ensure that its 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 provide 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 incidental take statement (ITS) that specifies the impact of any incidental taking and includes non-discretionary reasonable and prudent measures (RPMs) and terms and conditions to minimize such impacts.

2.1 Analytical Approach

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

CFR 402.02). Therefore, the jeopardy analysis considers both survival and recovery of the species.

This opinion relies on the definition of "destruction or adverse modification," which "means a direct or indirect alteration that appreciably diminishes the value of critical habitat as a whole for the conservation of a listed species" (50 CFR 402.02).

The designations of critical habitats for Sacramento River winter-run Chinook salmon, CV spring-run Chinook salmon, CCV steelhead, and sDPS green sturgeon use the term primary constituent element (PCE) or essential features. The 2016 critical habitat regulations (50 CFR 424.12) replaced these terms 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, essential features, or PBFs. In this opinion, we use the term PBF to mean PCE or essential feature, as appropriate, for the specific critical habitat.

The 2019 regulations define effects of the action using the term "consequences" (50 CFR 402.02). As explained in the preamble to the regulations (84 FR 44977), that definition does not change the scope of our analysis, and in this opinion, we use the terms "effects" and "consequences" interchangeably.

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

- Evaluate the rangewide status of the species and critical habitat expected to be adversely affected by the Project.
- Evaluate the environmental baseline of the species and critical habitat.
- Evaluate the effects of the Project on species and their habitats using an exposure-response approach.
- Evaluate cumulative effects.
- In the integration and synthesis, add the effects of the action and cumulative effects to the environmental baseline, and, in light of the status of the species and critical habitat, analyze whether the Project is likely to: (1) directly or indirectly 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, or (2) directly or indirectly result in an alteration that appreciably diminishes the value of critical habitat as a whole for the conservation of a listed species.
- If necessary, suggest a reasonable and prudent alternative to the Project.

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 Project. 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' "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 environments that make up the designated area, and discusses the function of the PBFs that are essential for the conservation of the species. Tables 5 and 6 summarize the current status of Sacramento River winter-run Chinook salmon, CV spring-run Chinook salmon, CCV steelhead, and the sDPS of North American green sturgeon and their designated critical habitats.

Table 5. Description of Species, Current Endangered Species Act (ESA) Listing Classifications, and Species Status Summary.

Species	**Listing Classification and Federal Register Notice**	**Status Summary**
Sacramento River winter-run Chinook salmon ESU	Endangered, 70 FR 37160; June 28, 2005	According to the NMFS 5-year species status review (NMFS 2016a), the extinction risk of the winter-run Chinook salmon ESU has increased from moderate risk to high risk of extinction since the 2007 and 2010 assessments. Based on the Lindley *et al.* (2007) criteria, the population is at high extinction risk in 2020. High extinction risk for the population was triggered by the hatchery influence criterion, with a mean of 62.5 percent hatchery origin spawners from 2016 through 2019. In contrast, the extinction risk has been somewhat tempered by the start of reintroduction of winter-run Chinook salmon into Battle Creek in 2018 (progeny from Brood Year 2017). The establishment of a self-sustaining population in this watershed is one of the priority recovery plan goals for this ESU. Adult escapement into Battle creek in 2019 was estimated at 95 fish (CDFW 2020a). Several listing factors have contributed to the recent decline, including drought, poor ocean conditions, and hatchery influence. Thus, large-scale fish passage and habitat restoration actions are necessary for improving winter-run Chinook salmon ESU viability.

Species	Listing Classification and Federal Register Notice	Status Summary
Central Valley spring-run Chinook salmon ESU	Threatened, 70 FR 37160; June 28, 2005	According to the NMFS 5-year species status review (NMFS 2016b), the status of the CV spring-run Chinook salmon ESU, until 2015, has improved since the 2010 5-year species status review. The improved status is due to extensive restoration, and increases in spatial structure with historically extirpated populations (Battle and Clear creeks) trending in the positive direction. Recent declines of many of the dependent populations, high pre-spawn and egg mortality during the 2012 to 2016 drought, and uncertain juvenile survival during the drought are likely increasing the ESU's extinction risk. Monitoring data showed a high of nearly 24,000 adults returning in 2013 (CDFW 2020a), to sharp declines in adult returns in the 5-year average of approximately 5,800 fish from 2014 to 2018 (CDFW 2020a). However this trend was somewhat reversed in 2019, when over 20,000 adult spring-run Chinook salmon returned to the Central Valley river systems.
California Central Valley steelhead DPS	Threatened, 71 FR 834; January 5, 2006	According to the NMFS 5-year species status review (NMFS 2016c), the status of CCV steelhead appears to have remained unchanged since the 2011 status review that concluded that the DPS was in danger of extinction. Most natural-origin CCV populations are very small, are not monitored, and may lack the resiliency to persist for protracted periods if subjected to additional stressors, particularly widespread stressors such as climate change. The genetic diversity of CCV steelhead has likely been impacted by low population sizes and high numbers of hatchery fish relative to natural-origin fish, particularly in tributaries with hatcheries producing steelhead. The life-history diversity of the DPS is mostly unknown, as very few studies have been published on traits such as age structure, size at age, or growth rates in CCV steelhead.

Species	Listing Classification and Federal Register Notice	Status Summary
Southern DPS of North American green sturgeon	Threatened, 71 FR 17757; April 7, 2006	According to the NMFS 5-year species status review (NMFS 2015) and the 2018 final recovery plan (NMFS 2018), some threats to the species have recently been eliminated, such as take from commercial and recreational fisheries and removal of some passage barriers (i.e., Red Bluff Diversion Dam). Also, several habitat restoration actions have occurred in the Sacramento River Basin, and spawning was documented on the Feather River (Seeholtz et al. 2015) and Yuba Rivers (CDFW 2018). Furthermore, professional fisheries biologists have verified observations of adult green sturgeon in the San Joaquin River system upstream of the Delta recently [Stanislaus River (October 2017) and within the mainstem of the San Joaquin River above the confluence with the Merced River (April 2020)]. However, the species viability continues to face a moderate risk of extinction because many threats have not been addressed, and the majority of spawning occurs in a single reach of the main stem Sacramento River. Current threats include poaching and habitat degradation. A recent method has been developed to estimate the annual spawning run and population size in the upper Sacramento River so species can be evaluated relative to recovery criteria (Mora *et al.* 2018).

Table 6. Description of Critical Habitat, Listing, and Status Summary.

Critical Habitat	Designation Date and Federal Register Notice	Description
Sacramento River winter-run Chinook salmon ESU	June 16, 1993; 58 FR 33212	Designated critical habitat includes the Sacramento River from Keswick Dam (river mile (RM) 302) to Chipps Island (RM 0) at the westward margin of the Sacramento-San Joaquin Delta (Delta) including the areas westward from Sherman Island to Chipps Island, which includes Kimball Island, Winter Island, and Browns Island.; all waters from Chipps Island westward to the Carquinez Bridge, including Honker Bay, Grizzly Bay, Suisun Bay, and the Carquinez Strait; all waters of San Pablo Bay westward of the Carquinez Bridge; and all waters of San Francisco Bay north of the San Francisco-Oakland Bay Bridge from San Pablo Bay to the Golden Gate Bridge. However it excludes waters within estuarine sloughs within San Francisco Bay or San Pablo Bay. Within the Sacramento River, this designation includes the river water, river bottom (including those areas and associated gravel used by winter-run Chinook salmon as spawning substrate), and adjacent riparian zone used by fry and juveniles for rearing. In the areas westward from Chipps Island, including San Francisco Bay to the Golden Gate Bridge, it includes the estuarine water column and essential foraging habitat and food resources used by winter-run Chinook salmon as part of their juvenile outmigration or adult spawning migration. PBFs considered essential to the conservation of the species include: Access from the Pacific Ocean to spawning areas; availability of clean gravel for spawning substrate; adequate river flows for successful spawning, Incubation of eggs, fry development and emergence, and downstream transport of juveniles; water temperatures at 5.8–14.1°C (42.5–57.5°F) for successful spawning, egg incubation, and fry development; habitat areas and adequate prey that are not contaminated, riparian and floodplain habitat that provides for successful juvenile development and survival; and access to downstream areas so that juveniles can migrate from spawning grounds to the San Francisco Bay and the Pacific Ocean. Although the current conditions of PBFs for winter-run Chinook salmon critical habitat in the Sacramento River are significantly limited and degraded, the habitat remaining is considered highly valuable.

Critical Habitat	Designation Date and Federal Register Notice	Description
Central Valley spring-run Chinook salmon ESU	September 2, 2005; 70 FR 52488	Critical habitat for CV spring-run Chinook salmon includes stream reaches of the Feather, Yuba and American rivers, Big Chico, Butte, Deer, Mill, Battle, Antelope, and Clear creeks, the Sacramento River, as well as portions of the northern Delta. Critical habitat includes the stream channels in the designated stream reaches and the lateral extent as defined by the ordinary high-water line. In areas where the ordinary high-water line has not been defined, the lateral extent will be defined by the bankfull elevation. Critical habitat includes portions of the San Francisco Bay- San Pablo Bay- Suisun Bay estuarine complex occupied by this ESU [approximately 254 square miles, with the South San Francisco Bay hydrologic sub area being excluded (70 FR 52531)]) which provides rearing and migratory habitat for this ESU. In estuarine areas the extreme high water is the best descriptor of lateral extent. This is the area inundated by extreme high tide and encompasses habitat areas typically inundated and regularly occupied during the winter, spring and summer when juvenile salmon are migrating in the nearshore zone and relying heavily on forage, cover, and refuge qualities provided by these occupied habitats. PBFs considered essential to the conservation of the species include: 1) freshwater spawning habitat with adequate water quality and substrate to support spawning, egg incubation, and larval development; 2) freshwater rearing habitat with floodplain connectivity supporting sheltering, movement, feeding, and growth; 3) freshwater migration corridors free of obstructions, and providing sheltering and holding for both adults and juveniles, and adequate prey resources for juvenile foraging; and 4) estuarine areas free of obstructions with adequate water quality to support adult and juvenile physiological transitions, shelter to provide protection, and prey for juvenile and adult foraging to sustain growth and maturation. Although the current conditions of PBFs for CV spring-run Chinook salmon critical habitat in the Central Valley are significantly limited and degraded, the habitat remaining is considered highly valuable.

Critical Habitat	Designation Date and Federal Register Notice	Description
California Central Valley steelhead DPS	September 2, 2005; 70 FR 52488	Critical habitat for CCV steelhead includes stream reaches of the Feather, Yuba and American rivers, Big Chico, Butte, Deer, Mill, Battle, Antelope, and Clear creeks, the Sacramento River, the Yolo Bypass, as well as most portions of the legal Delta and the San Joaquin River basin upstream to the confluence of the Merced River and major tributaries up to the first impassable dam. In addition, portions of the San Francisco Bay-San Pablo Bay-Suisun Bay estuarine complex [approximately 254 square miles, with the South San Francisco Bay hydrologic sub area being excluded; (70 FR 52531)] which provides rearing and migratory habitat for this ESU are included. Critical habitat also includes the stream channels in the designated stream reaches and the lateral extent as defined by the ordinary high-water line. In areas where the ordinary high-water line has not been defined, the lateral extent will be defined by the bankfull elevation. In estuarine areas the extreme high water is the best descriptor of lateral extent. This is the area inundated by extreme high tide and encompasses habitat areas typically inundated and regularly occupied during the winter, spring and summer when juvenile salmon are migrating in the nearshore zone and relying heavily on forage, cover, and refuge qualities provided by these occupied habitats. PBFs considered essential to the conservation of the species include: Spawning habitat; freshwater rearing habitat; freshwater migration corridors; and estuarine areas as previously described for CV spring-run Chinook salmon. Although the current conditions of PBFs for CCV steelhead critical habitat in the Central Valley are significantly limited and degraded, the habitat remaining is considered highly valuable.

Critical Habitat	Designation Date and Federal Register Notice	Description
Southern DPS of North American green sturgeon	October 9, 2009; 74 FR 52300	Critical habitat includes the stream channels and waterways in the legal Delta to the ordinary high water line. Critical habitat also includes the main stem Sacramento River upstream from the I Street Bridge to Keswick Dam, the Feather River upstream to the fish barrier dam adjacent to the Feather River Fish Hatchery, and the Yuba River upstream to Daguerre Dam. Critical habitat in coastal marine areas include waters out to a depth of 60 fathoms, from Monterey Bay in California, to the Strait of Juan de Fuca in Washington. Coastal estuaries designated as critical habitat include San Francisco Bay, Suisun Bay, San Pablo Bay, and the lower Columbia River estuary. Certain coastal bays and estuaries in California (Humboldt Bay), Oregon (Coos Bay, Winchester Bay, Yaquina Bay, and Nehalem Bay), and Washington (Willapa Bay and Grays Harbor) are included as critical habitat for sDPS green sturgeon. PBFs considered essential to the conservation of the species for freshwater and estuarine habitats include: food resources, substrate type or size, water flow, water quality, migration corridor; water depth, sediment quality. In addition, PBFs include migratory corridor, water quality, and food resources in nearshore coastal marine areas. Although the current conditions of PBFs for sDPS green sturgeon critical habitat in the Central Valley are significantly limited and degraded, the habitat remaining is considered highly valuable.

2.2.1 Climate Change

One factor affecting the range-wide status of Sacramento River winter-run Chinook salmon, CCV steelhead, CV spring-run Chinook salmon, and sDPS green sturgeon, and aquatic habitat at large is climate change.

The world is about 1.3°Fahrenheit (°F) warmer today than a century ago and the latest computer models predict that, without drastic cutbacks in emissions of carbon dioxide and other gases released by the burning of fossil fuels, the average global surface temperature may rise by two or more degrees in the 21st century [Intergovernmental Panel on Climate Change (IPCC) 2001, 2007]. Much of that increase likely will occur in the oceans, and evidence suggests that the most dramatic changes in ocean temperature are now occurring in the Pacific (Noakes et al. 1998). Using objectively analyzed data, Huang and Liu (2001) estimated a warming of about 0.9°F per century in the Northern Pacific Ocean.

Sea levels are expected to rise by 0.5 to 1.0 meters (1.6 to 3.3 feet) in the northeastern Pacific coasts in the next century (Cayan et al. 2008, 2009; Hayhoe et al. 2004; Parris et al. 2012), mainly due to warmer ocean temperatures, which lead to thermal expansion much the same way that hot air expands. This will cause increased sedimentation, erosion, coastal flooding, and permanent inundation of low-lying natural ecosystems (e.g., salt marsh, riverine, mud flats) affecting listed salmonid and green sturgeon PBFs. Increased winter precipitation, decreased snow pack, permafrost degradation, and glacier retreat due to warmer temperatures will cause landslides in unstable mountainous regions and destroy fish and wildlife habitat, including salmon-spawning streams. Glacier reduction could affect the flow and temperature of rivers and streams that depend on glacier water, with negative impacts on fish populations and the habitat that supports them.

Droughts along the West Coast and in the interior Central Valley of California will mean decreased stream flow in those areas, decreasing salmonid survival and reducing water supplies in the dry summer season when irrigation and domestic water use are greatest. Climate change may also change the chemical composition of the water that fish inhabit: the amount of oxygen in the water may decline, while pollution, acidity, and salinity levels may increase. This will allow for more invasive species to overtake native fish species and impact predator-prey relationships (Petersen and Kitchell 2001, Stachowicz et al. 2002).

In light of the predicted impacts of global warming, the Central Valley has been modeled to have an increase of between 2 and 7 degrees Celsius (ºC, 3.6 ºF to 12.6ºF) by 2100, with a drier hydrology predominated by rainfall rather than snowfall (Dettinger et al 2004, Hayhoe et al. 2004, VanRheenen et al 2004, Stewart et al. 2005). This will alter river runoff patterns and transform the tributaries that feed the Central Valley from a spring and summer snowmelt dominated system to a winter rain dominated system. Summer temperatures and flow levels will become unsuitable for salmonid survival under future temperature predictions. The cold snowmelt that furnishes the late spring and early summer runoff will be replaced by warmer precipitation runoff. This will truncate the period of time that suitable cold-water conditions exist downstream of existing reservoirs and dams due to the warmer inflow temperatures to the reservoir from rain runoff. Without the necessary cold water pool developed from melting snow pack filling reservoirs in the spring and early summer, late summer and fall temperatures downstream of reservoirs, such as Shasta Reservoir, could potentially rise above thermal tolerances for juvenile and adult salmonids that spawn, hold, and/or rear downstream of the dam over the summer and fall periods.

Projected warming is expected to affect Central Valley Chinook salmon. Because the runs are restricted to low elevations as a result of impassable rim dams, if climate warms by 5°C (9°F), it is questionable whether any Central Valley Chinook salmon populations can persist (Williams 2006). Based on an analysis of an ensemble of climate models and emission scenarios and a reference temperature from 1951- 1980, the most plausible projection for warming over Northern California is 2.5°C (4.5°F) by 2050 and 5°C by 2100, with a modest decrease in precipitation (Dettinger 2005). Chinook salmon in the Central Valley are at the southern limit of their range, and warming will shorten the period in which the low elevation habitats used by naturally-producing Chinook salmon are thermally acceptable. This would particularly affect fish that emigrate as fingerlings, mainly in May and June, and especially those in the San Joaquin River and its tributaries.

In summary, observed and predicted climate change effects are generally detrimental to the salmonid species (McClure 2011, Beechie et al 2012,Wade et al. 2013), so unless offset by improvements in other factors, the status of the species and critical habitats is likely to decline over time. The climate change projections referenced above cover the time period between the present and approximately 2100. While there is uncertainty associated with projections, which increases over time, the direction of change is relatively certain (McClure et al. 2013).

2.3 Action Area

"Action area" means all areas to be affected directly or indirectly by the Federal action and not merely the immediate area involved in the action (50 CFR 402.02). The action area is not the same as the project area because the action area must delineate all areas where federally-listed salmon, steelhead, and green sturgeon may be affected by the implementation of the action.

The action area for the Lehigh Southwest Stockton Terminal Project includes the ship turning basin in the Port of Stockton adjacent to the Berth 2 facility. The turning basin is used by vessels docking at the Lehigh Hanson facilities at Berth 2 to reverse course and navigate back downstream in the Stockton DWSC to the ocean. The action area continues from the Port of Stockton at approximately RM 40.5 downstream along the mainstem of the San Joaquin River following the dredged Stockton DWSC to the entrance of New York Slough. At New York Slough, adjacent to the cities of Antioch and Pittsburgh, the dredged ship channel deviates from the San Joaquin River and follows New York Slough. The lateral extent of the action area is defined by the margins of the river channels containing the Stockton DWSC. From the western most portion of New York Slough, the action area is defined as the shipping channel alignment through Suisun Bay, San Pablo Bay, and the northern portion of San Francisco Bay to the Golden Gate Bridge. In these reaches, the lateral extent of the action area is confined by the geometry of the shipping channel itself. Outside of the dredged channels, the open expanse of the bays reduces the effects of the shipping traffic, as the large vessels are constrained to stay within the shipping channels due to their draft. The geographical extent of the action area is defined by the routes that ocean going commercial vessels use to access the Lehigh Hanson facility (Figure 3).

2.4 Environmental Baseline

The "environmental baseline" refers to the condition of the listed species or its designated critical habitat in the action area, without the consequences to the listed species or designated critical habitat caused by the Project. 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 consultations, and the impact of State or private actions which are contemporaneous with the consultation in process. The consequences to listed species or designated critical habitat from ongoing agency activities or existing agency facilities that are not within the agency's discretion to modify are part of the environmental baseline (50 CFR 402.02).

2.4.1 Local and Regional Characteristics

The Project is located at the eastern border of the legal Delta, at the upstream terminus of the Stockton DWSC in the City of Stockton. The construction footprint is confined to the southwestern shoreline of the Port of Stockton ship turning basin. However the action area extends to the Golden Gate Bridge, as described above.

The action area is divided into three reaches based on the presence of listed salmonids from either the Sacramento River or the San Joaquin River basins. Reach 1 extends from the ship turning basin in the Port of Stockton to Prisoners Point on the San Joaquin River. This reach is predominately populated by salmonids originating in the San Joaquin River basin. Fish from the San Joaquin River basin enter the action area at Channel Point, where the San Joaquin River mainstem enters the Stockton DWSC between the East and West complexes. CCV steelhead from the Calaveras River also enter the DWSC adjacent to the West Complex of the Port of Stockton. These fish belong to the Southern Sierra Nevada diversity group. Fish from the San Joaquin River basin can also access the action area by routes following the Old River or Middle River corridors through the South Delta, before they join with the mainstem San Joaquin near Prisoners Point. Reach 2 of the action area is from Prisoners Point downstream to Chipps Island following the alignment of the Stockton DWSC through New York Slough. In addition to the fish from the San Joaquin River and Calaveras River basins present in Reach 1, listed species from the Sacramento River Basin (including the Northern Sierra Nevada, Basalt and Porous Lava, and Northwestern California diversity groups) have the potential to be present in this reach also. Fish from the Sacramento River basin can enter Reach 2 through either the lower Mokelumne River system via open Delta Cross Channel gates or through the routes offered by Georgiana Slough and Threemile Slough. Reach 3 extends from Chipps Island to the Golden Gate Bridge. Fish from both the Sacramento River and San Joaquin River basins, as well as all tributaries within the Central Valley, must pass through this reach when migrating upstream towards spawning grounds or moving back downstream towards the ocean. All three reaches are expected to contain sDPS green sturgeon due to their utilization of all waters within the Delta and estuary as well as potential occupancy in both major watersheds.

The Central Delta region is predominately freshwater habitat and provides critical habitat for CCV steelhead, and sDPS green sturgeon. Farther downstream starting in the vicinity of Jersey Point, the water becomes more brackish as salinity intrusion from tides mixes with the incoming freshwater flow. Within Suisun Bay and San Pablo Bay, the water becomes more saline as the marine influence upon tidal mixing becomes stronger, until the habitat is fully marine within the lower portions of San Pablo Bay and the northern portions of San Francisco Bay. This is the normal salinity gradient under all but the strongest freshwater outflows. Critical habitat for Sacramento River winter-run Chinook salmon is present in the lower Stockton DWSC (reaches 2 and 3) starting at the City of Antioch (riverine waters adjacent to Winter, Kimball, and Browns islands) and extends all the way to the Golden Gate Bridge. Likewise, critical habitat for CCV steelhead and sDPS green sturgeon is present throughout the Central Delta as well as in Suisun Bay, San Pablo Bay, and the northern portion of San Francisco Bay to the Golden Gate Bridge. Critical habitat for CV spring-run Chinook salmon includes all waters of the San Francisco Bay – San Pablo Bay – Suisun Bay complex north of the Bay Bridge (Reach 3 waters) as described in its listing. All of these water bodies are tidally influenced.

Within the Port of Stockton, the mainstem of the San Joaquin River (Reach 1) enters the Stockton DWSC between the East and West Complexes of the Port of Stockton (Channel Point). At this point the river leaves a "natural channel", which is not dredged and has a typical depth of 10 to 16 feet, and enters the Stockton DWSC, which has a maintained dredged depth of 35 feet mean lower low water (MLLW), and a dredged navigation channel width of approximately 225 to 250 feet. The southern shoreline of the Stockton DWSC within the Port of Stockton is comprised of commercial shipping docks, supported by multiple pilings with an armored shoreline (stone rip rap). The pilings are a mixture of original creosote treated wooden pilings from the 1930s, and newer cement or steel pilings as docks are refurbished and repaired. The distance between the ship turning basin and the end of the West Complex (Rough and Ready Island) is approximately 5.41 km (3.36 miles). The upland areas of the Port of Stockton are typified by industrial warehouses and dry material storage silos or domes, paved roads, storage yards, parking lots, and rail infrastructure. A substantial portion of the terrestrial surfaces within the limits of the Port of Stockton are considered impervious to rainfall. Current levels of commercial shipping to the Lehigh Hanson facility are 9 one way trips annually. Annual ship visits to the Port of Stockton are estimated at 252 (2018 data).

The northern shore of the Stockton DWSC within the Port of Stockton contains a mixture of commercial and residential buildings. Several parks and a golf course also are found along the northern shoreline in this reach. Two waterways enter the DWSC in this area, Smith Canal, which is a manmade waterway with water quality concerns, and the Calaveras River, which has degraded flow issues. The northern shoreline is comprised of armored levees, from which most of the riparian vegetation has been removed. Residences immediately adjacent to the levee typically have private boat docks in this reach which add to predator habitat. There are also 2 marinas and 2 boat launches in this area for public use which increases recreational boat use.

From the Port of Stockton (~RM 36) to the City of Antioch (~RM 8), the mainstem San Joaquin River (reaches 1 and 2) meanders through the Central Delta past several islands and tracts. These islands and tracts have been "reclaimed from the Delta" and are protected by State, Federal, and local Reclamation District levees against potential flooding. The levees are typically armored with stone rip rap to prevent erosion. Most natural vegetation, including almost all natural riparian vegetation, has been removed. In some pockets, emergent vegetation such as cattails (*Typha* species), and tules (*Scirpus* species) persist, providing some "natural" shoreline habitat in otherwise barren reaches. These areas are characteristically represented by reaches of the river where the navigation channel has bisected a meander of the natural river channel, creating a straight channel alignment for the ship channel and leaving the remnant portions of the river channel banks as mid-channel islands (i.e., Venice Cut and Mandeville Cuts, as well as other locations). These remnant mid-channel islands are usually tidally inundated and possess natural riparian growth and emergent marshes.

The upland areas within the Delta portion of the action area (reaches 1 and 2) consist primarily of irrigated fields, vineyards, and orchards traversed by irrigation canals and drainage ditches. These canals and ditches seasonally provide water from the Delta via pumps or siphons to the adjoining fields and then provide drainage back to the Delta, using pumps to move water over the levees to the adjoining sloughs. Most of these fields, vineyards, and orchards are at or below sea level in elevation due to subsidence, and are protected by a network of raised levees to protect them from flooding from the adjacent waterways. The water level in these channels can be upwards of 10-20 feet above the elevation of the fields under normal conditions, and can be considerably more during high flow events on the Sacramento River or San Joaquin River.

Land use within Suisun Bay, San Pablo Bay, and the northern portion of San Francisco Bay (Reach 3) is a mixture of heavy industry and residential use. Several petrochemical facilities are located on the shores of Suisun Bay and San Pablo Bay, and shipyards are found near the City of Richmond. Commercial shipping traffic enters into San Francisco Bay through the Golden Gate Bridge to access the ports of Oakland and San Francisco, one of the busiest port complexes in the world.

2.4.1.1 Water Development

The diversion and storage of natural flows by dams and diversion structures on Central Valley watersheds has depleted stream flows in the tributaries feeding the Delta and altered the natural cycles by which juvenile and adult salmonids and sDPS green sturgeon base their migrations. As much as 60 percent of the natural historical inflow to Central Valley watersheds and the Delta have been diverted for human uses. Depleted flows have contributed to higher temperatures, lower dissolved oxygen (DO) levels, and decreased recruitment of gravel and large woody debris (LWD, also referred to as instream woody material or IWM). More uniform flows year round have resulted in diminished natural channel formation, altered foodweb processes, and slower regeneration of riparian vegetation (Mount 1995).

Water withdrawals for agricultural and municipal purposes have reduced river flows and increased water temperatures during the critical summer months, and in some cases, have been of a sufficient magnitude to result in reverse flows in the lower San Joaquin River (Reynolds et al. 1993). Direct relationships exist between water temperature, water flow, and juvenile salmonid survival (Brandes and McLain 2001). Elevated water temperatures in the Sacramento River have limited the survival of young salmon in those waters. Juvenile fall-run survival in the Sacramento River is also directly related with June streamflow and June and July Delta outflow (Dettman et al. 1987).

Water diversions for irrigated agriculture, municipal and industrial use, and managed wetlands are found throughout the Delta region. Currently, 2,284 water diversions exist in the Delta waterways surrounding the intensively farmed islands within the legal Delta boundaries. Of these, 33 are screened and the remainder are unscreened or their status is unknown. Although efforts have been made in recent years to screen some of these diversions, many remain unscreened. Depending on the size, location, and season of operation, these unscreened diversions entrain and kill many life stages of aquatic species, including juvenile salmonids and green sturgeon (California Fish Passage Database 2020).

2.4.1.2 Water Conveyance and Flood Control

The development of the water conveyance system in the Delta has resulted in the construction of more than 1,100 miles of armored levees to increase channel flood capacity elevations and flow capacity of the channels (Mount 1995). Levee development in the action area affects freshwater rearing habitat, freshwater migration corridors, and freshwater riverine and estuarine habitat PBFs. As Mount (1995) indicates, there is an "underlying, fundamental conflict inherent in this channelization." Natural rivers strive to achieve dynamic equilibrium to handle a watershed's supply of discharge and sediment (Mount 1995). The construction of levees disrupts the natural processes of the river, resulting in a multitude of habitat-related effects; including isolation of the watershed's natural floodplain behind the levee from the active river channel and its fluctuating hydrology.

Many of these levees use angular rock (riprap) to armor the bank from erosive forces. The effects of channelization, and riprapping, include the alteration of river hydraulics and riparian vegetative cover along the bank as a result of changes in bank configuration and structural features. These changes affect the quantity and quality of nearshore habitat for juvenile salmonids and have been thoroughly studied (USFWS 2000, Schmetterling et al. 2001, Garland et al. 2002). Simple slopes protected with rock revetment generally create nearshore hydraulic conditions characterized by greater depths and faster, more homogeneous water velocities than occur along natural banks. Higher water velocities typically inhibit deposition and retention of sediment and woody debris. These changes generally reduce the range of habitat conditions typically found along natural shorelines, especially by eliminating the shallow, slow-velocity river margins used by juvenile fish as refuge and escape from fast currents, deep water, and predators.

2.4.1.3 Land Use Activities

Prior to 1850, approximately 1,400 km^2 of freshwater marsh surrounded the confluence of the Sacramento and San Joaquin rivers, and another 800 km^2 of saltwater marsh fringed San Francisco Bay's margins. Since the 1850s, wetlands reclamation for urban and agricultural development has caused the cumulative loss of 79 and 94 percent of the tidal marsh habitat in the Delta downstream and upstream of Chipps Island, respectively (Conomos et al. 1985, Nichols et al. 1986, Wright and Phillips 1988, Goals Project 1999). Of the original 2,200 km^2 of tidally influenced marsh, only about 125 km^2 of undiked marsh remains today. Even more extensive losses of wetland marshes occurred in the Sacramento and San Joaquin River basins. Little of the extensive tracts of wetland marshes that existed prior to 1850 along the valley's river systems and within the natural flood basins exist today. Most has been "reclaimed" for agricultural purposes, leaving only small remnant patches. Engineered levees have isolated the rivers from their natural floodplains and have resulted in the loss of their ecological functions.

Dredging of river channels to enhance inland maritime trade and to provide raw material for levee construction has significantly and detrimentally altered the natural hydrology and function of the river systems in the Central Valley. Starting in the mid-1800s, the USACE and other private consortiums began straightening river channels and artificially deepening them to enhance shipping commerce. This has led to declines in the natural meandering of river channels and the formation of pool and bar segments. The deepening of channels beyond their natural depth also has led to a significant alteration in the transport of bedload in the riverine system as well as the local flow velocity in the channel (Mount 1995). The Sacramento Flood Control Project at the turn of the nineteenth century ushered in the start of large scale USACE actions in the Delta and along the rivers of California for reclamation and flood control. The creation of levees and the deep shipping channels reduced the natural tendency of the San Joaquin and

Sacramento rivers to create floodplains along their banks with seasonal inundations during the wet winter season and the spring snow melt periods. These annual inundations provided necessary habitat for rearing and foraging of juvenile native fish that evolved with this flooding process. The armored riprapped levee banks and active maintenance actions of Reclamation Districts precluded the establishment of ecologically important riparian vegetation, introduction of valuable LWD/ IWM from these riparian corridors, and the productive intertidal mudflats characteristic of the undisturbed Delta habitat.

Urban stormwater and agricultural runoff may be contaminated with pesticides, oil, grease, heavy metals, poly-aromatic hydrocarbons (PAHs), and other organics and nutrients (Regional Board 1998), which can destroy aquatic life necessary for salmonid survival (NMFS 1996a, b) and are also expected to negatively impact the different green sturgeon life stages also present. Point source (PS) and non-point source (NPS) pollution occurs at almost every point that urbanization activity influences the watershed. Impervious surfaces (i.e., concrete, asphalt, and buildings) reduce water infiltration and increase runoff, thus creating greater flood hazard (NMFS 1996a, b). Flood control and land drainage schemes may increase the flood risk downstream by concentrating runoff. A flashy discharge pattern results in increased bank erosion with subsequent loss of riparian vegetation, undercut banks and stream channel widening. In addition to the PS and NPS inputs from urban runoff, juvenile salmonids and green sturgeon are exposed to increased water temperatures as a result of thermal inputs from municipal, industrial, and agricultural discharges.

2.4.1.4 Water Quality

The water quality of the Delta has been negatively impacted over the last 150 years. Increased water temperatures, decreased DO levels, and increased turbidity and contaminant loads have degraded the quality of the aquatic habitat for the rearing and migration of salmonids and sDPS green sturgeon. Some common pollutants include effluent from wastewater treatment plants and chemical discharges such as dioxin from San Francisco Bay petroleum refineries (McEwan and Jackson 1996). In addition, agricultural drain water, another possible source of contaminants, can contribute up to 30 percent of the total inflow into the Sacramento River during the low-flow period of a dry year. The Regional Board, in its 1998 Clean Water Act §303(d) list, characterized the Delta as an impaired waterbody having elevated levels of chlorpyrifos, dichlorodiphenyltrichlor (i.e. DDT), diazinon, electrical conductivity, Group A pesticides [aldrin, dieldrin, chlordane, endrin, heptachlor, heptachlor epoxide, hexachlorocyclohexanes (including lindane), endosulfan and toxaphene], mercury, low DO, organic enrichment, and unknown toxicities (Regional Board 1998, 2001, California State Water Resources Control Board 2010).

In general, water degradation or contamination can lead to either acute toxicity, resulting in death when concentrations are sufficiently elevated, or more typically, when concentrations are lower, to chronic or sublethal effects that reduce the physical health of the organism, and lessens its survival over an extended period of time. Mortality may become a secondary effect due to compromised physiology or behavioral changes that lessen the organism's ability to carry out its normal activities. For example, increased levels of heavy metals are detrimental to the health of an organism because they interfere with metabolic functions by inhibiting key enzyme activity in metabolic pathways, decrease neurological function, degrade cardiovascular output, and act as mutagens, teratogens or carcinogens in exposed organisms (Rand et al. 1995, Goyer 1996). For listed species, these effects may occur directly to the fish or to its prey base, which reduces the forage base available to the listed species.

In the aquatic environment, most anthropogenic chemicals and waste materials, including toxic organic and inorganic chemicals, eventually accumulate in sediment (Ingersoll 1995). Direct exposure to contaminated sediments may cause deleterious effects to listed salmonids and green sturgeon. This may occur if a fish swims through a plume of the resuspended sediments or rests on contaminated substrate and absorbs the toxic compounds through one of several routes: dermal contact, ingestion, or uptake across the gills. Elevated contaminant levels may be found in localized "hot spots" where discharge occurs or where river currents deposit sediment loads. Sediment contaminant levels can thus be significantly higher than the overlying water column concentrations [U.S. Environmental Protection Agency (USEPA) 1994]. However, the more likely route of exposure to salmonids or green sturgeon is through the food chain, when the fish feed on organisms that are contaminated with toxic compounds. Prey species become contaminated either by feeding on the detritus associated with the sediments or dwelling in the sediment itself. Therefore, the degree of exposure to the salmonids and green sturgeon depends on their trophic level and the amount of contaminated forage base they consume. Response of salmonids and green sturgeon to contaminated sediments is similar to water borne exposures once the contaminant has entered the body of the fish.

2.4.1.5 Hydrology of the Delta

Substantial changes have occurred in the hydrology of the Central Valley's watersheds over the past 150 years. Many of these changes are linked to the ongoing actions of the Central Valley Project (CVP) and State Water Project (SWP) in their pursuit of water storage and delivery of this water to their contractors.

Prior to the construction of dams on the tributaries surrounding the Central Valley, parts of the valley floor hydrologically functioned as a series of natural reservoirs seasonally filling and draining every year with the cycles of rainfall and snow melt in the surrounding watersheds. These reservoirs delayed and muted the transmission of floodwaters traveling down the length of the Sacramento and San Joaquin rivers. Historically, there were at least six distinct flood basins in the Sacramento Valley. These extensive flood basins created excellent shallow water habitat for fish such as juvenile Chinook salmon, steelhead, and sturgeon to grow and rear before moving downstream into the Delta (The Bay Institute 1998). The magnitude of the seasonal flood pulses were reduced before entering the Delta, but the duration of the elevated flows into the Delta were prolonged for several months, thereby providing extended rearing opportunities for emigrating Chinook salmon, steelhead, and green sturgeon to grow larger and acquire additional nutritional energy stores before entering the main Delta and upper estuarine reaches.

Mean outflow from the Sacramento River during the later portion of the 19th century has been reduced from nearly 50 percent of the annual discharge occurring in the period between April and June to only about 20 percent of the total mean annual outflow under current dam operations (The Bay Institute 1998). Currently, the highest mean flows occur in January, February, and March. The San Joaquin River has seen its snowmelt flood peak essentially eliminated, and the total discharge to the valley floor portion of the mainstem greatly reduced during the spring. Only in very wet years is there any marked late spring outflow peak (The Bay Institute 1998).

These changes in the hydrographs of the two main river systems in the Central Valley are also reflected in the inflow and outflow of water to the Delta. The operations of the dams and water transfer operations of the CVP and SWP have reduced the winter and spring flows into the Delta, while artificially maintaining elevated flows in the summer and late fall periods. The Delta has thus become a conveyance apparatus to move water from the Sacramento side of the Delta to the southwestern corner of the Delta where the CVP and SWP pumping facilities are located. Releases of water to the Delta during the normally low flow summer period have had several impacts on Delta ecology and hydrology. Since the CVP and SWP started transferring water through the Delta, the normal variability in the hydrology of the Delta has diminished. Annual incursions of saline water into the Delta still occur each summer, but have been substantially muted compared to their historical levels by the release of summer water from the reservoirs (Herbold and Moyle 1989, Figures 4 and 5). The Delta has become a stable freshwater body, which is more suitable for introduced and invasive exotic freshwater species of fish, plants, and invertebrates than for the native organisms that evolved in a fluctuating and "unstable" Delta environment.

Furthermore, Delta outflow has been reduced by approximately 14 percent from the pre-dam period (1921-1943) when compared to the modern state and federal water project operations period (1968-1994). When differences in the hydrologic year types are accounted for and the "wet" years are excluded, the comparison between similar year types indicates that outflow has been reduced by 30 to 60 percent (The Bay Institute 1998), with most of this "lost" water going to exports. Currently, the Sacramento River contributes roughly 75-80 percent of the Delta inflow in most years and the San Joaquin River contributes about 10-15 percent; the Mokelumne, Cosumnes, and Calaveras rivers, which enter into the eastern side of the Delta, contribute the remainder. The sum of the river contributions flow through the Delta and into Suisun Bay, San Pablo Bay, San Francisco Bay, and eventually empties into the Pacific Ocean. Historical annual Delta inflow between 1945 and 1995 (i.e., the period of modern dam operations) averaged approximately 23 million acre-feet (MAF), with a minimum inflow of approximately 6 MAF in 1977 and a maximum of approximately 70 MAF in 1983 (USACE 2015).

Water movement in the Delta responds to four primary forcing mechanisms: (1) freshwater inflows draining to the ocean; (2) Delta exports and diversions; (3) operation of water control facilities such as dams, export pumps, and flow barriers; and (4) the regular tidal movement of seawater into and out of the Delta. In addition, winds and salinity behavior within the Delta can generate a number of secondary currents that, although of low velocity, can be of considerable significance with respect to transporting contaminants and mixing different sources of water. Changes in flow patterns within the Delta, whether caused by export pumping, winds, atmospheric pressure, flow barriers, tidal variations, inflows, or local diversions, can influence water quality at drinking water intakes (USACE 2015).

2.4.1.6 NMFS Salmon and Steelhead Recovery Plan Actions

The NMFS Recovery Plan that includes Sacramento River winter-run Chinook salmon, CV Spring-run Chinook salmon and CCV steelhead (NMFS 2014) identifies recovery goals for the Sacramento River and San Joaquin River basin populations that utilize the waterways of the Delta, including the action area, for aspects of their life history. Recovery efforts focus on addressing several key stressors that are vital to Sacramento River winter-run Chinook salmon, CV spring-run Chinook salmon, and CCV steelhead: (1) Altered natural riverine flows entering the Delta from the Sacramento and San Joaquin River basins affecting adult and juvenile migration and holding; (2) Altered hydrodynamics due to operations of the CVP and SWP export facilities affecting migratory cues of migrating juveniles; (3) Altered riparian and marsh habitats due to levee construction and marshland reclamation efforts; and (4) Increased exposure to non-native predation within the waterways of the Delta.

2.4.1.6.1 Specific Key Stressors in the Delta described in the Salmonid Recovery Plan

- Altered hydrographs of the Sacramento and San Joaquin rivers entering the Delta due to upstream operations of reservoirs that does not represent the historic natural unimpaired inflow pattern used by fish for attraction and migratory behavioral cues.

- Altered hydrodynamics in the central and southern Delta due to the operations of the SWP and CVP export facilities.

- Loss of natural ecological function in the majority of the Delta landscape due to human activities.

- Limited quantity and quality of rearing and migratory habitat due to human actions related to levee construction.

- Loss of extensive marshland habitat in both fresh and saltwater habitats used for rearing and holding of migrating salmonids due to human activities.

- Unscreened or poorly screened agricultural diversions.

- Increased predation risks to juvenile salmonids from non-native predators.

- Restoration and/or creation of floodplain habitat for juvenile salmonids entering or rearing in the Delta.

None of the recovery actions for the Delta identified in the salmonid Recovery Plan are relevant to this consultation. The USACE does not propose any actions that address any of the key stressors mentioned in the salmonid Recovery Plan.

2.4.1.7 NMFS sDPS Green Sturgeon Recovery Plan Actions

The NMFS Recovery Plan for sDPS green sturgeon (NMFS 2018) identifies recovery goals for this species that utilizes the waterways of the Delta, including the action area, for different components of their life history. Recovery efforts focus on addressing several key stressors that are vital to sDPS green sturgeon:

- Barriers to migration of juveniles, subadults, and adults within the San Francisco Bay-Delta Estuary (SFBDE).

- Altered water flows, and water temperatures within the SFBDE.
- Take, as defined by the ESA, associated with water diversions, poaching, commercial and recreational fisheries bycatch, within the SFBDE.
- Alterations to the prey base due to contaminants and identification of trophic transfer of contaminants through the different life stages of green sturgeon.
- Predation impacts to green sturgeon due to native and non-native species.
- Competition for habitat between native and non-native species and green sturgeon.
- Effects of climate change on habitat usage and availability for green sturgeon.

None of the recovery actions for the Delta identified in the sDPS green sturgeon Recovery Plan are relevant to this consultation. Ship strikes were identified as a low level stressor within the SFBDE, however the level of data was also low to assess it. The USACE does not propose any actions that address any of the key stressors mentioned in the Recovery Plan.

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

2.4.2.1 Status of the Species within the Action Area

The action area functions primarily as a migratory corridor for Sacramento River winter-run Chinook salmon, CV spring-run Chinook salmon, CCV steelhead, and the sDPS green sturgeon, but it also provides some use as holding and rearing habitat for each of these species as well. The status of each listed species and their designated critical habitat is described in the following sections.

2.4.2.1.1 Sacramento River Winter-run Chinook Salmon

No adult or juvenile winter-run Chinook salmon are expected to be in the vicinity of the construction footprint or within the upper portions of Reach 1 at any time. There are no spawning areas in the action area that could be used by adult winter-run Chinook salmon, therefore the potential that eggs would be present in the action area is nonexistent. Likewise, the potential for alevins to be present in the action area is also unlikely, since the only known spawning areas for winter-run Chinook salmon are in the Sacramento River basin below Keswick Dam and in Battle Creek by the “jumpstart” reintroduction population, and only extreme precipitation events in the summer and fall resulting in high river flows in the Sacramento River basin could flush alevins out of their natal rearing areas into the action area. However, storms of this magnitude are very infrequent during summer and fall. Fry and parr are more likely to be present in the action area in response to high river flows due to the timing of late fall and early winter storms and the progressive maturation of the fish from approximately mid-October through late-November. By early-December, winter-run Chinook salmon juveniles are of sufficient maturation to start emigrating downstream in the Sacramento River towards the Delta. Once entering the Delta, juveniles may rear for up to 3 months, before completing their emigration to the ocean. At this time they have the potential to be present in the action area in reaches 2 and 3. A review of fish monitoring data for juvenile winter-run Chinook salmon from 1995–2019 from the Sacramento River trawl (Sherwood Harbor) and the Chipps Island trawl showed very low numbers present from July through October during the in-water work window (USFWS 2013, 2015, 2017; USFWS DFJMP data 2000-2019, University of Washington Columbia Basin Research, 2020; Figures 6 and 7). Juvenile winter-run Chinook salmon occur in the Delta primarily from November through early May with a peak occurrence in March, using length-at-date criteria from trawl data in the Sacramento River near Sherwood Harbor (USFWS 2013, 2015, 2017; Table 7). Although juvenile winter-run Chinook salmon could be present in the Delta portions of the action area (primarily Reach 2) during the in-water work window of July 1 to November 30, they are not expected to be in the vicinity of the Project's construction footprint in Reach 1 during the same period due to their spatial distribution within the Delta.

Adult winter-run Chinook salmon are expected to be in the action area (San Francisco estuary and Delta – reaches 2 and 3) from November through June, with a peak presence from February to April (Table 7) as they migrate upstream to spawn in the upper Sacramento River. Since the Delta portion of the action area (Reach 2) is a transition zone between marine and estuarine tidal habitat and riverine sections of the lower Sacramento and San Joaquin rivers, adult salmon sometimes wander through the Delta searching for specific scents that lead them to their natal spawning area. Adult winter-run Chinook salmon have been known to stray into open channels such as the Sacramento Ship Channel (SSC), the Stockton DWSC, and around the Delta islands and sloughs as they make their way through the maze of channels leading to the mainstem Sacramento River upstream of the Delta, including the Yolo Bypass when inundated. Adult winter-run Chinook salmon may move up the lower San Joaquin River (Reach 2) and gain access to the Sacramento River through Threemile Slough, Georgiana Slough, or the Mokelumne River complex (if the DCC gates are open).

Table 7. Temporal occurrence of winter-run Chinook salmon in the Delta with darker shades indicating months of high presence and lighter shades indicating months of low presence.

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Adult WR[1]	MED	HIGH	HIGH	HIGH	MED	MED	NONE	NONE	NONE	NONE	MED	MED
Juvenile WR[2]	LOW	MED	HIGH	MED	NONE	NONE	NONE	NONE	NONE	LOW	LOW	MED
Salvaged WR[3]	MED	HIGH	HIGH	LOW	LOW	LOW	NONE	NONE	NONE	NONE	NONE	LOW

HIGH MED LOW NONE

[1]Adults enter the Bay November to June (Hallock and Fisher 1985) and are in spawning ground at a peak time of June to July (Vogel and Marine 1991).
[2]Juvenile presence in the Delta was determined using DJFMP data.
[3]Months in which salvage of wild juvenile winter-run Chinook salmon at State and Federal pumping plants occurred (NMFS 2016d).

2.4.2.1.2 CV Spring-run Chinook Salmon

Currently, there are no existing documented natural populations of CV spring-run Chinook salmon in the San Joaquin River basin that would likely occur in the area occupied by the Project's construction footprint within the action area (Reach 1). The last natural runs of spring-run Chinook salmon in the San Joaquin River basin were extirpated by the early 1950s. The presence of any CV spring-run Chinook salmon in the Project's construction area is likely the result of the San Joaquin River Restoration Project's (SJRRP) efforts at reintroduction of this run into the San Joaquin River watershed. The SJRRP's goal of re-establishing an experimental population of CV spring-run Chinook salmon in the San Joaquin River basin will create the potential that CV spring-run Chinook salmon will be present in the entirety of the action area and, thus, be exposed to the ongoing commercial shipping associated with the Project. These fish are treated as threatened under the ESA outside of their experimental reintroduction area (i.e., the San Joaquin River from Friant Dam to the confluence of the Merced River). In the sections of the action area from approximately Prisoners Point downstream to the Golden Gate (reaches 2 and 3), the naturally occurring spring-run Chinook salmon populations from the Sacramento River basin's watersheds are also present. Presence of adult or juvenile CV spring-run in the Project's construction footprint within the action area during the proposed in-water construction window of July 1 through November 30 is unlikely based on the following life history characteristics.

There are no spawning areas in the action area that could be used by adult spring-run Chinook salmon, therefore, the potential that eggs would be present in the action area is nonexistent. Likewise, the potential for alevins to be present in the action area is also unlikely, since only extreme precipitation events in the fall and early winter resulting in high river flows in the San Joaquin River basin could flush alevins out of their natal tributaries into the action area. Alevins from the Sacramento River basin are also highly unlikely to reach the action area, including the reaches of the San Joaquin River adjacent to the Port of Stockton under any conditions. Fry and parr are more likely to be present in the action area in response to high river flows due to the timing of winter storms and the progressive maturation of the fish. Fish from both the Sacramento and San Joaquin watersheds could potentially be present in the lower San Joaquin River portion of the action area (Prisoners Point and downstream – reaches 2 and 3), but fish in the action area upstream of Prisoners Point (Reach 1) would originate from the San Joaquin River basin. This period would be from approximately November through March. By April, juvenile CV spring-run Chinook salmon are reaching the size that smoltification occurs, and the majority of smolts would be moving downriver to enter the Delta on their emigration to the ocean. CV spring-run Chinook salmon smolt outmigration is essentially over by mid-May with only a few late fish emigrating in early June. There is the potential that some juvenile CV spring-run Chinook salmon will remain in the tributaries through the summer and emigrate the following fall and winter as yearlings, but until the experimental population has had time to establish itself, this behavior is uncertain to occur in the San Joaquin River basin (Table 8 and Figures 8 and 9). Adult CV spring-run Chinook salmon are expected to migrate upstream through the action area from January to June with a peak presence from February to April (Table 8). Adult migration into the San Joaquin River basin is also likely to be strongly influenced by the flow levels in the San Joaquin River which provides access to the upstream holding and spawning areas. The broodstock for the CV spring-run Chinook salmon experimental population came from the Sacramento River basin (Feather River Fish Hatchery spring-run Chinook salmon) and are expected to exhibit similar migration timing behavior for both adult and juvenile life stages in the San Joaquin River basin.

The proposed in-water construction period for the Project within the Port of Stockton (Reach 1) is from July 1 through November 30. This will not overlap with the adult CV spring-run Chinook salmon migration period in the San Joaquin River basin (i.e., the months of January through

June). The construction window will also avoid overlapping with juvenile CV spring-run Chinook salmon emigration during late winter and spring. However, the operations of the Project related to commercial navigation to the Lehigh Hanson facility will overlap with both adult migration upstream and juvenile migration downstream every year.

Table 8. Temporal occurrence of spring-run Chinook salmon in the Delta with darker shades indicating months of high presence and lighter shades indicating months of low presence.

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Adult SR[1]	MED	HIGH	HIGH	HIGH	MED	MED	NONE	NONE	NONE	NONE	NONE	NONE
Juvenile SR[2]	LOW	LOW	LOW	HIGH	MED	NONE	NONE	NONE	NONE	NONE	NONE	LOW
Salvaged SR[3]	LOW	LOW	MED	HIGH	MED	NONE	NONE	NONE	NONE	NONE	NONE	NONE

HIGH MED LOW NONE

[1]Adults enter the Bay late January to early February (CDFW 1998) and enter the Sacramento River in March (Yoshiyama *et al.* 1998). Adults travel to tributaries as late as July (Lindley *et al.* 2004). Spawning occurs September to October (Moyle 2002).
[2]Juvenile presence in the Delta based on DJFMP data.
[3]Juvenile presence in the Delta based on salvage data (NMFS 2016d).

2.4.2.1.3 CCV Steelhead

Overall for the Delta, wild CCV steelhead juveniles (smolts) from the Sacramento River basin can start to appear as early as October, based on the data from the Sacramento River and Chipps Island trawls (USFWS 2013, 20115, and 2017, University of Washington Columbia Basin Research, 2020; Figures 10 and 11) and CVP/SWP Fish Salvage Facilities (CDFW 2020 ftp salvage website). In the Sacramento River, juvenile CCV steelhead generally migrate to the ocean in spring and early summer at 1 to 3 years of age and 100 to 250 mm FL, with peak migration through the Delta occurring in March and April (Reynolds et al. 1993).

Juvenile CCV steelhead presence in CVP/SWP Fish Salvage Facilities increases from November through January (12.4 percent of average annual salvage) and peaks in February (40.4 percent) and March (26.9 percent) before rapidly declining in April (13.3 percent) and May (4.4 percent) (NMFS 2016d). By June, emigration essentially ends (Table 9), with only a small number of fish being salvaged through the summer at the CVP/SWP Fish Salvage Facilities.

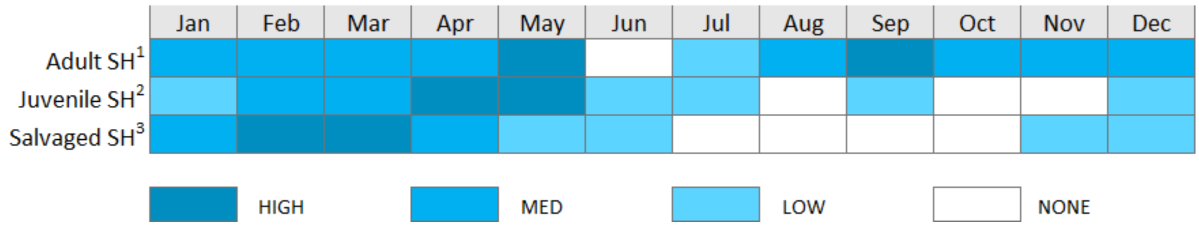
All adult CCV steelhead heading into the Sacramento River basin begin to migrate through the action area (San Francisco estuary and portions of the western Delta – reaches 2 and 3) starting in July and continue through late fall, with a secondary peak occurring in late spring (presumably adults returning downstream as kelts). The percentage of the annual adult escapement into the Sacramento River basin is estimated to be 2 percent for July, 12 percent for August, 44.5 percent for September, 25 percent for October and 6.8 percent for November (Hallock et al. 1957, 1961). Adult CCV steelhead migrating into the San Joaquin River basin are expected to start moving upstream through the action area (reaches 1 and 2) into the lower San Joaquin River as early as September, with the peak migration period occurring later in the fall from October through January. Approximately half of the assumed CCV steelhead moving upriver annually into the Stanislaus River do so between mid-October and the end of November, based on Stanislaus River fish weir counts conducted by Fish Bio, Inc., Oakdale, California. However in some years, the peak of migration occurs in December and January. Adult CCV steelhead will continue to migrate upriver through March, with post spawn fish, "kelts", moving downstream potentially through spring and early summer, although most are expected to move back downstream earlier than later (Table 9).

There are no spawning areas in the action area that could be used by adult CCV steelhead; therefore the potential that eggs would be present in the action area is nonexistent. All adult CCV steelhead originating in the San Joaquin River basin will pass through portions of the action area to reach their spawning grounds in the Calaveras, Stanislaus, Tuolumne, and Merced rivers, and the tailwater section of the San Joaquin River below Friant Dam, and return to the ocean following spawning through these same waterways. Some adults may access the San Joaquin River basin through the south Delta waterways leading to the Head of Old River near Lathrop, and may return to the ocean via this route too, but most fish are believed to use the mainstem of the San Joaquin River as their migratory route and therefore remain in the action area (Reach 1) until leaving the Stockton DWSC at Channel Point in the Port of Stockton. CCV steelhead smolts leaving the San Joaquin River basin during their emigration also pass through the action area. Some fish will use the Old River corridor while others will remain in the mainstem of the river, particularly if a barrier is installed at the Head of Old River during their emigration period. Emigrating CCV steelhead smolts from the San Joaquin River basin will migrate through the action area once they are in the mainstem of the San Joaquin River within the Port of Stockton (Reach 1) and continue downstream towards the estuary and ocean (reaches 2 and 3). The waterways in the action area are expected to be used primarily as migration corridors for adult steelhead and emigrating steelhead smolts, but may also provide some rearing benefits to the emigrating smolts. In comparison, while all adult CCV steelhead from the Sacramento River basin will pass through the San Francisco estuary (Reach 3), only a fraction of those will continue up the San Joaquin River portion of the action area (Reach 2) before following one of the alternative routes back to the mainstem Sacramento River to complete their spawning run (i.e. Threemile Slough, Georgiana Slough, or the Mokelumne River complex). A smaller subset of this group will continue up the Mokelumne River to spawn. Once leaving the mainstem of the San Joaquin River, these fish are no longer in the action area.

CCV steelhead smolts from the San Joaquin River basin are expected to appear in the action area waterways as early as January, based on observations in tributary monitoring studies on the Stanislaus River, but in very low numbers. The peak emigration in the lower San Joaquin River, as determined by the Mossdale trawls near the Head of Old River, occurs from April to May, but with presence of fish typically extending from late February to late June. In comparison, the apparent peak of emigration into the Delta for Sacramento River basin fish is in February and March. These fish will be in the action area as they emigrate towards the ocean through the western Delta and San Francisco estuary (reaches 2 and 3).

The proposed in-water construction period for the Project (i.e., the Berth 2 location in the Port of Stockton – Reach 1) is from July 1 through November 30. This will overlap with the adult CCV steelhead migration period in the San Joaquin River basin (i.e., the months of September, October, and November). This in-water work window will avoid the period of smolt emigration from the San Joaquin River basin. No smolts from the Sacramento River basin are expected to be in this portion of the action area (Reach 1) at any time. However, the operations of the Project related to the commercial navigation utilizing the Lehigh Hanson facilities will overlap with both adult migration upstream, and juvenile migration downstream every year for both the Sacramento and San Joaquin river basin's populations of CCV steelhead.

Table 9. Temporal occurrence of steelhead in the Delta with darker shades indicating months of high presence and lighter shades indicating months of low presence.



[1]Adult presence was determined using information in Moyle (2002), Hallock et al. (1961), and CDFW (2015).
[2]Juvenile presence in the Delta was determined using DJFMP data.
[3]Months in which salvage of wild juvenile steelhead at State and Federal pumping plants occurred; values in cells are salvage data reported by the facilities (NMFS 2016d).

2.4.2.1.4 Southern DPS of North American Green Sturgeon

Adult sDPS green sturgeon begin to enter the Sacramento – San Joaquin Delta in late February and early March during the initiation of their upstream spawning run (Moyle et al. 1995, Heublein et al. 2009, Miller et al. 2020). The peak of adult entrance into the Delta appears to occur in late February through early April, with fish arriving upstream of the Glen-Colusa Irrigation District's water diversion on the upper Sacramento River in April and May to access known spawning areas (Moyle 2002). Adults continue to enter the Delta until early summer (June-July) as they move upriver to spawn in the upper Sacramento River basin. It is also possible that some adult sDPS green sturgeon will be moving back downstream as early as April and May through the Delta, either as early post-spawners or as unsuccessful spawners. The majority of post-spawn adult sDPS green sturgeon will move down river to the Delta either in the summer or during the fall. Fish that over-summer in the upper Sacramento will move downstream when the river water cools and rain events increase the river's flow and either hold in the Delta or migrate to the ocean. Data on green sturgeon distribution are extremely limited and out-migration appears to be variable, occurring at different times of year. Seven years of recreational fishing catch data for adult green sturgeon (CDFW sturgeon fishing report cards) show that they are present in the Delta during all months of the year (Figure 12). Although the majority of sDPS green sturgeon are expected to be found along the Sacramento River corridor and within the western Delta, observations of sDPS green sturgeon occur in the San Joaquin River and upstream of the action area based on the information provided in the CDFW sturgeon fishing report cards. Presence of fish occurs during all seasons of the year, but primarily from fall through spring. Few fish are caught during the summer period.

Juvenile sDPS green sturgeon migrate to the sea when they are 1 to 4 years old (Moyle et al. 1995). According to Radtke (1966), juveniles were collected year round in the Delta during a 1-year study in 1963-1964. The DJFMP rarely collected juvenile green sturgeon at the seine and trawl monitoring sites. From 1981 to 2012, 7,200 juvenile green sturgeon were reported at the

State and Federal Fish Salvage Facilities (Figure 13), which indicates a higher presence of juvenile green sturgeon during the spring and summer months in the south Delta where the export facilities are located. Based on the above information, adult and juvenile green sturgeon were determined to be present in the Delta year-round (Table 10).

Table 10. Temporal occurrence of green sturgeon in the Delta with darker shades indicating months of high presence and lighter shades indicating months of low presence.

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
*Adult GS[1]	MED	MED	MED	MED	MED	MED	MED	MED	MED	MED	MED	MED
*Juvenile GS[2]	MED	MED	MED	MED	MED	MED	MED	MED	MED	MED	MED	MED
Salvaged GS[3]	LOW	LOW	LOW	LOW	LOW	NONE	MED	HIGH	LOW	LOW	LOW	LOW

HIGH	MED	LOW	NONE

[1]Adult presence was determined to be year round according to information in (CDFW sturgeon report cards 2008-2014), (Heublein *et al.* 2009), and (Moyle 2002).

[2]Juvenile presence in the Delta was determined to be year round by using information in (USFWS DJFMP data), (Moyle *et al.* 1995) and (Radtke 1966).

[3]Months in which salvage of green sturgeon at the CVP/SWP Fish Salvage Facilities occurred

2.4.2.2 Status of Critical Habitat within the Action Area

Critical habitat for Sacramento River winter-run Chinook salmon within the action area includes the westward margin of the Sacramento-San Joaquin Delta (Delta; part of Reach 2, and Reach 3), including the areas westward from Sherman Island to Chipps Island. This area includes the river channels surrounding Kimball Island, Winter Island, and Browns Island, including New York Slough. Critical habitat for Sacramento River winter-run Chinook salmon also includes all waters from Chipps Island westward to the Carquinez Bridge, including Honker Bay, Grizzly Bay, Suisun Bay, and the Carquinez Strait; all waters of San Pablo Bay westward of the Carquinez Bridge; and all waters of San Francisco Bay north of the San Francisco-Oakland Bay Bridge from San Pablo Bay to the Golden Gate Bridge. In the areas westward from Chipps Island, including San Francisco Bay to the Golden Gate Bridge, the PBFs for Sacramento River winter-run Chinook salmon critical habitat includes the estuarine water column and essential foraging habitat and food resources used by Sacramento River winter-run Chinook salmon as part of their juvenile outmigration or adult spawning migration. Within the action area, designated Sacramento River winter-run Chinook salmon critical habitat is degraded by anthropogenic activities, including dredging, shipping, effluent runoff from development on the shoreline, and long-term contamination from historical industrial and urban discharges to the waters of the Delta and San Francisco estuary.

Critical habitat for CV spring-run Chinook salmon includes the estuarine regions (Reach 3) westwards of Chipps Island. Estuarine areas occur farther downstream than freshwater migration and rearing habitats where tidal mixing occurs and salinity is greater than 0.5 parts per thousand (ppt). Since the San Joaquin River is not part of the designated critical habitat for CV spring-run Chinook salmon, there are no freshwater critical habitat PBFs associated with the action area in reaches 1 and 2. The PBFs in estuarine areas support unobstructed migration, adequate water quality to facilitate physiological transitions, and suitable prey populations to sustain growth and maturation through successful foraging of adults and juveniles. Like critical habitat for Sacramento River winter-run Chinook salmon, critical habitat for CV spring-run Chinook salmon within the action area has been highly degraded by human activities such as dredging and industrial activities such as discharging wastewater effluents to the waters of the Delta and estuary. Although critical habitat has been degraded in its functionality, it still provides essential utility to CV spring-run Chinook salmon.

Designated critical habitat for CCV steelhead encompasses all of the waters of the legal Delta with only a few exceptions, Suisuin Bay, San Pablo Bay and the northern portion of San Francisco Bay. Thus the entire action area is within the designated critical habitat for CCV steelhead. The PBFs for CCV steelhead critical habitat within the action area include freshwater rearing habitat and freshwater migration corridors as well as estuarine habitat. The features of the PBFs included in these different sites essential to the conservation of the CCV steelhead DPS include the following: sufficient water quantity and floodplain connectivity to form and maintain physical habitat conditions necessary for salmonid development and mobility, sufficient water quality, food and nutrients sources, natural cover and shelter, migration routes free from obstructions, no excessive predation, holding areas for juveniles and adults, and shallow water areas and wetlands. Habitat within reaches 1 and 2 is primarily utilized for freshwater rearing and migration by CCV steelhead smolts and for adult freshwater migration. In addition, estuarine areas (Reach 3) provide habitat for juvenile and adult life stages to undergo physiological transformations (osmoregulatory transitions) and sufficient forage base to sustain growth and maturation. No spawning of CCV steelhead occurs within the action area. Designated critical habitat for CCV steelhead in the action area is also highly altered and is degraded in its functionality. However, like the designated critical habitat for Sacramento River winter-run Chinook salmon and CV spring-run Chinook salmon, it is still considered important and essential to the species.

In regards to the designated critical habitat for sDPS green sturgeon, the action area includes PBFs for both freshwater riverine systems and estuarine areas which provide: adequate food resources for all life stages utilizing the Delta and bays; water flows sufficient to allow adults, sub-adults, and juveniles to orient to flows for migration and normal behavioral responses; water quality sufficient to allow normal physiological and behavioral responses; unobstructed migratory corridors for all life stages utilizing the Delta and estuary; a broad spectrum of water depths to satisfy the needs of the different life stages present in the Delta and estuary; and sediment with sufficiently low contaminant burdens to allow for normal physiological and behavioral responses to the environment. Reach 1 of the action area contains the freshwater riverine portions of critical habitat for sDPS green sturgeon. Reach 2 contains both freshwater riverine habitat and estuarine area habitat. Reach 3 of the action area contains only the estuarine areas of critical habitat. Currently, the diminished status of the designated critical habitat reflects the substantial alterations of the system by human activities and its reduced ability to provide ecological functionality to the species. Preservation of the functionality of the PBFs within this region is important to the long term viability of sDPS green sturgeon by providing suitable habitat for the rearing of juveniles, and the foraging and migratory movements of adults.

2.5 Effects of the Action

Under the ESA, "effects of the action" are all consequences to listed species or critical habitat that are caused by the Project, including the consequences of other activities that are caused by the Project. A consequence is caused by the Project if it would not occur but for the Project and it is reasonably certain to occur. Effects of the action may occur later in time and may include consequences occurring outside the immediate area involved in the action (see 50 CFR 402.17). In our analysis, which describes the effects of the Project, we considered 50 CFR 402.17(a) and (b).

To evaluate the effects of the Project's dock repairs and modifications at Berth 2, NMFS analyzed construction-related impacts as well as the long-term impacts of increased commercial shipping to the facility. We also reviewed and considered Lehigh Hanson's avoidance and minimization measures to be taken during the construction activities.

Our assessment considers the nature, duration, and extent of the action relative to the rearing, and migration timing, behavior, and habitat requirements of all life stages of federally listed fish in the action area. Effects of the dock repair on aquatic resources included both short- and long-term impacts. Short-term impacts include the impacts of construction during the repairs and modifications. Long-term impacts include the increased volume of commercial ocean going shipping expected to call on the enhanced Lehigh Hanson facility, which will continue into the foreseeable future.

Adverse effects can include any impact that reduces the quality or quantity of critical habitat, and may include direct or indirect physical, chemical, or biological alteration of the waters or substrate and loss of (or injury to) benthic organisms, prey species and their habitat, and other ecosystem components that in turn result in negative effects to the listed species. In addition, adverse effects can include any direct or indirect impact to an individual fish that results in take. "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).

The approach used for this analysis was to identify which ESA-listed species would likely be present in the action area from July 1 through November 30 during the in-water construction activities and be exposed to the stressors associated with the Project's construction activities (Table 11). Furthermore, NMFS conducted a review of nearby CDFW and USFWS monitoring locations, run timing, and fish salvage data to determine the likelihood of ESA-listed fish presence during shipping activities (Tables 7-10). Adult salmonids typically migrate through the Delta within a few days. Juvenile Chinook salmon spend from 3 days to 3 months rearing and migrating through the Delta to the mouth of San Francisco Bay (Brandes and McLain 2001, MacFarlane and Norton 2002). Juvenile sDPS green sturgeon may spend from 1-3 years rearing and maturing in the action area. Sub-adults may spend from several days to several months holding, feeding, or migrating through the action area.

Table 11. Presence of ESA-listed species in the action area during in-water construction (July 1 through November 30) and exposed to the stressors associated with the Project's construction activities.

Month										
	July		August		September		October		November	
Life Stage										
Species	Adult	Juvenile	Adult	Juvenile	Adult	Juvenile	Adult	Juvenile	Adult	Juvenile
SR Winter-run	No	No	No	No	No	No	No	No	No	No
CV Spring-run	No	No	No	No	No	No	No	No	No	No
CCV Steelhead	No	No	No	No	Yes (Low[a])	Yes (Very Low[b])	Yes (Medium[a])	Yes (Very Low[b])	Yes (High[a])	Yes (Very low[b])
sDPS Green Sturgeon	Year-round		Year-round		Year-round		Year-round		Year-round	

[a] Based on the data from the Stanislaus Fish Weir, adult CCV steelhead begin to migrate through the lower San Joaquin River region starting in September, and increasing to higher levels in October and November.

[b] Based on the DJFMP Sacramento trawl and Chipps Island trawl data, very low levels of juvenile steelhead have been observed in July, September, October, and November in the Delta region. Fall pulse flows on the San Joaquin River tributaries and fall storms in the San Joaquin River basin may stimulate out migration of steelhead smolts from the San Joaquin River Basin due to elevated flows similar to the emigration behavior observed in Sacramento River basin fish.

2.5.1 Construction-Related Effects

NMFS expects that adult CCV steelhead as well as low numbers of juvenile and adult green sturgeon are likely to be present in the vicinity of the Lehigh Hanson Berth 2 facilities (Reach 1 of the action area) during the in-water construction work window. There is a very low probability that juvenile CCV steelhead may be present during the in-water work window. Adult or juvenile CV spring-run or Sacramento River winter-run Chinook salmon are not expected to be present at the berth facilities during the in-water construction window for the Project. No spawning habitat for Sacramento River winter-run Chinook salmon, CV spring-run Chinook salmon, CCV steelhead, or green sturgeon is present in the action area, therefore no adverse effects to spawning adults, incubating eggs, alevins, fry or parr are expected.

2.5.1.1 Acoustic Stress – Pile Driving

Construction activities are described in the BA (Anchor QEA 2019) for the pile driving within the aquatic environment. The Project requires a maximum of one hundred forty four, 18-inch diameter octagonal concrete pilings to support the dock infrastructure; twenty, 14-inch square concrete piles to support the replacement fender system; and thirty, 18-inch octagonal concrete piles to support the replacement railroad trestle. The applicant proposes using an impact hammer to achieve the final required tip depth and load-bearing strength for each piling. The BA states that the estimated time to drive all of the piles will be 35 days, with a maximum of 6 piles driven per day. The applicant estimated that it will take 600 strikes per pile to drive the pilings to the appropriate depth. Pile driving will be limited to the hours between 7 a.m. and 7 p.m. for a maximum daily duration of 12 hours of construction activity. Pile driving activities are scheduled to occur over two different phases of the proposed construction schedule, Phases 2 and 4 (Table 4), which may occur in different years.

Installing piles with an impact hammer is expected to result in adverse effects to salmonids and sturgeon due to high levels of underwater sound. Exposure to noise from an impact hammer is an impulsive sound source with a high intensity and rapid rise time and is known to injure or kill fish.

Impact pile driving creates a wave of energy that propagates from the pile location. Concrete piles are driven into the substrate until the hammer encounters a predetermined level of resistance. As the pile is driven into the substrate and meets resistance, a wave of energy travels down the pile, causing it to resonate radially and longitudinally. Most of the acoustic energy results from the outward expansion and inward contraction of the surfaces of the concrete pile as the compression wave moves down the pile from the hammer to the end of the pile buried in the substrate. Because water is virtually incompressible, the outward movement of the pile followed by the pile surfaces pulling back inward to their original shape sends an underwater pressure wave that propagates outward from the pile in all directions. The pile resonates, sending a succession of pressure waves as it is pushed several inches deeper into the substrate (Burgess and Blackwell 2003).

The physical injury or damage to body tissues associated with very high sound level exposure and drastic changes in pressure are collectively known as barotraumas. Fish can survive and recover from some barotrauma, but in other cases, death can be instantaneous, occur within minutes after exposure, or occur several days later. The degree to which an individual fish is affected by underwater sound exposure depends on a number of variables, including differences in sensitivity to acoustic pressure, fish species, presence of a swim bladder, hearing sensitivity, the proximity and linkage of the swim bladder to the inner ear, and fish size (Popper et al. 2003, Ramcharitar et al. 2006, Braun and Grande 2008, Deng et al. 2011). Because the air within a fish's swim bladder is less dense than water or the fish body, the air and swim bladder can be easily compressed by sound pressure waves traveling through the fish's body. As sound pressure waves pass through the fish's body, the swim bladder routinely expands and contracts with the fluctuating sound pressures, resulting in injury through the routine expansion and contraction of the bladder. The characteristics of the sound source also play an important role in its effect to fish. For high sound pressure level exposure, such as impact hammer pile driving, the swim bladder may rapidly and repeatedly expand and contract and pound against the internal organs. This pneumatic pounding may result in hemorrhage and rupture of blood vessels and internal organs, including the swim bladder, liver, and kidneys. External damage, such as loss of scales or hematoma in the eyes or at the base of fins, has also been documented (Yelverton et al. 1975, Wiley et al. 1981, Linton et al. 1985, Gisiner 1998, Godard et al. 2008, Carlson et al. 2011, Halvorsen et al. 2012a, Halvorsen et al. 2012b, Casper et al. 2012).

The severity of injury sustained by a fish may also be dependent upon the amount of air in the swim bladder during sound exposure, which characterizes the state of buoyancy (Govoni et al. 2003, Halvorsen 2012a, Stephenson et al. 2010, Carlson 2012), and the physiological state of fish at the time of exposure. For example, a deflated swim bladder (i.e., negatively buoyant) could put the fish at a lower risk of injury from the sound pressure exposure compared to a fish with an inflated swim bladder (i.e., positively buoyant). However, given the rapid rise time of impact hammer pile driving, the inability of fish to quickly regulate buoyancy, and the inability to know the buoyancy state of the fish during exposure to these sound sources, NMFS assumes the worst-case scenario: that swim bladders are positively buoyant, and, therefore, exposed fishes could be subjected to the highest degree of trauma.

Besides injuries to the soft tissues surrounding the swim bladder, additional acoustic-related injuries can occur within the auditory structures of fish exposed to high intensity sounds. Injury from exposure to high levels of continuous sound manifests as a loss of hair cells of the inner ear (Popper and Hastings 2009), which may result in a temporary decrease in hearing sensitivity or temporary threshold shift.

Temporary threshold shift is considered a temporary reduction in hearing sensitivity due to exposure durations lasting a few minutes to hours. This type of noise-induced hearing loss in fishes is generally considered recoverable because fish, unlike mammals, are able to regenerate damaged hair cells (Smith et al. 2006). An important consideration when evaluating auditory structure damage due to noise is determining the sound level at which hearing loss has significant implications for behavior and associated fitness consequences such as preventing individuals from detecting biologically relevant signals. Hastings (2002) expected damage of auditory hair cells in salmon to occur with exposure to continuous sound at about 200 decibel (dB) (Root Mean Square - RMS), which equates to a peak sound level of 203-dB peak as the onset of damage to the sensory hearing cells of salmon.

Beyond barotrauma-related tissue damage, additional direct physiological effects to fishes from exposure to sound include increases in stress hormones or changes to other biochemical stress indicators (Sverdrup et al. 1994, Santulli et al. 1999, Wysocki et al. 2006, Nichols et al. 2015). These effects can affect both predation risk by compromising predator evasion and feeding success by affecting prey detection, leading to reduced fitness or survival success.

Besides direct physical injury because of the sound pressure wave, underwater sounds have also been shown to alter the behavior of fishes (Hastings and Popper 2005, Hawkins et al. 2012, Popper et al. 2014). There is significant variation among species. The potential for adverse behavioral effects depends on a number of factors, including the sensitivity to sound, the type and duration of the sound, and the life stages of fish present. Observed behavioral responses to anthropogenic sounds may include startle responses, changes in swimming directions and speeds, increased group cohesion, and bottom diving (Engås et al. 1995, Wardle et al. 2001, Mitson and Knudsen 2003, Boeger et al. 2006, Sand et al. 2008, Neo et al. 2014), and "alarm" as detected by Fewtrell et al. (2003) and Fewtrell and MacCauley (2012).

The startle response in fishes is a quick burst of swimming that may be involved in avoidance of predators (Popper 1997). Other potential changes in behavior in response to underwater sounds include reduced predator awareness and reduced feeding (Voellmy et al. 2014a,b, Simpson et al. 2015) and changes in distribution in the water column or schooling behavior (e.g., Skalski et al. 1992, Feist et al. 1992, Engås et al. 1996, Engås and Løkkeborg 2002, Slotte et al. 2004). A fish that exhibits a startle or other behavioral response may not necessarily be injured, but is exhibiting behavior that suggests it perceives a stimulus that indicates potential danger in the immediate environment. Therefore, these types of responses likely do not have a fitness consequence for the individual unless the reaction increases susceptibility to predation or some other negative effect.

The tolerance of sound pressure levels causing either direct injury or behavioral responses varies among species and life stage. Adult salmonids, because of their large size, can usually tolerate higher pressure levels (40 to 50 pounds per square inch [psi]) (Hubbs and Rechnitzer 1952), so immediate mortality rates for adults are expected to be less than those for juvenile salmonids. However, some uncertainty regarding the relative sensitivity of larger fishes remains (Halvorsen et al. 2012b). Given that adult green sturgeon are on average significantly larger than salmon, they could, presumably, tolerate higher levels of sound pressure and be less affected by pile-driving activities. Similarly, juvenile green sturgeon are typically between 200 to 600 mm long (~8 to 24 inches) by the time they inhabit the Delta (Radtke 1966). Because of the similarity in size to adult salmonids, juvenile green sturgeon are expected to be more tolerant than juvenile salmonids of temporary sound disturbances associated with pile driving. Green sturgeon are vulnerable to injury or death from pile driving, especially if within close proximity to the sound source, due to the presence of a swim bladder.

Criteria have been established to support assessing acoustics effects to west coast fish species. The Fisheries Hydroacoustic Working Group (FHWG), which consists of representatives from NMFS, USFWS, the Federal Highway Administration, and the West Coast Departments of Transportation, established interim thresholds to assess physical injury to fish exposed to underwater sound produced during pile driving (FHWG 2008). Thresholds include a single strike peak sound pressure level of 206-dB (re: 1 micro pascal [µPa]) and an accumulated sound exposure level (SEL) of 187-dB (re: 1 μPa^2-sec) for fish greater than 2 grams and 183-dB (re: 1 μPa^2-sec) for fish less than 2 grams. Physical injury is assumed to occur if either the peak or SEL threshold is exceeded. The SEL limit referred to as "effective quiet," however, can be used to identify the distance beyond which no physical injury is expected from a single strike, regardless of the number of strikes. The effective quiet currently assumed for fish is 150-dB (re: 1 μPa^2-sec). When the SEL from a single individual pile strike is below this level, the accumulated energy from multiple strikes is not expected to contribute to injury, regardless of how many pile strikes occur. The effective quiet level is used to identify the maximum distance from the pile where injury to fishes is expected to occur. It is the distance at which the sound from a single strike to a piling attenuates to 150-dB using the SEL measurement metric. At this distance, the cumulative sound exposure, as referenced by the number of strikes to the pile, is calculated to reach the 187-dB cSEL threshold.

In areas where we have limited information, we have developed assumptions about fish behavior and the recovery time of affected tissue to determine fish response (i.e., avoidance, injury, and death) based on the limited available information. Although fish exhibit a startle response during the first few acoustic exposures, they do not move away from areas of very loud underwater sounds and can be expected to remain in the area unless they are carried away by currents or normal movement patterns. Therefore, NMFS assumes that fish will remain in the vicinity of a construction site unless currents or behavior patterns unrelated to loud underwater sound avoidance would indicate that movement is likely to occur.

Although there may be some tissue recovery between the completion of one pile and the beginning of driving at the next, NMFS will sum the underwater sound energy produced during the installation of all piles on any given day to determine potential physical effects to listed salmonids and sturgeon each day pile driving occurs. NMFS assumes that normal behavior patterns will move any actively migrating salmonids and green sturgeon out of the affected area within 1 day, and therefore, underwater sound energy will not be summed over consecutive days. For the purposes of the pile driving model development, NMFS assumed that fish would move out of the area in 1 day, except if it was a spawning area or natal rearing area.

2.5.1.1.1 Pile Driving Assessment

The BA included an assessment of the maximum impacts of the pile driving actions by characterizing all of the piles as 18-inch piles. NMFS conducted noise modeling with the NMFS Underwater Noise Calculation Spreadsheet model (NMFS 2009a) and the information provided in the BA regarding the pile size and composition, number of strikes per pile, and water depth at the Project location. In addition, the Compendium of Pile Driving Sound Data [California Department of Transportation (Caltrans) 2015] provides sound level data on a variety of pile sizes and driver types and this information will be incorporated into the analyses of sound exposure. NMFS used the following sound level data from the Caltrans Compendium for 18-inch concrete piles driven in less than 3 meters (9.8 feet) of water as the starting reference values for pile driving sound characteristics. Sound is propagated more efficiently in deeper water and NMFS adjusted the sound metrics by adding 3 dB to the compendium values to adjust for the deeper water depth at the Berth 2 location [~10 meters (33 feet), Table 12)].

Table 12. Source sound level characteristics for 18-inch concrete piles driven with an impact hammer – unattenuated, measured at 10 meters from piling.

Pile material/size	Relative water Depth	Peak Sound (dB)	RMS (dB)	SEL (dB)
18-inch octagonal concrete	<3 meters (< 9.8 feet)	185	166	155
*Adjusted for 10 m water depth (+3 dB)	10 meters (33 feet)	188*	169*	158*

For the proposed pile driving action, the calculated distances to the different acoustic parameters for physical or behavioral effects to fish were calculated for each day of pile driving.

Original source sound metrics for 18-inch piles driven in less than 3 meters of water (unattenuated):

- The $SEL_{accumulated}$ is 190.6 dB at 10 meters (33 feet) and the calculated distance to each of the applicable thresholds is as follows:
- Distance to 206 dB-peak = <1 meter (less than 3.3 feet)

- Distance to 150 dB-RMS = 117 meters (384 feet)
- Distance to 187 dB-$SEL_{accumulated}$ = 17 meters (56 feet, for fish > 2 g)

Adjusted source sound metrics for 18-inch concrete piles driven in 10 meters of water (unattenuated):

- The $SEL_{accumulated}$ is 193.6 dB at 10 meters (33 feet) and the calculated distance to each of the applicable thresholds is as follows:
- Distance to 206 dB-peak = 1 meter (3.3 feet)
- Distance to 150 dB-RMS = 185 meters (607 feet)
- Distance to 187 dB-$SEL_{accumulated}$ = 27 meters (89 feet, for fish > 2 g)

Based on these calculations, there is potential for behavioral modifications to fish that remain within a 185 meter (607 feet) radius of the pile being driven during installation of the dock and trestle pilings (6 per day). There is the potential to exceed the threshold for physical injury (187 dB $SEL_{accumulated}$) if fish larger than 2 grams remain within a 27 meter (89 feet) radius of the pile driving actions. Single strike injury would extend only a meter from each pile during installation for any size fish. The modeled zone of effects for larger fish (> 2 g) would cover approximately 10 percent of the channel width of the Stockton DWSC at the western most portion of the dock facility where the DWSC transitions into the ship turning basin. The zone of potential injury would also extend approximately 90 feet outboard of the dock's waterside edge in the turning basin. Any fish swimming through this reach during the impact hammer use would likely suffer some degree of injury and potentially mortality. Behavioral effects would cover the entire width of the Stockton DWSC as it transitions into the ship turning basin and would cover approximately 25 percent of the turning basin adjacent to Berth 2 of the Lehigh Hanson facility.

Fish moving upstream through the Stockton DWSC towards the location where the mainstem of the San Joaquin River enters the Stockton DWSC may be exposed to the pile driving actions. Tidal excursion in this location is approximately 1.25 miles based on a study of tidal hydraulics in the DWSC (Jones and Stokes 2002). The location of Berth 2 is approximately 0.8 miles from the point at which the mainstem San Joaquin River enters the Stockton DWSC, and fish are expected to follow the tidal excursion both upstream and downstream of this junction before committing to their continued upstream migration into the river channel. Based on the timing of the in-water construction actions, only adult steelhead and adult and juvenile green sturgeon are likely to be present in the action area adjacent to the pile driving and, therefore, may be exposed to pile driving related noise. There is a very low probability that juvenile CCV steelhead may be present in the action area during the construction window and, thus, be exposed to construction related noise (Table 11). Presence of juvenile steelhead would likely only occur if significant increases in river flows occur either through dam releases or strong fall storms.

2.5.1.2 Contaminants – Piling removal

During the demolition of the existing 180-foot long wooden rail trestle structure in Phase 4 (2022-2024), the Project proposes to remove a total of 71 creosote treated wooden piles. Fifty-six of these piles are located in-water within the turning basin, and the remaining 15 are on the slope of the surrounding turning basin bank. Of the piles on the slope of the bank, 10 are below the MHHW line and the remaining 5 are above the MHHW line. The Project proposes to cut off the

56 pilings located within the underwater portion of the channel at the mudline, leaving the remaining "stub" in the channel bottom, rather than removing the entire piling. The 15 piles on the bank will be removed in their entirety.

Creosote is a wood preservative that has been used for more than 100 years to repel marine borers and preserve wooden structures placed in aquatic environments. It is derived from crude coal tar distillates. Creosote is comprised of hundreds to thousands of different chemical compounds, with polycyclic aromatic hydrocarbons (PAHs) accounting for 90 percent of the mixture. Many of the PAHs identified in creosote are considered priority pollutants by the EPA. The behavior of a chemical in an aquatic environment is dependent on the physical and chemical properties of that compound. Creosote and its constituents are soluble in aquatic environments to varying degrees, with higher solubilities in freshwater conditions. Low molecular weight PAHs (LPAHs) and other low molecular weight constituents of creosote are more water soluble than the higher molecular weight constituents, have higher rates of volatilization and degradation, are lost from aquatic systems more quickly, and have the potential to be acutely toxic to aquatic organisms. High molecular weight PAHs (HPAHs) have lower solubilities and tend to partition into the sediments of aquatic systems. HPAHs that are adsorbed to sediment or other particulate material have the potential to persist in the environment for decades. PAH bioavailability is controlled by the chemical and physical properties of the compound, in addition to the source of the PAH (e.g., petroleum derived PAHs are more bioavailable than combustion derived PAHs; Werme et al. 2010).

Some PAHs, particularly the HPAHs that tend to accumulate in sediments, are teratogenic and carcinogenic. Therefore, there is concern for biota effects due to aquatic exposure to PAHs. Organism effects can be either lethal or sublethal. Sublethal effects include impacts to growth and reproduction in fish (Johnson et al. 2002) and have also been linked to immunotoxicity (Karrow et al. 1999), abnormal cardiac function and morphology (Incardona et al. 2004) and hepatic lesions (Malins et al. 1985, Myers et al. 2003) in several species of estuarine fish.

Since the extraction of the railroad trestle wooden pilings will take place adjacent to the location of the Lehigh Hanson Berth 2 site during the in-water work window of July 1 through November 30, only adult steelhead and juvenile and adult green sturgeon are expected to be present in the adjacent waters. These fish will have the potential to be exposed to any sediment disturbances created by the cutting off of pilings below the water surface that create a sediment plume in the surrounding waters. Piles extracted from the bank are expected to have minimal likelihood of creating a sediment plume within the adjacent water body.

However, while the sediment plumes are short lived, the presence of the 56 cutoff piling stubs, which are still exposed at the mudline surface with the overlying water column, will continue to expose aquatic organisms to the leaching of PAHs from the freshly exposed core of the pile into the surrounding water column. By leaving the "stub" exposed at the mudline, fresh, unweathered contaminates from the core of the creosote treated wood pilings can continue to leach into the overlying water column and the surrounding sediment (Younie 2015, Werme et al. 2010). This presents a new source of the PAH compounds which has not undergone weathering in the environment, and thus is considered more toxic. Furthermore, movement of the sediment layer due to propeller wash, currents, or wave action in the turning basin can expose additional portions of the remaining pile stub, exposing even more of the remaining pile to leaching, particularly if the piles are in less than 10 feet of water (EPA 2016). This is expected to also cause deposition onto the surrounding sediment surfaces. This may cause both lethal and sublethal effects to fish and invertebrates through direct exposure pathways and foodweb bioaccumulation. Over the long-term, migrating and rearing adult and juvenile CCV steelhead, CV spring-run Chinook salmon, and sDPS green sturgeon have the potential to be present in the waters surrounding the cutoff pile stubs. Exposure to the contaminated sediments either on the bottom or as suspended materials can cause adverse physiological effects, the severity increasing with prolonged exposure times. Consumption of tainted prey organisms can lead to additional adverse effects, which is dependent on the level of contamination in the prey organisms consumed. No individuals of Sacramento River winter-run Chinook salmon are ever expected to be present in the Stockton DWSC turning basin at any time due to the spatial distance from their expected migratory routes in the Delta.

2.5.2 Long-term Effects – Shipping

2.5.2.1 Shipping Related Noise

Based on information provided in the BA and supplemental material, at least one commercial ocean going vessel will deliver the unassembled ship unloader to the Lehigh Hanson Berth 2 facility. In addition, the applicant anticipates that with construction and operation of the proposed Project, ship calls to the facility could double within approximately 5 years after construction from 9 ship calls to a total of 18 ship calls annually, and could potentially increase beyond that amount in the future if market conditions are favorable (Anchor QEA 2020). Accordingly, based on the applicant's projections, it is possible that between one and three vessels could ultimately call on Berth 2 each month following completion of the Project, although fewer vessels are expected monthly over the first 5 years than over the next 5 years. Lehigh Hanson also reported that based on past usage, there is not a seasonal component to when the berth would be used for operations (Anchor QEA 2020). Shipping traffic will transit the entire action area from the Golden Gate Bridge to the Port of Stockton and back again, a total distance of approximately 290 kilometers (180 miles) of travel through the waters of northern San Francisco Bay, San Pablo Bay, Suisun Bay, and the San Joaquin River (*i.e.,* Stockton DWSC). The construction-related effects of shipping noise related to the delivery of the ship unloader parts on listed species will be included in the long-term impacts for the sake of efficiency.

Shipping traffic will create additional sources of anthropogenic noise in the aquatic environment. This will be an acoustic-related stressor that can result in negative impacts to exposed aquatic organisms. Ships under power produce a substantial amount of mechanical- and flow-induced noise from the ship's power plant, propeller, and hull turbulence. Measurements of sound intensity from commercial shipping have shown sound levels up to approximately 180-dB (ref. 1 µPa) at the point source approximately 1 meter (3.3 feet) from ship, Kipple and Gabriele (2007). This level of noise will drop off by 40-dB at 100 yards away and approximately 53-dB lower at one-quarter mile away (Kipple and Gabriele 2007). This would be in the general range of ambient noise for bays and rivers with ship traffic and below the threshold considered as affecting fish behavior (150 dB). The narrow confines of channels in the Delta region would indicate that the elevated noise levels generated by the passage of commercial vessels such as bulk carriers and cargo ships would extend essentially from bank to bank in the San Joaquin River, thus subjecting all fish within the confines of the channel to anthropogenic-produced noise conditions. The relatively rapid passage of the commercial vessel past a given point will somewhat attenuate these effects by decreasing the duration of the elevated sound levels, but some temporary effects can be anticipated to occur, depending on the proximity of the exposed fish to the sound source. Within Suisun Bay, San Pablo Bay, and the northern portion of San Francisco Bay, the shipping-produced sounds will fall away to near background levels given the expanse of open water in the bays, thus having minimal effects on aquatic organisms located more than a quarter mile away from the shipping channel alignment.

The presence of underwater anthropogenic noise, such as that originating with shipping, may negatively affect a fish's ability to detect predators, locate prey, or sense their surrounding acoustic environment (Slabbekoorn et al. 2010, Radford et al. 2014). Other species of fish have been shown to respond to recorded ambient shipping noise by either reacting more slowly to predators, thus increasing their susceptibility to predation (Simpson et al. 2015, Simpson et al. 2016), or becoming hyper-alert and reacting more quickly to a visual predator stimulus, causing them to cease feeding and hide (Voellmy et al. 2014b). Voellmy et al. (2014a) stated that elevated sound levels could affect foraging behavior in three main ways:

- Noise could act as a stressor, decreasing feeding behavior directly through reduced appetite or indirectly through a reduction in activity and locomotion and alterations to the cognitive processes involved in food detection, classification, and decision making;
- Noise could act as a distracting stimulus, diverting an individual's limited amount of attention from their primary task to the noise stimuli that have been added to the environment; and
- Noise could mask crucial acoustic cues such as those made by both prey and predators.

Fish also may exhibit noise-induced avoidance behavior that causes them to move into less suitable habitat for foraging or to feed when the noise has abated. Voellmy et al. (2014a) surmised that sustained decreases in food consumption could have long-term energetic impacts that result in reductions in growth, survival, and breeding success. Moreover, compensatory feeding activities could increase predation risks by increasing time exposed to predators or by forcing animals to feed in less favorable conditions, such as in times or areas of higher predation pressure.

The increased noise produced by commercial vessel traffic may result in salmonids and green sturgeon fleeing the area of those noises and moving into the channel's shallowest margins or adjacent habitat. The channel margins of many Delta waterways have submerged and emergent vegetation (e.g., *Egeria densa*) and rock rip-rapped levees where predatory species are likely to occur in greater numbers than in the open waters of the channel. This scenario, therefore, could increase the predation risk of salmonids, particularly salmonid smolts. Likewise, elevated noise exposure can reduce the ability of fish to detect piscine predators either by reducing the sensitivity of the auditory response in the exposed fish or masking the noise of an approaching predator. Such would be the case if open water predators such as striped bass encounter the juvenile fish in the open channel while commercial shipping is present.

Within the context of the long-term aspects of the Project, the exposure to anthropogenically-produced shipping noise will occur over a very broad area (San Francisco estuary and the Sacramento-San Joaquin Delta) and into the foreseeable future. Shipping traffic will traverse nearly a hundred miles of waterways from the Golden Gate Bridge to the Port of Stockton. Exposure to anthropogenically-produced sounds will occur during each passage of a ship and will potentially be as much as 54 additional trips annually based on the 10-year projection provided by the applicant compared to the current level of 18 trips annually. This is in addition to the current volume of shipping that calls on the Port of Stockton's other facilities [currently 252 ship visits annually (2018 data)].

Since shipping traffic is expected to occur year-round without any specific seasonality, noise associated with shipping traffic will likely affect both adult and juvenile life stages of Sacramento River winter-run Chinook salmon, CV spring-run Chinook salmon, CCV steelhead, and sDPS green sturgeon. Both juveniles and adults of these species must pass through the Sacramento-San Joaquin Delta waterways and the San Francisco estuary while migrating to and from the ocean. In reaches 2 and 3 of the action area, all populations of listed Chinook salmon and steelhead are present during their adult or juvenile migratory phase and will be exposed to shipping traffic noise. In Reach 1 of the action area, CCV steelhead and the experimental population of CV spring-run Chinook salmon from the San Joaquin River basin will be exposed. Since adult and juvenile green sturgeon are present in all Delta waterways, as well as the San Francisco estuary, fish present in all of the reaches of the action area will be exposed to shipping noise.

Effects related to the increased frequency and level of shipping noise associated with the Project are primarily expected to alter behavior in juvenile salmonids more so than adults because juveniles are more likely to be actively feeding and using the Delta and estuarine areas for rearing. Increased levels of shipping noise will influence their responses to foraging because elevated shipping noise can disrupt the effectiveness of foraging behavior by reducing the time spent actively feeding or increasing the effort required to successfully attack and consume prey items. The noise can affect predator avoidance by masking sounds of predator approach. Effects are expected to be more frequently experienced in the waters of the Delta, due to the more constricted widths of the channels. In waters of Suisun Bay, San Pablo Bay, and the northern portion of San Francisco Bay, effects will be reduced substantially due to the greater expanses of open water in those water bodies where sound will attenuate with distance from the ship, eventually diminishing to background levels within approximately a quarter mile of the shipping channel.

2.5.2.2 Altered Hydrodynamics Related to Shipping

The passage of a ship hull through the water creates a series of complex pressure fields surrounding the hull. Factors such as hull shape, vessel speed, channel geometry, and hull displacement all contribute to the behavior of water as it flows around the hull. When a vessel moves forward through the water, it displaces water and pushes the water forward leading to increased pressure and the generation of the front wave. These pressure changes are termed the primary wave system. Inertia causes the water surface to lag behind its equilibrium position and produces a surface oscillation when responding to the sharp pressure gradients at the bow (and possibly at the stern), which induces a rapid rise and fall in the water surface. This in turn produces the pattern of free waves that propagate out from the vessel and follow it (Gabel et al 2017, Sorensen 1997). This wave pattern is commonly termed the secondary wave system.

The primary wave system with its increased difference in static pressure between the bow and the stern accelerates the water passing underneath and around the ship. Static pressure rises in the vicinity of the bow, falls at the midsection of the vessel, and rises again near the stern (Sorensen 1997). The water surface profile along the hull responds to this pressure distribution by causing the water surface to rise at the bow and stern and to fall and accelerate water along the midsection (Sorensen 1997). In spatially confined waterways, the resulting swell and down-surge cause return currents and drawdown at the banks. Behind the ship, the pressure equalizes with the undisturbed water level and thus creates the stern wave. Primary waves appear most pronouncedly in the vicinity of ships and particularly affect the shorelines of waterways that are restricted in water depth and width (Sorensen 1997, Figure 14).

The secondary wave system is the wake produced by a ship's passage which produces both a diverging surface wave that originates at the bow of the ship and spreads at an angle to the sailing line, and a transverse wake that is propagated in the sailing direction but is perpendicular to the sailing line (Sorenson 1997). These wakes encounter the shallow edges of the channel and disturb bottom sediment, forcing it into the water column as resuspended sediment (Parchure et al. 2001, Mazumder et al. 1993). Large and small vessels operated in confined channels with minimal under keel clearance are subjected to additional forces such as the jet of the propeller interacting with the bottom (Mazumder et al. 1993, Beachler and Hill 2003).

2.5.2.2.1 Changes in Community Structure related to Shipping

In heavily developed waterways, the diversity and productivity of fish assemblages typically become reduced, mainly due to migration barriers, pollution, habitat loss and simplification of the existing environment. However, commercial navigation (shipping) may also directly or indirectly reduce these assemblages, amplifying the effects of habitat destruction. Several studies have indicated that ship-induced changes in nearshore hydrodynamics alter the community composition of fish species, the local density of fish species composition, and disrupts the ability of species to utilize the nearshore waters for necessary stages of their development. Wolter and Arlinghaus (2003) compared the hydraulic forces created by moving barge tows to the swimming capabilities of freshwater fish at different life stages. They found that the swimming performance of fish, in particular the capacity for absolute swimming speed, was the best predictor of the thresholds and limitations of habitat use by fish. The authors developed a navigation-induced habitat bottleneck hypothesis (NBH) as the best determinant for the habitat available for fish to use. The NBH was inferred from the maximum threshold swimming velocities that fish could achieve, compared to the flow velocities present in the drawdown and subsequent bank directed shipping-induced flows. According to the NBH, swimming performance of juvenile freshwater fish is the major bottleneck for fish recruitment in waterways, as a result of their inability to withstand bank-directed shipping-induced physical forces (i.e., flows). Under common shipping navigation conditions considered in their study, with respect to inland waterway morphology, channel cross section, vessel speeds, and dimensions of commercial vessels, the shipping-induced return currents along the shore are usually around 0.8 m/sec (0.7–1.0 m/ sec ; 2.3 to 3.3 feet/ sec) accompanied by a 0.1–0.3 m (0.3

to 1 foot) drawdown. Under such conditions, the proposed threshold for small fish survival was estimated to be 147 mm total length at critical swimming performance (>20 s – 60 min without fatigue) and 47 mm at burst performance (<20 s). The capacity and performance of individual fish to withstand and survive the physical forces, wave actions, and currents during a vessel passage can determine the amount of fish assemblage degradation possible due to ship navigation (Wolter and Arlinghaus 2003). If a fish cannot counteract these flow velocities they are at risk of being washed out of the nearshore habitat during drawdown or being stranded on the bank as the slope supply current runs up the bank.

Several subsequent studies have supported the NBH and the impacts to local fish assemblages in response to frequent shipping-induced flow changes. Gutreuter et al. (2006) demonstrated that the chronic effects of disturbances by commercial vessels (towboats and barge strings) in the upper Mississippi River affected the fish community distribution between the active navigation channel and adjacent secondary channels, which possessed very similar physical and biological parameters. Species density of several common fish species decreased in the navigation channels with increasing frequency of disturbances by commercial shipping. Gutreuter et al. (2006) concluded that the high frequency of disturbance (>6-8 tows day^{-1}) from river towboats created demonstrable differences in the spatial distribution and local magnitudes of fish species density and shifted the abundance of certain fish species from the navigation channel to the secondary channels. Studies of fish distribution in the River Danube in Austria also supported the NBH (Kucera-Hirzinger et al. 2009), showing that ship induced wave wash caused larval and young-of-the-year (YOY) juvenile fish to be displaced from their preferred littoral habitat due to the water velocities from the ship's wake exceeding the maximum swimming capabilities of the 0+ age fish. In addition, suspended solids in the water column increased due to the ship's wake, and limited the foraging efficiency of the YOY fish. Similar to Kucera-Hirzinger et al.'s (2009) findings for turbidity, Kano et al. (2013) found that ship wake induced turbidity was a significant cause of degraded fish species diversity and abundance in the East Tiaoxi River in China. Diversity of species and fish density decreased with increasing turbidity, which was positively correlated with increases in ship traffic in the river reaches studied.

Gabel et al. (2017) reviewed the effects of ship-induced waves on aquatic systems from over 200 studies and papers, and found that shipping profoundly affects aquatic ecosystems. Ship-induced waves act at multiple organizational levels and different spatial and temporal scales. All the abiotic and biotic components of aquatic ecosystems are affected, from the sediment and nutrient budgets to the planktonic, benthic, and fish communities. The review highlights how the effects of ship-induced waves cascade through ecosystems and how different effects interact and feed back into the ecosystem finally leading to altered ecosystem function.

As presented in the findings of Wolter and Arlinghaus (2003), smaller fish are more susceptible and vulnerable to the effects of the ship-induced waves due to their lower absolute swimming speed. Therefore, fry, parr, or smaller juvenile salmonids, emigrating from the Sacramento River or San Joaquin River basins to rear in the Delta waters, are at risk. This would typically happen under extreme precipitation events when flows flush the smaller fish down river to the Delta, or as habitat upriver becomes saturated, and density dependent emigration occurs to find unexploited rearing habitat downstream. Smaller salmonids tend to occupy nearshore waters and habitats compared to open water in the mid-channel. These fish will hold for several weeks to months rearing and growing bigger in these nearshore habitats within the Delta region. This is particularly true of Sacramento River winter-run Chinook salmon (Phillis et al. 2017), but also occurs for other runs as well (Miller et al. 2010, Sturrock et al. 2015).

Within the action area, the effects of navigation-induced disturbances on fish communities due to altered hydrodynamics will be associated with primarily reaches 1 and 2, where the dimensions of the river channel are the most restricted compared to the dredged shipping channel. In these two reaches, the commercial shipping is confined to the maintained shipping channel, which is dredged to ~35 feet below MLLW. The dredged channels are typically maintained with a width of 200 to 250 feet in Reach 1 and 400 to 600 feet in reach 2, but the dredged shipping channel comes into close proximity of the shoreline in numerous places. Furthermore, extensive shoals and areas of shallow water are immediately adjacent to the dredged shipping channel, having depths frequently less than 10 feet, and as shallow as 3-5 feet at low tide. These conditions are conducive to causing breaking waves as the ship-induced waves transition from the deeper waters of the DWSC to the adjacent shallow water shoals and shorelines. However, in most of the areas of reaches 1 and 2, numerous side channels, sloughs, river channels and oxbows occur in conjunction with the dredged shipping channel alignment. These adjacent habitats will be less impacted by the shipping-induced waves, providing protected habitats that can serve as refuges for YOY and juvenile fish, sheltering them from the effects of the shipping-related disturbances. In Reach 3, which is primarily surrounded by open water in Suisun, San Pablo, and north San Francisco bays, the effects of shipping-induced waves will be substantially reduced, due to the greater expanse of the water bodies outside of the shipping channels. Shipping-induced waves will attenuate with increasing distance away from the alignment of the shipping channel.

Since shipping is expected to continue year-round into the Port of Stockton and the Lehigh Hanson Berth 2 facilities, without any apparent seasonality associated to the frequency of visits, exposure to shipping-induced hydrodynamics will overlap with all juvenile phases of Sacramento River winter-run and CV spring-run Chinook salmon, and CCV steelhead within reaches 2 and 3. Likewise, juvenile sDPS green sturgeon will be present year round in the entire action area. In Reach 1, juvenile steelhead and CV spring-run Chinook salmon originating from the San Joaquin River Basin will overlap with the shipping traffic and will be vulnerable to the effects of shipping-induced waves. No YOY or juvenile Sacramento River winter-run Chinook salmon are expected to be present at any time in Reach 1. As stated previously, only smaller fish (< ~50 mm in length) are highly vulnerable to the effects of shipping-induced waves and flows due to their limited absolute swimming speed. Vulnerability is reduced as fish length increases. Larger juveniles (> 150 mm) and adults are expected to have adequate absolute swimming speeds to avoid the effects of the drawdown and return current effects.

2.5.2.2.2 Turbulence and Turbidity

As described above, the passage of a large hull displaces a large volume of water away from the sailing line of the ship. As the ship passes a given point on the nearby channel bank, the water forced away from the hull's passage (the primary wave) surges back towards the sailing line of the ship to "fill in" the void left by the reduced water elevation adjacent to the hull's passage (i.e., the return current or flow). This creates "drawdown" of the water level along the bank, followed by the sharp jump in the water level created by the following transverse wave front. These effects are accentuated by increased ship speeds, shallow channel depths, shallow-water berms along the channel edge and the proximity to the sailing line of the vessel. This effect is magnified in confined channels such as the "cuts" between islands along the route of the Stockton DWSC. This effect causes resuspension of bottom sediment and creates the turbulent conditions mentioned previously. NMFS will assume that the entire length of the commercial vessel's transit will have these conditions present, although the magnitude will vary with channel configuration, being more enhanced in the narrow river reaches, such as in reaches 1 and 2, and less prevalent in Reach 3, which has greater channel width and the wide spatial expanses of the open waters of the bays. Studies have also indicated that propeller washes that are directed at confining structures like levee banks or dock structures or in tight quarters requiring extensive maneuvering accelerate erosion of the bottom substrate (Hamill et al. 1999). Large vessel traffic can resuspend and expose heavier grain sediments to fairly deep depths (> 23 meters) within maritime ports and navigation channels while maneuvering (Lepland et al. 2010).

Resuspended sediment can expose legacy contaminants that have previously been buried in the waterway's bottom sediment. Sediment is usually thought of as acting as a sink for anthropogenic contaminants in marine and freshwater environments. Regardless of whether discharges originate from air, rivers, urban or agriculture runoff or effluents from wastewater treatment plants, contaminants such as heavy metals and organic pollutants are typically scavenged by suspended, fine grained, mineral and organic particles in the aqueous environment and will eventually settle out of the water column when quiescent hydrodynamic conditions prevail (Lepland et al. 2010, Roberts 2012). Benthic and infauna species are primarily exposed to these contaminated sediment horizons. When sediment is resuspended, the bound contaminants are remobilized into the water column and become bioavailable to an additional assemblage of aquatic species through chemical processes that change their charge and chemical properties (*i.e.*, oxidation in the aerobic water). While most of the material will likely settle out of suspension in close proximity to the disturbance, some of it may be transported considerable distances from the point of disturbance due to tidal or river currents. The resuspended material can be thought of as a pulsed disturbance resulting in episodic (pulsed) exposures of organisms to the contaminants. In order to fully understand the responses of exposed organism, one must know not only the toxicological effects of the contaminant exposure to different organisms and the aquatic community, but also the frequency, magnitude, and duration of the disturbance event (Roberts 2012).

Within the context of the Project, the disturbance of sediments will occur over a very broad area (San Francisco estuary and the Sacramento-San Joaquin Delta) and over an extended period of time (i.e., the foreseeable future). Commercial shipping traffic will traverse nearly a hundred miles of waterways from the Golden Gate Bridge to the Port of Stockton where the Lehigh Hanson Berth 2 facilities are located. While most of the route will be in open water with fairly deep dredged channels (shipping channels), the draft of the ocean going commercial vessels will draw most of the available water depth in the dredged channel. The expected draft of the average 50,000 deadweight tonnage (dwt) commercial vessel calling on the Lehigh Hanson facilities is approximately 11-12 meters (36 to 39 feet), with a beam of 32 meters (106 feet) and an overall length of 190 meters (624 feet). The passage of vessels, coupled with the effects of the propeller jet during normal operations and docking, is expected to resuspend thousands to hundreds of thousands of tons of sediment material each year. Resuspension of material will occur during each passage of a vessel and has been estimated to be an additional 9 to 18 trips annually over the course of the first 5 years, and up to 54 additional trips annually by 10 years after construction of the new facilities. The total number of vessels calling on the Port of Stockton was 252 ships (2018 data, Anchor QEA 2020), which equates to 504 trips to and from the Port. This is 1.4 trips per day averaged over a year. The frequency of disturbance associated with the Project is a maximum of 54 additional trips annually (an average of one trip every 5 days) which will overlap with trips to the Port of Stockton in general made by other vessels. However, during each trip, sediment that has been resuspended by the passage of one vessel, is likely to be resuspended again during the trip of another vessel traveling to or from the Port of Stockton in the next day and half, on average. Thus, there is essentially a constant influx of newly resuspended materials (and any contaminants associated with that material) in the channels leading from the Port of Pittsburgh to the Port of Stockton on essentially a daily basis. This will expose listed fish to any contaminated sediment present in those waterways through resuspension. Likewise, the benthic community, including any prey species for the Sacramento River winter-run Chinook salmon, CV spring-run Chinook salmon, CCV steelhead, or sDPS green sturgeon will be exposed to a chronic source of potentially contaminated sediment which can lead to enhanced bioaccumulation of the contaminant as it moves up the food chain. The entire food chain may exhibit the effects of exposure to contaminated sediments during resuspension, ranging from sublethal to lethal responses.

In summary, since there is no seasonality to the shipping traffic, there will be a constant resuspension of sediments potentially contaminated with toxic compounds throughout the action area throughout the year. This will expose the entire populations of Sacramento River winter-run Chinook salmon, CV spring-run Chinook salmon, CCV steelhead and sDPS green sturgeon migrating into and out of the Central Valley either directly through exposure to the resuspended sediments or through the prey of these fish that live in the benthic communities exposed to the sediments for the foreseeable future. The potential for the shipping traffic to liberate and mobilize previously buried legacy contaminants is greatest within the confined channels of the Delta in reaches 1 and 2. This resuspension of sediments provides a mechanism to reintroduce these compounds into the current environment and spread them throughout a much larger area due to river and tidal flows. The increased level of resuspended sediments and any related contaminants will act as an additional stressor on the aquatic community and the organisms within that community.

Both adult and juvenile salmonids, as well as adult and juvenile sDPS green sturgeon from the Central Valley will be exposed to this stressor due to the wide spatial and temporal overlap of the increased vessel traffic with their migration timing and routes. Exposed fish are expected to have reduced fitness due to exposure to potentially contaminated prey organisms, physical contact with contaminated sediments in suspension, and any additional stress related to turbidity plumes from the pulsed sediment plumes in the migratory corridors.

2.5.2.2.3 Fish Stranding

In addition to the stressors already described, shipping-induced alterations to the channel hydrodynamics increases the risk of stranding along the shores of the waterways in the Delta. Studies from the Pacific Northwest have observed the stranding of salmonids in the lower Columbia River following the passage of deep draft commercial vessels (Pearson and Skalski 2011, Nagrodski et al. 2012). Fish stranding occurs when the passage of a large, deep draft vessel in a narrow confined channel creates the drawdown and subsequent run-up or surge of the following flows onto the shoreline. The long-period primary waves travel along the shoreline at the speed of the ship, and create the conditions necessary for stranding to occur. Pearson and Skalski (2011) found that over the three sites they observed, Chinook salmon subyearlings [range of mean total length over winter, spring, and summer seasons 50 mm to 70 mm (2 to 2.75 inches)]) made up 82 percent of the fish observed in stranding events, although they only comprised 49.1 percent of the fish captured in reference seines at the beach sites during the stranding events. Pearson and Skalski (2011) developed statistical modeling to assess the factors necessary for the stranding of fish and concluded that as the index of salmon in the beach seines increased, so did the rate of stranding events. Similarly, as kinetic energy increased (estimated by the ship's speed and volume), so did the probability of a stranding event occurring. The kinetic energy translates into the strength of the resulting wave as measured by wave run-up distance and height. Increasing the size and speed of the ships increased the extent of the drawdown and the subsequent wave run-up on the beach. Tidal height also played a significant role in stranding rates. All other factors being held equal, lower tidal heights tended to increase stranding rates.

Adams et al. (1999) found that behavioral responses of fish during channel dewatering events by ships determined the likelihood that they would become stranded. Species favoring littoral, backwater habitats generally moved out during periods of drawdown (either through self-propulsion or passive drift) whereas young fish residing in the main channel exhibited positive rheotaxis, leaving them more susceptible to stranding as they swam into the current as it receded down the beach face. This finding was also supported by the work done by Pearson and Skalski (2011) for juvenile Chinook salmon.

Although the studies by Pearson and Skalski (2011) were conducted on shallow, gently sloping beaches, and found significant relationships between ship size, speed and draft, tidal height, salmon abundance and the likelihood of stranding, they cautioned that their findings should not be extrapolated to all beach types and habitats that may be found. Additional studies and modeling are required to determine whether the stranding probabilities they observed are consistent across habitats. This is important when considering the Delta waterways which are heavily altered and have relatively steep shoreline slopes (levees) armored with large angular rock riprap containing many voids and interstitial spaces. These voids and spaces could easily trap small fish that are washed up onto the levee face. Fish that do escape entrapment and stranding are likely to be injured or otherwise physically compromised. It does seem likely however that the basic findings from their study could be applied as to the role of kinetic energy from ship passage creating the conditions for drawdown and wave run-up, and that periods with higher salmon abundance would see an increase in stranding of salmonids along the shoreline.

The potential for stranding events to occur within the action area are highest in reaches 1 and 2, which have relatively confined channels as previously described. Ship passage within these confined waterways in the Delta would create the conditions necessary for drawdown flows and the subsequent run-up flows that could potentially strand fish. Reach 3 would have lesser likelihood to have stranding events occur even though the shorelines tend to have more gradual slopes to them. This is due to the wide expanses of open water in the bays of Reach 3 as well as deeper waters within the shipping channel that would attenuate the primary waves created by the moving ships. However, in Reach 3, ships are allowed to travel at faster speeds, which generates greater kinetic energy and greater hydrodynamic effects. This may offset some of the benefits provided by the greater distance between the shoreline and the shipping channel as waves will travel farther from the sailing line of the ship. In other areas of Reach 3, particularly where the shipping channel runs close to the shoreline, such as in the Carquinez Strait or western Suisun Bay, shipping induced waves can interact with shoaling water and the shoreline to create conditions suitable for stranding.

As discussed previously, shipping is expected to continue year-round into the Port of Stockton and the Lehigh Hanson facilities, without any apparent seasonality associated to the frequency of visits. Thus, exposure to shipping-induced hydrodynamics and potential stranding risks will overlap with all juvenile phases of Sacramento River winter-run and CV spring-run Chinook salmon, and CCV steelhead within reaches 2 and 3. Brandes and McLain (2001) indicated that the presence of fall-run Chinook salmon smaller than 70 mm (<2.75 inches) in the Delta and San Francisco estuary increased with increasing flows in the Sacramento or San Joaquin rivers. Sacramento River winter-run Chinook salmon fry were observed in the Delta in October, November, and December at small sizes (average total lengths over the 3 months ranged from 56 to 71 mm, 2.2 to 2.75 inches) from fish captured in regional monitoring (del Rosario et al. 2013). Analysis of otoliths in adult Sacramento River winter-run Chinook salmon over a 3-year period (Phillis et al. 2018) showed that approximately 7 to 23 percent of the individuals (mean =15 percent, n = 188 fish) reared in the Delta. Assuming that juvenile Chinook salmon from different runs would use the Delta for non-natal rearing in similar proportions, 15 percent of the expected Chinook salmon juvenile populations would be vulnerable to stranding events based on size and presence in the Delta. Likewise, juvenile sDPS green sturgeon will be present year round in all three reaches of the action area, but these fish are expected to be much larger than the size of fish susceptible to stranding due to ship-induced waves, and are not expected to be present in nearshore locations affected by wave wash. In Reach 1, juvenile CCV steelhead and CV spring-run Chinook salmon originating from the San Joaquin River Basin will overlap with the shipping traffic and will be vulnerable to the effects of shipping-induced waves. No YOY or juvenile Sacramento River winter-run are expected to be present at any time in Reach 1. As stated previously, only smaller fish are highly vulnerable to the effects of shipping-induced waves and flows due to their limited absolute swimming speed. Vulnerability is reduced as fish length increases. Larger juveniles (> 150 mm) and adults are expected to have adequate absolute swimming speeds to avoid the effects of the drawdown and return current effects and the potential for stranding.

2.5.2.3 Ship Strikes and Propeller Entrainment

2.5.2.3.1 Chinook Salmon and Steelhead

The typical size of the ships calling on the Lehigh Hanson facilities is assumed to be the typical dimension for a 50,000 dwt vessel: a draft of approximately 11-12 meters (36 to 39 feet), with a beam of 32 meters (106 feet) and an overall length of 190 meters (624 feet). The expected propeller diameter for a ship of this size is given by the ratio of propeller diameter (d) to typical maximum draft (T_d). For a bulk cargo ship, such as those carrying cement products, the ratio is 0.65, thus $d = 0.65 * T_d$ and for the range of drafts, would provide a propeller diameter of ~23 to ~25 feet (7-7.6 m). NMFS used these diameters in their assessment of propeller entrainment risk.

NMFS calculated the volume of water that is swept through the propeller disc during three legs of the transit distance between the Port of Pittsburgh and the Port of Stockton: Port of Pittsburg (RM 0) to Blind Point, Blind Point to channel marker "47" at the mouth of the South Fork of the Mokelumne River, and channel marker "47" to the Port of Stockton (RM 41). The volume was simplified to be equivalent to the diameter of the propeller multiplied by the distance of each leg. Since specific information for the pitch of the propeller, the revolutions per minute of the propeller disc, the area of water in front of the propeller entrained into the propeller, and the variability of the speed of the engine during the ship's maneuvering within the DWSC was unavailable, the model calculating the volume had to be simplified. NMFS also assumes that there is only a single propeller on each ship, thus the volume swept by a single propeller disc is the cumulative volume per ship transit. These volumes were then multiplied by the different Chinook salmon densities, as measured by the USFWS during their monitoring efforts at Chipps Island (USFWS DJFMP data 1996-2016), Jersey Point, and Prisoners Point (Wichman 2005). This represents the anticipated number of salmonids that would be encountered by a ship's propeller passing through the shipping channel at a given time of the year. The products of these calculations were then adjusted to 40 percent for the projected rate of mortality for smolting salmonids between 85 mm and 250 mm in length passing through the blades of a propeller or turbine (Gutreuter et al. 2003, Killgore et al. 2001, Dubois and Gloss 1993, Cada 1990, Holland 1986, Giorgi et al. 1988, and Gloss and Wahl 1983) to derive the number of salmon mortalities for one year's volume of ship traffic in the Stockton DWSC associated with the Project. Based on the ranges of mortality risks observed in the previous studies, NMFS used a mortality value of 40 percent for fish that encountered the propeller resulting from direct death due to being struck by the propeller blade, death from the cavitation surrounding the blade, or delayed death following the encounter with the propeller for fish >85 mm (salmon smolts) and a mortality rate of 80 percent for fish > 250 mm (steelhead smolts).

NMFS realizes that this model is crude in its estimates. The zones of effects for water entrainment by the propellers (inflow zone) are calculated only for the diameter of a given propeller along the length of the ship channel from Pittsburgh to Stockton. Studies by Maynord (2000) indicated that the inflow zone for barge tows on the Mississippi River extend slightly beyond the beam of the tow (about 20 percent wider than the beam of the tow from centerline). Therefore, NMFS calculations may be underestimating the true volume of water entrained by the vessels's propeller during its transit of the Stockton DWSC from the Port of Pittsburg to the Port of Stockton. Likewise, NMFS does not have any data for potential avoidance of juvenile and adult salmonids to oncoming vessel traffic. However, the data gathered by the USFWS trawls should represent a reasonable approximation of fish density that a vessel would encounter within the shipping channel. The trawling activities involve motorized vessels dragging a net through the channel's waters, which creates a substantial disturbance within the water column. The speed of the trawl is quite slow, generally less than 5 mph, providing ample opportunity for fish to escape the net by either moving laterally or vertically in the water column. Ships are limited to 10 mph from New York Slough to Prisoners Point and 7 mph from Prisoners Point to the Port of Stockton (33 CFR §162.205). Oncoming vessel traffic would be moving at a faster rate than the trawl vessels, and would take up a greater percentage of the channel's cross section. The draft of the vessel (11-12 m; 36-39 feet) would be much greater than that of the trawl (~3 m; 9.8 feet), and would have a greater beam (~32 m; 105 feet) than the width of the mouth of the trawl net (maximum of 9.14 m; 30 feet), which would necessitate moving greater lateral distances to avoid the oncoming vessel compared to the mouth of the mid-water trawl net. Therefore the Chinook salmon and steelhead densities measured by the trawls are a conservative estimate of the fish densities in the field.

The vessels are moving through the channel at approximately 8 to 10 mph (3,600 mm to 4,500 mm per second). This is equivalent to approximately 40 to 50 times the length of an average sized Chinook salmon smolt (~90 mm; 3.5 inches) and 16 to 20 times the length of an average steelhead smolt (~220 mm; 8.7 inches). A smolt located along the sailing line of a large vessel would have to swim at least 19,000 mm (62.3 feet) to escape the predicted zone of inflow for a ship with a beam of 32 meters (105 feet). The maximum burst swimming speed for juvenile salmonids is approximately 10 times their body length (Webb 1995) or 900 mm/sec (35.4 inches/sec) for Chinook salmon and 2,200 mm/sec (86.6 inches/sec) for steelhead smolts. At maximum swimming velocity, a 90 mm (3.5 inches) Chinook salmon smolt would take ~21 seconds to cover the distance from the ship's sailing line to the outside margins of the zone of inflow. Twenty one seconds is within the outside limits of salmonid burst swimming duration (approximately 15 seconds), however any fish that exerted this type of energetic output would be fatigued by the activity. For the larger steelhead smolt, it would only take about 8.5 seconds to cover the same distance, and the fish would be less fatigued by the escape. In 21 seconds the vessel would have moved 76,000 mm to 94,500 mm (76 to 95 meters; 249 to 312 feet) forward along its course of travel. Any Chinook salmon smolt along the centerline of travel would have to initiate its escape response at least 100 meters (~330 feet) ahead of the ship in order to assure its movement out of the inflow zone. For the larger steelhead smolt, the ship will have moved about 30,600 mm to ~38,000 mm (~30 to 38 meters) forward in 8.5 seconds. Although a salmonid would easily be able to detect the ship's propulsion system at these distances, data are lacking as to the critical distances at which a salmonid would exhibit escape responses as a result of the increasing noise levels. Note that at 100 meters (~330 feet) in front of the bow of an oncoming ship, the propulsion unit of a ship and its propeller will be an additional 100 to 200 meters (330 to 660 feet) farther distant from this point due to the length of the vessel. Therefore the noise source as detected by the fish 100 meters in front of the ship is actually about 200 to 300 meters (660 to 990 feet) distant. This distance is shorter for steelhead and is less than 250 meters (80 feet).

Fish densities, as calculated by the USFWS during their salmon monitoring trawls in the San Joaquin River and at Chipps Island, indicate that the relative density of fish in the river water column is quite low. The USFWS calculated Chinook salmon densities per 10,000 m^3 (353,147 cubic feet) of water sampled for their mid-water and Kodiak trawls. Trawls were conducted on the northern, southern, and mid-channel portions of the Sacramento River channel at Chipps Island, and in mid-channel at Jersey Point and Prisoners Point within the Stockton DWSC. The trawls sampled the top 3 meters (10 feet) of the water column. Fish densities for beach seines in different locations in the Delta were typically higher than the data from the trawls, however this may be a reflection of the different capture efficiencies of the two methods as well as behavioral characteristics of the fish. Fish densities for steelhead smolts are considerably lower and are strongly biased by the ability of steelhead smolts to avoid the net gear. Fish density data were presented by year, month and run-type in the USFWS annual reports (USFWS 2013, 2015, 2017, USFWS DJFMP data web site) and also by total capture (Wichman 2010). From the available density data, it is apparent that the highest mortalities will occur during the winter-spring emigration period for juvenile salmonids, and will increase the closer the ship is to the western edge of the Delta where densities are higher. This is a reflection of the different contributions that the San Joaquin River basin stocks and Sacramento River basin stocks make to the overall fish density measurements. Farther up the San Joaquin River near Jersey Point and Prisoners Point, the majority of fish are most likely from the San Joaquin River basin, although a proportion will have Sacramento River origins due to the cross Delta flows created by the open waterways leading south from the Sacramento River (DCC, Georgiana Slough, Threemile Slough). In order to account for this, NMFS weighted fish densities from the available data for Chipps Island and the San Joaquin River sites and extrapolated fish densities at the San Joaquin River sites for months in which sampling did not occur on the San Joaquin River. The fish densities for each reach were then used to calculate the expected rate of entrainment for each river segment over a year's period.

Within the context of the Project, the exposure to increased vessel traffic and the potential for propeller entrainment will occur over a very broad area (San Francisco estuary and the Sacramento-San Joaquin Delta) and over an extended period of time. Vessel traffic will traverse ~90 miles of waterways from the Golden Gate Bridge to the Port of Stockton. Exposure to propellers will occur during each passage of a ship and has been estimated to be approximately 54 additional trips annually at the maximum anticipated rate of ships calling on the Lehigh Hanson facilities. Each trip will bear some risk of propeller entrainment when fish are present, but presence of fish will not occur on each trip since fish are only present at certain times of the year based on their migratory behavior.

Projected entrainment for Chinook salmon utilizing the San Joaquin River due to the increased shipping activities represent an additional stressor on these populations of fish. NMFS estimates that Sacramento River winter-run Chinook salmon will encounter annual entrainment mortalities in the lower segments of the San Joaquin River between the Port of Stockton and the Port of Pittsburgh (reaches 1 and 2) of approximately 100 to 118 fish annually. CV spring-run Chinook salmon annual mortalities are estimated to range between 811 to 956 fish over the same reaches (Table 13).

Steelhead are much more difficult to assess due to the lower numbers recovered from the monitoring gear and their greater ability to avoid the trawl gear in the first place. It is important to note that although larger steelhead smolts should be able to avoid the passage of ships more readily than Chinook salmon smolts, those that do encounter the propellers will have a higher mortality rate than the smaller salmon smolts. This is due to their greater probability of not passing successfully through the blades of the propeller as the blades rotate. NMFS estimates that mortalities for "wild" steelhead will range between 30 to 36 fish annually (Table 13).

Encounters between steelhead and the propellers of the vessel will likely result in the death of the individual fish. Due to its larger size compared to a Chinook salmon smolt, the steelhead is less likely to pass through the disc of the propeller blades without encountering one of the blades. The force of the impact is likely to dismember the individual fish resulting in immediate death, or incur an injury that is fatal in the short term or that make them more vulnerable to predation or later infection as a result of their injuries. Steelhead surviving the propeller entrainment also risk being disoriented and stunned following passage through the propeller disc, and thus become easy targets for predators to attack before they recover from their encounter.

Table 13. Maximum and Current Annual Propeller Entrainment and Mortality Estimates[a]:

	WR		SR		FR		LFR		"Wild" SH		Clipped SH	
Prop Diameter	Entrained	Mortality	Entrained	Mortality	Entrained	Mortality	Entrained	Mortality	Entrained	Mortality	Entrained	Mortality
7.0 m	251	100	2,027	811	38,407	15,363	357	143	38	30	193	154
7.6 m	296	118	2,389	956	45,273	18,109	421	168	44	36	228	182
7.0 m	63	25	507	203	9,602	3,841	89	36	10	7	48	39
7.6 m	74	29	597	239	11,318	4,527	105	42	11	9	57	46

[a]Top 2 rows of estimated entrainment and mortality values are for maximum estimated vessel trips, bottom 2 rows of values are for current shipping levels.

WR = winter-run Chinook salmon
SR = spring-run Chinook salmon
FR = fall-run Chinook salmon
LFR = late fall-run Chinook salmon
SH = steelhead
Wild SH = has intact adipose fin
Clipped SH = clipped adipose fin meaning hatchery origin fish

Assumptions for mortality estimates:

1) Maximum of 72 vessel trips annually, evenly distributed across 12 months = 6 trips per month. Current levels of vessel trips are 18 trips annually, evenly distributed across 12 months = 1.5 trips per month.
2) No entrainment has been calculated for vessels from SF transiting SF Bay, San Pablo Bay, and Suisun Bay.
3) 40 percent mortality for fish > 85 mm (smolts)
   80 percent mortality for fish > 250 mm (steelhead smolts)

In summary, the increased level of vessel traffic will act as an additional stressor on the aquatic community and the organisms within that community. Both adult and juvenile Chinook salmon and steelhead from the Central Valley will be exposed to this stressor due to the wide spatial and temporal overlap of the stressor with their migrations. Exposed fish are expected to have reduced fitness due to incurring fatal injuries following propeller entrainment and if surviving the encounter, enhanced predation risk due to injuries or disorientation following propeller entrainment.

2.5.2.3.2 Green Sturgeon

Ship strikes and propeller entrainment are a source of injury and mortality for many aquatic species, including sturgeon. There have been several reports over the last 20 years indicating that sturgeon are at risk for lethal interactions with ships, particularly large deep draft vessels. Gutreuter et al. (2003) estimated that on average, entrainment mortality rates for shovelnose sturgeon (*Scaphirhynchus platyrynchus*) were 0.53 fish per kilometer for towboat passage through the upper Mississippi River system. These vessels travelled in defined shipping channels and the cross-section of the barge tow and tow boat occupied a considerable fraction of the confined navigation channel. Killgore et al. (2011) provided additional information regarding the risk of towboat – fish interactions in follow-up studies to the earlier Gutreuter et al. (2003) study using a specially designed tow net to capture fish entrained by the towboats propellers. They found that towboat speed and propeller revolutions per minute (RPM) did not affect the entrainment rate of fish through the propellers (i.e., fish/km), however the risk of being hit by the propeller increased with fish length and engine RPM (i.e., propeller turning faster). Killgore et al. (2011) also found that entrainment rates were lower in wider sections of the river, deeper water, or swift currents; however entrainment in narrow sections of the river with shallow, slow water was typically greater, but variable. Entrainment rates of more than 30 fish/ km were observed in such conditions. The effects of towboat entrainment mortality on shovelnose sturgeon in the navigation pools of the upper Mississippi River was compared to the estimates of fishery harvest and ambient population densities to evaluate the population effects of entrainment (Miranda and Killgore 2013). They estimated that the average entrainment rate of shovelnose sturgeon per kilometer of navigation channel traveled was 0.02 fish/km. Mortality and injury (loss) associated with entrainment were generally less than fishery harvest, although the absolute difference was not large. They concluded that the two sources of loss combined could potentially reduce the mature adult population of shovelnose sturgeon to a level that was not capable of replenishing itself.

Observations of sturgeon-ship interactions also occur in populations of Atlantic sturgeon (*Acipenser oxyrinchus*). Brown and Murphy (2010) observed 28 Atlantic sturgeon mortalities in the Delaware River estuary between 2005 and 2008. Sixty-one percent of these fish were adult sized and 50 percent of the mortalities were due to apparent vessel strikes based on lacerations and decapitations to the bodies. The remaining fish were too decomposed to ascertain the cause of mortality, but based on the appearances of the bodies were also likely due to vessel strikes. Brown and Murphy (2010) concluded that a small remnant population of Atlantic sturgeon, such as found in the Delaware River, cannot sustain losses at this scale. Similar levels of losses would also be detrimental to the long term viability of the sDPS green sturgeon if mature adults were killed. The Delaware River has similarities to the San Francisco estuary and Delta. It has wide open waters with wide shipping channels in its lower reaches where it joins with the ocean. The estuary becomes progressively narrower farther upstream as the shipping channel approaches the inland ports of Camden and Philadelphia. The shipping channel is maintained at a depth of 40 feet until Philadelphia. Brown and Murphy (2010) found that sturgeon followed the shipping channel to move upstream and downstream through the estuary and riverine reaches of the Delaware River. This places them in direct conflict with deep draft ocean going vessels. These vessels typically have drafts and beams that take up a large percentage of the dredged shipping channel, leaving little room or depth for the sturgeon to avoid the ship's hull and propeller.

Similar observations of vessel strike-related mortalities of Atlantic sturgeon were observed in the James River in Virginia (Balazik et al. 2012). From 2007 to 2010, there were 31 documented mortalities of Atlantic sturgeon, 26 by vessel propellers and the remaining 5 too decomposed to ascertain the cause of death. The majority of these mortalities (84 percent) were observed in a narrow portion of the shipping channel that cut through a large bend in the river at river kilometer (rkm) 120 allowing shipping to have a more direct path to the Port of Richmond, Virginia (this is similar to the channel cutoffs observed in the Stockton DWSC and the natural restriction created by the Carquinez Strait). Based on acoustically tagged adult sturgeon data from this reach of the James River, Balazik et al. (2012) determined that the sturgeon remained in the dredged shipping channel 69 percent of the time and within 1 m of the bottom 51 percent of the time. Since the minimum dredged depth of the shipping channel was only slightly deeper than the draft of the large vessels using the channel, the sturgeon were vulnerable to the movements of deep draft vessels even if they stayed on the bottom of the channel. During this study, the frequency of deep draft ocean shipping traffic using the Port of Richmond was observed to be 1 round trip per week, which is similar to the rate of shipping traffic anticipated to be calling on the Lehigh Hanson facilities in the future. In addition, dead sturgeon carcasses implanted with acoustic tags were released to ascertain the behavior of drifting carcasses and the probability of recovery. These results indicated that carcasses could drift for up to 4 days and cover ~50 kilometers of river before washing up on the shoreline. The difficulty in finding the tagged carcasses lead the authors to estimate that only one third of the actual sturgeons killed by ship strikes are observed in this river system, thus greatly underestimating the true extent of sturgeon killed by ship strikes.

Demetras et al. (2020) reported the observation of a vessel strike in the San Francisco estuary within the Carquinez Strait, near the Port of Benicia, California. The crude oil tanker which apparently struck the white sturgeon (*Acipenser transmontanus*) was in deep water near the Benicia Bridge when the strike occurred. As populations of both white sturgeon and the listed sDPS of green sturgeon use these waters to migrate both upstream into the Central Valley to access spawning habitat, and back downstream to the estuary and ocean environments, vessel strikes may have a greater impact on populations than previously recognized, even though the shipping lanes are deep. sDPS green sturgeon are found year-round in the waters of the San Francisco estuary and Delta, and would be vulnerable to interactions with deep draft vessels using the shipping channels in these waters, including both the Sacramento and Stockton DWSCs in the Delta.

2.5.2.3.2.1 Sturgeon behavioral traits that amplify vulnerability to ship strikes

Several studies within the past 15 years have shown behavioral traits within sturgeon that can potentially amplify their vulnerability to ship strikes. NMFS will first look at general behavioral traits within sturgeon that increase vulnerability to ship-sturgeon interactions, then focus on specific behaviors of green sturgeon that can increase this risk.

It is commonly believed that sturgeon are almost always benthically oriented, however recent studies have shown this may not be the case. Watanabe et al. (2013) examined swimming behaviors of Chinese sturgeon (*A. sinensis*) in the Yangtze River in China. Earlier studies by Watanbe et al. (2008) showed that acoustically tagged Chinese sturgeon released into a very deep reservoir (>100m) lost buoyancy and stayed nearly motionless on the bottom. Since natural swimming behavior of this sturgeon species was not known, the authors released 9 acoustically tagged adult wild sturgeon into the Yangtze River in an unimpounded reach to compare natural riverine behaviors to the behaviors observed in the artificial impoundment. The pop-up tags used in the study measured depth, swimming speed, water temperature and two dimensional accelerations (including tail beat frequency). Data from the tags indicated that fish swam up and down in the water column 64 percent of the time. Fish remained near the bottom the other 36 percent of the time. The consistent tail beat frequency indicated that fish were maintaining their buoyancy. However, within the acoustic tag record, fish were also observed rapidly swimming towards the surface (>3 m/sec; 10 feet/ sec) approximately 0.35 times per hour with speeds that would indicate breaching or porpoising at the surface. Watanabe et al. (2013) postulated that fish were swimming to the surface to gulp air to refill their swim bladders since sturgeon are physostomous and cannot generate gases to fill their swim bladder. This surfacing behavior was identified as a behavior that would put sturgeon at risk of being struck by vessels at the surface.

Similar behavior was observed in Atlantic sturgeon in the Bay of Fundy (Minas Basin) by Logan-Chesney et al. (2018). This study examined the swimming behavior of 6 tagged Atlantic sturgeon in the Minas Basin, where there is a substantial tidal range (40 feet) that can influence sturgeon buoyancy. Over the course of the study, 49.5 percent of the surfacing behavior occurred on a flood tide as water depth was quickly increasing, causing sturgeon to have to compensate for their changing buoyancy status. Maintaining buoyancy control was hypothesized to allow sturgeon to feed over the extensive flats without touching bottom, thereby enhancing their feeding success. Little surfacing behavior was seen as the tide entered the ebb phase, with water depth rapidly decreasing. A physostomous fish could easily “burp” air out of its swim bladder through its esophagus to compensate for pressure changes caused by the falling tide. Surfacing behavior occurred up to 12 times a day, with most of the surfacing behavior occurring at night. Surfacing behavior was very rapid, with swimming speeds up to 4.17 m/sec (13.5 feet/ Sec) indicating a breach or porpoising at the water surface. Descents were also rapid (0.17-3.17 m/sec; 0.5 to 10.4 feet/ sec)), indicating conserved potential energy from a breach, or potentially active swimming to regain depth after filling the swim bladder with air. Logan-Chesney et al. (2018) also observed that breaching behavior is seen in many species of sturgeon, not just Atlantic sturgeon.

A different behavior that was observed in sturgeon that would enhance the vulnerability to ship strikes is the preference of sturgeon for deep navigation channels for migration or movements. A study by Hondrop et al. (2017) in Michigan examined the behavior of Lake sturgeon (*A. fulvescens*) within the Detroit and the St. Clair rivers. They found that altered flows and channelization attracted sturgeon to the dredged navigation channel in the Detroit River, but not in the St. Clair River. The Detroit River was more heavily channelized, and the navigation channel had higher flows, faster currents, and was deeper than the non-channelized routes available to the sturgeon. Approximately 85 percent of the sturgeon in the Detroit River selected the navigation channel, whereas only 32 percent of the fish in the St. Clair River selected the navigation channel to migrate through. Within the St. Clair system, the navigation channel did not have the flows, water depths, or current velocities that the alternative routes had. Hondrop et al. (2017) surmised that the selection of the navigation channel by sturgeon in the Detroit River placed them at a higher risk of ship strikes and potential lethal injuries. There was little depth refugia in the navigation channel in the Detroit River for sturgeon to avoid the deeper drafts of large vessels. Hondrop et al. (2017) observed wounds and lacerations on dead sturgeon that were consistent with propeller strikes by large ships in the Detroit River ship channel. Hondrop et al (2017) also commented that controlling adult mortality was a key aspect for recovering the Lake sturgeon populations.

Behaviors of sDPS green sturgeon have been examined for nearly 15 years. Kelly et al. (2007) studied the swimming behavior of 6 acoustically tagged sDPS green sturgeon in San Pablo Bay (5 subadults and 1 adult). The movements of the tagged fish were divided into 2 categories: directional movements and non-directional movements. Non-directional swimming occurred 63.4 percent of the time (slow swimming on the bottom, frequent changes in direction, possibly associated with foraging), however the other 36.6 percent of the time, the tagged sturgeon were swimming in the top 20 percent of the water column and swimming in a directed manner holding a steady course for prolonged periods of time. Kelly and Klimley (2012) re-evaluated the data from the tagged 6 sDPS green sturgeon in the 2006 study using vector analysis of the tagged tracks with vectors from a water current analysis produced by a hydrodynamic model to assess movement behavior. They found that three of the fish which swam near the surface, swam at much higher speeds over ground, but had the same functional swim speed as fish that stayed near the bottom and which swam in a non-directional manner. This indicated that the sturgeon were using the tidal currents in the upper water column to their advantage to swim in a more efficient manner and cover more distance. Fish that stayed on the bottom frequently swam into the current. Kelly and Klimley (2012) hypothesized that this was a behavior to generate lift for the fish to swim at slower speeds near the bottom, perhaps as an aid to foraging efficiency. Such swimming behavior allows the fish to remain near the bottom but not touch it and thus alert prey to their presence. The aspect of more efficient swimming strategy by moving with the ambient tidal current was further studied (Kelly et al. 2020). This study showed that sDPS green sturgeon moving near the surface and taking advantage of tidal currents swam at an estimated 85.5 percent of optimal efficiency compared to fish tested in a laboratory setting. This is in comparison to fish that swam near the bottom that swam with much less efficiency, with a cost of transport that was similar to swimming directly into the ambient current. The results of this study indicate that sDPS green sturgeon may opportunistically utilize tidal stream transport in their daily movements, swimming at the surface and orienting with currents to achieve substantial energy savings.

A study by Thomas et al. (2019) tracked acoustically tagged juvenile sDPS green sturgeon in the San Joaquin River near the confluence of Potato Slough. These fish also showed the tidal transport behavior during their daily movements, but remained near the bottom during almost all of their swimming movements. Fish also showed high fidelity to the San Joaquin River channel, rarely venturing away into peripheral waters.

The spatio-temporal distribution of sDPS green sturgeon within the San Francisco estuary and Central Valley Delta and riverine waters was described by Miller et al. (2020) and provides context to the overlap of sDPS green sturgeon with shipping activity. This study used acoustic tag data from 2010 to 2016 to develop fine scale reach specific information for juvenile, subadult, and adult sDPS green sturgeon movements within the area covered by acoustic receiver locations. This broad area encompassed receivers in the ocean north and south of the Golden Gate Bridge as well as receiver arrays within the San Francisco estuary, the Delta, and the Sacramento River basin to provide the spatio-temporal distribution of the different life stages over the course of a year. Juvenile sDPS green sturgeon were present throughout the estuary and the Delta regions during the entire year, with most detections occurring within the Delta. However, no detections of juveniles were reported for January in the Delta. Detections of subadults also occurred year-round in the estuary, with much less frequency in the Delta. Very few detections of subadult sDPS green sturgeon occurred upstream of the Delta in the lower Sacramento River and none within the spawning reaches farther upriver. Most detections occurred within the Central San Francisco Bay region and had a distinct shift towards more marine environments. Adults were detected year-round in all of the regions occupied by acoustic receivers within the estuary, Delta, and riverine reaches of the Sacramento River. The spawning migration into the Sacramento River was clearly seen, with the peak moving progressively upstream from the Delta to the lower reaches of the Sacramento River until reaching the spawning grounds in the upper river from April through July, with a peak presence in May. Detections then declined through fall and winter, but did not completely disappear in the spawning reaches, indicating that some adults were always present in those waters. Adult sDPS green sturgeon showed high fidelity to the mainstem Sacramento River during their downstream migration from the spawning grounds (82 percent), but dispersed more during their upstream migration into several of the channels in the north Delta (i.e., Sutter, Steamboat, and Miner sloughs). Adult sDPS green sturgeon selected the mainstem route mostly (46 percent), followed by Miner-Sutter route (32 percent) and the Steamboat route (13 percent) with the remaining 9 percent moving through the central Delta routes, which includes portions of the action area (reaches 1 and 2).

Based on the information provided by these studies, sDPS green sturgeon are anticipated to have an increased risk of ship strikes within the action area due to their innate behaviors and regional distributions. The studies have clearly shown that sDPS green sturgeon do not spend all of their time on the bottom, but rather spend a significant amount of time in the upper portions of the water column swimming in a directed manner over long distances. They do this on a daily basis, taking advantage of the higher swimming efficiency afforded by selective tidal stream transport to move to new locations within the estuary and Delta. Furthermore, the studies showing breaching behavior in Chinese and Atlantic sturgeon are applicable to sDPS green sturgeon, as the anatomical and physiological characteristics are consistent throughout sturgeon species. Green sturgeon have also been observed breaching in their normal wild behavior (Erickson and Hightower 2007, Van Eenennaam et al. 2012), as have many other sturgeon species (Logan-Chesney et al. 2018). This places the fish into portions of the water column occupied by deep draft vessels on a fairly routine basis. In addition, sturgeon affinity for the deep navigation channels (Hondrop et al. 2017, Thomas et al. 2019) places them in the path of deep draft vessels during the expression of their normal behaviors.

NMFS expects that multiple life stages of green sturgeon (adult, subadult and juvenile stages) will be exposed to the effects of vessel strikes and propeller entrainment. These life stages will occupy the waters of the Delta and the San Francisco estuary that co-occur with the navigational shipping channels used by the vessels calling on the Lehigh Hanson facilities. Since there is no seasonality to the predicted schedule of ship visits to the facility, the volume of traffic is assumed to be consistent throughout the year. Therefore, the exposure of sDPS green sturgeon to ship strikes and propeller entrainment will occur throughout the year, and will impact all of the rearing and migration behaviors of sDPS green sturgeon within the action area, stretching from the Port of Stockton to the Golden Gate Bridge. Ships travelling within Reach 1 will have the lowest overlap with sDPS green sturgeon presence due to the low frequency of use of this portion of the San Joaquin River by any of the life stages of sDPS green sturgeon occupying the Delta. However, due to the greater proportion of the river channel occupied by the shipping channel in this reach, any sturgeon within the shipping channel has a higher likelihood of encountering a deep draft vessel and thus a higher risk of a vessel strike or contact with the propeller. In Reach 2 there is increasing exposure to shipping interactions with sturgeon due to the increasing frequency of use of these waters by adult, subadult, and juvenile life stages of sDPS green sturgeon. While the proportion of the river channel occupied by the shipping channel is less than in Reach 1, the greater frequency of use by sDPS green sturgeon increases the risk of a ship-sturgeon interaction. Finally, Reach 3 has the highest potential for overlap between sDPS green sturgeon presence and shipping as all sturgeon must pass through Reach 3 to travel between the ocean and the upstream spawning grounds. Furthermore, the waters of Reach 3 are continually occupied by adult, subadult, and juvenile life history stages over the entire year. This risk is somewhat ameliorated by the much greater expanse of water in the bays and estuary that can be occupied by green sturgeon, but constricted areas such as the Carquinez Strait will still have a high degree of risk for ship-sturgeon interactions and the potential for ship strikes and propeller entrainment.

NMFS could not conduct a similar modeling of propeller mortality for sDPS green sturgeon as was done for Chinook salmon and steelhead due to the lack of fish density data for sDPS green sturgeon. NMFS considers that the vast majority of ship strikes and propeller entrainment incidents will result in the death of the sturgeon involved. If these individuals are reproductive age adults, then the future reproductive capacity of that fish is lost and the subsequent viability of the population may suffer. This reduces the potential for the recovery of the species.

2.5.3 Effects to Critical Habitat

The effects of the proposed Project on designated critical habitat within the action area can be separated into short term impacts related to the construction elements of the Project (i.e., pile driving and the removal of the creosote treated pilings supporting the railroad trestle) and those associated with the longer term elements of the Project related to shipping traffic (i.e., noise, turbidity, and aquatic community alterations). In both instances, any alterations to the quality of habitat are none permanent, transitory in nature, and do not impact a substantial proportion of the available habitat within the Delta and San Francisco estuary. Without the constant input of the stressor causing the alteration to the PBFs of the designated critical habitat, the changes will either stop instantly (pile driving noise or ship noise) or gradually dissipate (turbidity, ship waves, or sediment disturbance), allowing the habitat to resume its normal function.

2.5.3.1 Pile Driving

The pile driving will occur for a short defined period of time within the ship turning basin at the Port of Stockton. Pile driving will last for up to 12 hours per day (sunrise to sunset) and for a short period of time (no more than a cumulative period of 35 days) during the proposed in-water work window of July 1 to November 30. When pile driving is done for the day, or for the Project in total, the habitat impacts associated with the acoustic stressor ceases after the last pile strike (within a few seconds). Once pile driving ends, there is no more noise associated with the pile driving action. The acoustic environment returns to its pre-pile driving condition with no lingering acoustic effects of the pile driving action. The pile driving only affects designated critical habitat for CCV steelhead and for sDPS green sturgeon. The sounds generated during the period of active pile installation has the potential to create a barrier to migration within the area surrounding the dock, but this only lasts while the piles are being driven. After the pile driving has stopped for the day, the migratory corridor is free from obstruction without being affected by the sound associated with the pile driving. This is also the case after the pile driving actions are finished for the Project.

The area associated with the impacts of the pile driving is spatially separated from the parts of the action area that contain designated critical habitat for Sacramento River winter-run Chinook salmon and CV spring-run Chinook salmon by 40 miles of river channel. The effects of pile driving will not extend to that distance under any circumstance, thus designated critical habitat for these species will not be affected.

2.5.3.2 Creosote treated piling removal

The removal of the creosote pilings supporting the old railroad trestle will also have a finite impact on the surrounding habitat in the turning basin. Work will be conducted during the in-water work window, and efforts will be made to contain any disturbed sediment or debris associated with piling removal (Project BMPs in section 1.3.4.6. Avoidance and Minimization Measures). The majority of impacts will be associated with the actual removal of the piles by cutting off the piles at the mudline underwater. This will likely result in sediment disturbance and some resuspension of sediment surrounding each pile. This sediment will likely be contaminated with PAHs from the leaching of the creosote over the past several decades. This sediment is expected to quickly settle back out of suspension, and any surface sheens should be contained within the debris booms and other BMPs described for the Project. There is a long term risk of continued leaching of PAHs from the freshly exposed wood in the center of the cutoff piling stumps into the surrounding waters with deposition onto the sediments surrounding this location. This source of creosote has not weathered in the environment and is thus more likely to give off fresh materials into the surrounding waters, with potentially more toxicity. However, the volume of creosote treated wood has been substantially reduced by removal of the existing piles and the amount of any materials leaching into the surrounding aquatic environment should be reduced compared to the current condition, although not eliminated. Complete removal of the pilings located in the water would eliminate this factor, which is what is recommended by the U.S Environmental Protection Agency (EPA) guidelines as well as several other agencies for the removal of creosote treated wood from aquatic environments (EPA 2016, NMFS 2009b, and Washington Department of Natural Resources 2017).

The removal of the creosote treated piles occurs in designated critical habitat for CCV steelhead and sDPS green sturgeon. For the CCV steelhead, the designated critical habitat in this area functions as a freshwater rearing site and a freshwater migratory corridor. For the sDPS green sturgeon, the freshwater riverine PBFs that may be affected by the removal of the pilings include food resources, water quality, and sediment quality. The release of PAHs and other compounds associated with the creosote treated lumber has the potential to contaminate the sediment and water surrounding the piles during removal. This may directly degrade the water quality of the surrounding turning basin which in turn may affect the health of CCV steelhead or sDPS green sturgeon that may be present in the area during the removal of the piles, or more likely by ingesting prey that have been contaminated by living in the contaminated sediment surrounding the piles. However, since the piles have been present in this location for almost a century (since the 1930s), the sediment surrounding the piles has already been exposed to compounds leaching from the creosote and is likely already contaminated. Thus, it would be difficult to determine how much contamination of the forage base occurred prior to the removal of the piles and how much has occurred due materials deposited during and after the removal of the piles.

Designated critical habitat for Sacramento River winter-run Chinook salmon and CV spring-run Chinook salmon does not occur in the area adjacent to the creosote pile removal. The construction site in the Port of Stockton turning basin is spatially separated from the parts of the action area that contain designated critical habitat for Sacramento River winter-run Chinook salmon and CV spring-run Chinook salmon by 40 miles of river channel. The effects of the removal of creosote piles will not extend to that distance under any circumstance, thus designated critical habitat for these species will not be affected.

2.5.3.3 Ship-related impacts to critical habitat

Shipping traffic related to the Project occurs on average once every 5 days at the maximum rate of Port visits estimated for the Lehigh Hanson facilities (6 vessel trips per month; 72 trips annually). There is a period of "rest" between ship transits associated with the Project that allows the affected channel and shoreline habitat to recover without other shipping traffic present. However, in combination with the expected ship traffic visiting the Port of Stockton that is not associated with the Project, this rest period is on the order of several hours to days. Based on the estimated current shipping traffic (252 visits to the Port in 2018), there are 504 vessel transits of the Stockton DWSC a year, with an average of 1.4 transits per day.

Periods of rest allows the sediment resuspended by the ship's passage to settle back out of suspension and displaced fish to move back into their normal habitats, particularly along the shoreline. Low frequencies of disturbance have lower rates of adverse impacts to habitat, as the time between episodes of disturbance allow the habitat to recover. Higher frequencies of disturbance have a cumulative effect on the habitat, and if the period of recovery is too short, the habitat starts to show an increase in the loss of functioning with permanent changes to its biotic and abiotic characteristics.

The passage of each ship past a given point is fairly short, on the order of a few minutes. Thus, impacts from stressors such as ship noise or ship induced waves is on the order of a few seconds to minutes. The effects linger for a few minutes until the ship travels farther down the channel away from any given point, and then diminish to background levels. However, each passage of a vessel affects the entire length of the shipping channel, rather than only a discrete point in the environment, and thus has a much broader level of impact. The effects of the shipping traffic related to this Project on the habitat are thus a low frequency of events (i.e., low number of ship transits) with a low level of intensity (i.e., short duration of exposure but a broad spatial distribution along the entire route of the shipping channel).

In many of the studies referenced earlier, impacts to the aquatic habitat were evident when multiple ship passages were made in a given day, on the order of a dozen or more transits where the rest period was measured in minutes rather than multiple hours in a day. Kano et al. (2013) reported an average of 25.6 vessels per hour on the East Tiaoxi River during their study. Kucera-Herzinger et al. (2009) reported an average of large vessel passage every 56 minutes in March and every26 minutes in September, with a typical rate of between 800 and 1,000 cargo ship passages per month on the River Danube in Austria. Gutreuter et al. (2006) reported a range of 3.7 to 21.7 barge tows per day on the Upper Mississippi River with an average of approximately 8 barge tows per day in their study area. Thus, the Stockton DWSC has a relatively low frequency of disturbance compared to other heavily used waterways in the world.

Finally, substantial habitat is present within the action area that is not directly adjacent to the ship channels. Within the Delta (reaches 1 and 2), there are numerous side channels, sloughs, and alternate river channels that can provide the habitat necessary for fresh water migration and rearing for listed species, and are within designated critical habitat for CCV steelhead and sDPS green sturgeon (and Sacramento River winter-run Chinook salmon in the lowest portions of Reach 2, as previously described). These side channels are unaffected by the deep draft vessels using the Stockton DWSC. Farther downstream, the broad expanses of Suisun Bay, San Pablo Bay and the northern San Francisco Bay provide critical habitat for all of the listed species that are outside of the shipping channels and are unaffected by the shipping traffic due to the expanse of open waters in those water bodies. These areas provide the necessary PBFs for estuarine habitat for these species.

Designated critical habitat for CCV steelhead and sDPS green sturgeon is present in Reach 1 of the action area (Port of Stockton to Prisoners Point) and consists of freshwater migratory corridors and rearing habitat for CCV steelhead and freshwater riverine areas for sDPS green sturgeon. Ship transits will temporarily diminish the value of this habitat for rearing by elevating turbidity through the resuspension of sediments, and possibly exposing existing contaminants in the sediment horizons. This will temporarily impact growth, foraging, and the quality of the prey base. The passage of ships may also disturb or block the free passage of adults and juveniles using the dredged shipping channel as a migratory route, causing them to abandon the channel or seek refuge during the passage of the ship. However, this blockage will also be a temporary condition, as free passage can resume after the ship has left the area that the fish are occupying. The action will temporarily degrade the quality of the local critical habitat but will not permanently degrade its function.

Designated critical habitat for CCV steelhead and sDPS green sturgeon is found in Reach 2 (Prisoners Point to Chipps Island) and consists of freshwater rearing and migratory corridor PBFs as well as estuarine area PBFs for CCV steelhead, and estuarine and freshwater riverine area PBFs for sDPS green sturgeon. The impacts from the Project's shipping traffic on the freshwater habitat PBFs is the same as described for Reach 1. Similarly, the impacts to estuarine area PBFs are on the quality of water in the estuarine area as well as the abundance and quality of the forage base for adults and juveniles. Disturbance of the channel bottom and banks by passing ships will increase local turbidity and has the potential to resuspend contaminants from exposed sediment horizons. This in turn can negatively impact the ability to find prey by reducing visibility in turbid waters, smothering of benthic prey colonies with sediment as it settles out of suspension, or reducing the quality of food resources through exposure to contaminants. However, any impacts are expected to be temporary and of a low magnitude. Critical habitat for Sacramento River winter-run Chinook salmon is present in Reach 2 near the area of Winter, Kimball, and Browns islands. The PBFs in this area for Sacramento River winter-run Chinook salmon include free access from the ocean to upstream spawning areas for adults and free access for juveniles migrating from upstream locations to the ocean. In addition, any prey base should be free of contaminants to support growth and maturation for juveniles. Effects on the functioning of critical habitat PBFs for Sacramento River winter-run Chinook salmon are similar to those already described for CCV steelhead and sDPS green sturgeon for turbidity, contaminants, food resources, and blockage of migration by ship passage and are also considered to be temporary. Designated critical habitat for CV spring-run Chinook salmon does not include the portions of Reach 2 near Chipps Island.

In Reach 3, designated critical habitat generally includes all of the waters of Suisun Bay, the Carquinez Strait, San Pablo Bay, and the northern portion of San Francisco Bay to the Golden Gate Bridge for Sacramento River winter-run Chinook salmon, CV spring-run salmon, CCV steelhead and sDPS green sturgeon. Impacts to designated critical habitat in Reach 3 are expected to be minor and will not impact its function. This is based on the broad areas of the bays that are not immediately adjacent to the shipping channels, and would not be expected to have any demonstrable effects from ship traffic. Shipping traffic within the ship channel may impact sediments within the channel itself, but is not expected to rise to the level that it would negatively affect the functioning of the habitat. Shipping induced waves that reach adjacent shorelines are expected to be of low energy and have minimal impact on the shoreline. Only those shorelines that are immediately adjacent to the shipping channels would have ship induced waves that could create localized turbidity and sediment disturbance in the littoral zone. This particular condition is rare in Reach 3.

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 and 402.17(a)). Future Federal actions that are unrelated to the Project are not considered in this section because they require separate consultation pursuant to section 7 of the ESA.

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

2.6.1 Agricultural Practices

Agricultural practices in the Delta may negatively affect riparian and wetland habitats through upland modifications of the watershed that lead to increased siltation or reductions in water flow in stream channels flowing into the Delta. The Delta islands surrounding the action area are primarily agricultural lands with orchards, row crops, and grazing lands for dairy cattle present. Unscreened agricultural diversions throughout the Delta entrain fish including juvenile salmonids and juvenile sDPS green sturgeon and are present in the action area within the mainstem San Joaquin River. Grazing activities from dairy and cattle operations can degrade or reduce critical habitat for listed salmonids by increasing erosion and sedimentation as well as introducing nitrites, nitrates, ammonia, and other nutrients into the watershed, which then flow into the receiving waters of the Delta. Stormwater and irrigation discharges related to both agricultural and urban activities contain numerous pesticides and herbicides that may negatively affect salmonid reproductive success and survival rates (Dubrovsky et al. 1998, 2000; Daughton 2003).

2.6.2 Increased Urbanization

The action area occurs within the Delta, Antioch, and Stockton regions, which include portions of San Joaquin County, and Contra Costa County. Expansion of urban development is occurring in the cities of Manteca, Lathrop, Stockton, and Tracy along the I-5 and I-205/580 corridors as well as in portions of the East Bay near the cities of Brentwood and Oakley, and the Highway 4 corridor near the cities of Antioch and Pittsburg. Increases in urbanization and housing developments can impact habitat by altering watershed characteristics, and changing both water use and stormwater runoff patterns. Increased growth will place additional burdens on resource allocations, including natural gas, electricity, and water, as well as on infrastructure such as wastewater sanitation plants, roads and highways, and public utilities. Some of these actions, particularly those which are situated away from waterbodies, will not require Federal permits, and thus will not undergo review through the ESA section 7 consultation processes with NMFS.

Increased urbanization also is expected to result in increased recreational activities in the region. Among the activities expected to increase in volume and frequency is recreational boating. There are currently several boating facilities (large private and public facilities with docks, boat launches, and marinas) within the vicinity of the action area. These sites provide recreational boaters access to the Delta. Any increase in recreational boating due to population growth would likely result in increased boat traffic in the action area. Boating activities typically result in increased wave action and propeller wash in waterways. This will potentially degrade riparian and wetland habitat by eroding channel banks and mid-channel islands, thereby causing an increase in siltation and turbidity. Wakes and propeller wash also churn up benthic sediments, thereby potentially resuspending contaminated sediments and degrading areas of submerged vegetation. This, in turn, would reduce habitat quality for the invertebrate forage base required for the survival of juvenile salmonids and green sturgeon moving through the system. Increased recreational boat operation in the Delta is anticipated to result in more contamination from the operation of gasoline and diesel powered engines on watercraft entering the water bodies of the Delta. Furthermore, increased recreational boating, particularly those that can be trailered from one water body to another, greatly increases the risk of spreading non-native invasive species into the Delta.

Increased commercial activity in the Port of Stockton has the potential to increase commercial shipping in the Port of Stockton. Increased commercial shipping increases the potential for spills of petroleum products and other toxic compounds into the Stockton DWSC from the large vessels, as well as the introduction of non-native invasive species into the area waterways through the discharge of ballast waters. Ship movements increase the resuspension of sediments from the channel bottom which may introduce contaminants into the water column and increase turbidity in the DWSC. Finally, increased shipping traffic may increase the risks of propeller entrainment and propeller strikes to listed fish in the DWSC. Propeller strikes are particularly dangerous to adult sturgeon (Brown and Murphy 2010, Balazik et al. 2012, Demetras et al. 2020).

2.6.3 Rock Revetment and Levee Repair Projects

Depending on the scope of the action, some non-Federal riprap projects carried out by state or local agencies do not require Federal permits. These types of projects, as well as illegal placement of riprap, occur within the watersheds of the Sacramento and San Joaquin rivers and their tributaries, in addition to the waterways of the Delta. For example, most of the levees have roads on top, which are either maintained by the county, the local reclamation district, the landowner, or by the state. Landowners may utilize roads on the top of the levees to access parts of their agricultural lands and repair the levees to protect property with unauthorized materials (i.e., concrete rubble, asphalt, etc.). The effects of such actions result in continued fragmentation of existing high-quality habitat, and conversion of complex nearshore aquatic to simplified habitats that negatively affect salmonids and sDPS green sturgeon.

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 Project. 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 Project 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 diminish the value of designated or proposed critical habitat as a whole for the conservation of the species.

2.7.1 Status of Sacramento River Winter-run Chinook Salmon and Critical Habitat

The most recent 5-year status review (NMFS 2016a) reports that the overall viability of Sacramento River winter-run Chinook salmon has declined since the 2010 viability assessment, with the ESU still represented by a vulnerable single spawning population on the mainstem Sacramento River. New information available since the last 5-year review (NMFS 2011a) indicates an increased extinction risk to this ESU. Factors that have influenced this increased extinction risk include extreme drought and poor ocean conditions over the past several years, a sustained rate of decline in abundance over the past decade, a limited spatial distribution of the remaining population, and the large influence of the hatchery produced juveniles on the genetic diversity of the population. Many of the factors originally identified as being responsible for the decline of this ESU are still present, though in some cases they have been reduced by regulatory actions (e.g., NMFS CVP/SWP biological opinion in 2019, an ocean harvest biological opinion in 2010, and actions implemented under the Central Valley Project Improvement Act. Despite efforts to reduce these and other threats (e.g., controlling water temperatures with cold water releases, annual spawning gravel augmentation, stabilizing mainstem flows, unimpeded fish passage at Red Bluff Diversion Dam, harvest restrictions, and reduction in Delta export pumping), the ESU has continued to decline in abundance.

The most recent 5-year review (NMFS 2016a) reports that the best available information on the biological status of the ESU and new threats to the ESU indicate that its ESA classification as an endangered species is appropriate and should be maintained. Long-term recovery of this ESU will require improved freshwater habitat conditions, abatement of a wide range of threats, and the establishment of additional spawning areas in Battle Creek and the McCloud River, as described in the 2014 Recovery Plan (NMFS 2014).

Designated critical habitat for Sacramento River winter-run Chinook salmon exists in the action area in the western portion of Reach 2 and all of Reach 3. The status of critical habitat is of a degraded nature and limited in the action area, but is considered to be of high value as all of the Sacramento River winter-run Chinook salmon population must pass through Reach 3 and the portion of the western Delta adjacent to the Sherman Island occupied by Reach 2. The status of designated critical habitat for Sacramento River winter-run Chinook salmon has been described in Sections 2.2 and 2.4.2 of this opinion.

2.7.2 Status of CV Spring-run Chinook Salmon and Critical Habitat

In the 2016 status review (NMFS 2016b), NMFS found, with a few exceptions, that CV spring-run Chinook salmon populations have generally increased through the 2013 returns (23,696 fish total including hatchery fish), but then sharply declined in 2014 (9,901 total fish including hatchery fish; the last escapement numbers available to the Technical Recovery Team (TRT) since the last status review in 2010/2011(NMFS 2011b). Based on these escapement numbers, the 2016 status review changed the status of the Mill and Deer creek populations from the high extinction risk category, to moderate, while keeping the Butte Creek in the low risk of extinction category. Additionally, the Battle Creek and Clear Creek populations continued to show stable or increasing numbers in that period, putting them at moderate risk of extinction based on abundance. Overall, the TRT (NMFS 2016b) found that the status of CV spring-run Chinook salmon (through 2014) had probably improved since the 2010/2011 status review and that the ESU's extinction risk may have decreased.

However, between 2015 and 2018, adult escapement was low and the extinction risk is likely to have increased during this period. The low adult escapement trend was somewhat reversed in 2019, when over 20,000 adult spring-run Chinook salmon returned to the Central Valley river systems, compared to a 5-year average of approximately 5,800 fish from 2014 to 2018 (CDFW 2020).

Designated critical habitat for CV spring-run Chinook salmon exists in the action area in all of Reach 3. The status of critical habitat is of a degraded nature and limited in the action area, but is considered to be of high value as all of CV spring-run Chinook salmon population must pass through Reach 3. The status of designated critical habitat for CV spring-run Chinook salmon has been described in Sections 2.2 and 2.4.2 of this opinion.

2.7.3 Status of CCV Steelhead

The 2016 status review (NMFS 2016c) concluded that overall, the status of CCV steelhead appears to have changed little since the 2011 status review (NMFS 2011c) when the TRT concluded that the DPS was in danger of extinction. Furthermore, there is still a general lack of data on the status of wild populations. The Central Valley population of steelhead still faces the loss of the majority of the historical spawning and rearing habitat due to dams and other passage impediments, as well as the other factors previously described for their decline. There are some encouraging signs however, as several hatcheries in the Central Valley have experienced increased returns of steelhead over the last few years. There has also been a slight increase in the percentage of wild steelhead in salvage at the CVP/SWP Fish Salvage Facilities, and the percentage of wild fish in those data remains much higher than at Chipps Island. The new video counts at Ward Dam show that Mill Creek likely supports one of the best wild steelhead populations in the Central Valley, though at much reduced levels from the 1950s and 60s. Restoration efforts in Clear Creek continue to benefit CCV steelhead. However, the catch of unmarked (wild) steelhead at Chipps Island is still less than 5 percent of the total smolt catch, which indicates that natural production of steelhead throughout the Central Valley remains at very low levels. Despite the positive trend on Clear Creek and encouraging signs from Mill Creek, all other concerns raised in the previous status review remain.

Designated critical habitat for CCV steelhead exists in the action area in all of the reaches. The status of critical habitat is of a degraded nature and limited in the action area, but is considered to be of high value as all of CCV steelhead population must pass through Reach 3. All CCV steelhead originating in the San Joaquin River basin must pass through reaches 1 and 2. The status of designated critical habitat for CCV steelhead has been described in Sections 2.2 and 2.4.2 of this opinion.

2.7.4 Status of sDPS North American Green Sturgeon

The viability of sDPS green sturgeon is constrained by factors such as a small population size, lack of multiple populations, and concentration of spawning sites into just a few locations. The risk of extinction is believed to be moderate because, although threats due to habitat alteration are thought to be high and indirect evidence suggests a decline in abundance, there is much uncertainty regarding the scope of threats and the viability of population abundance indices (NMFS 2015). In 2018, NMFS issued its Recovery Plan for sDPS green sturgeon (NMFS 2018).

Only one population of sDPS green sturgeon currently exists, and that occurs only in the Sacramento River basin. Lindley et al. (2007), in discussing winter-run Chinook salmon, states that an ESU represented by a single population at moderate risk of extinction is at high risk of extinction over the long run. This concern applies to any DPS or ESU represented by a single population, and if this were to be applied to sDPS green sturgeon directly, then sDPS green sturgeon face a high extinction risk. However, the position of NMFS, upon weighing all available information (and lack of information) has stated the extinction risk to be moderate (NMFS 2015).

Recent observations of green sturgeon spawning in the Feather River (Seeholtz et al. 2015) and Yuba River (CDFW 2018) at least indicate that green sturgeon will make opportunistic use of other watersheds for spawning if conditions are appropriate. Furthermore, verified observations by professional fisheries biologist of adult green sturgeon in the San Joaquin River system upstream of the Delta have occurred recently [Stanislaus River (October 2017) and within the mainstem of the San Joaquin River above the confluence with the Merced River (April 2020)] indicating that green sturgeon make opportunistic use of the San Joaquin River watershed and its tributaries, however no spawning has been observed.

There is a strong need for additional information about sDPS green sturgeon, especially with regards to a robust abundance estimate, a greater understanding of their biology, and further information about their micro- and macro-habitat ecology.

Designated critical habitat for sDPS green sturgeon exists in the action area in all of the reaches. The status of critical habitat is of a degraded nature and limited in the action area, but is considered to be of high value as individuals must migrate through Reach 3 and have the potential to use waters in reach 1 and 2 for rearing and migration. The status of designated critical habitat for sDPS green sturgeon has been described in Sections 2.2 and 2.4.2 of this opinion.

2.7.5 Status of Environmental Baseline and Cumulative Effects in the Action Area

Sacramento River winter-run and CV spring-run Chinook salmon, CCV steelhead, and sDPS green sturgeon use the action area as an upstream and downstream migration corridor from the ocean to the Central Valley watersheds and for rearing. Within the Delta portion of the action area, the freshwater habitats for salmon, steelhead and green sturgeon have been transformed from meandering waterways lined with dense riparian vegetation, to a highly leveed system. Levees have been constructed near the edge of the river and sloughs and most floodplains have been completely separated and isolated from the river. Severe long-term riparian vegetation losses have occurred throughout the Delta, and there are large gaps along leveed shorelines devoid of riparian vegetation due to the high amount of riprap. The change in the ecosystem as a result of halting the lateral migration of the river channels, the loss of floodplains, and the removal of riparian vegetation and IWM have negatively affected the functional ecological processes that are essential for growth and survival of Sacramento River winter-run and CV spring-run Chinook salmon, CCV steelhead, and sDPS green sturgeon in the action area. Within the estuarine portion of the action area (Reach 3), the artificially dredged and maintained shipping channel has replaced the naturally meandering flooded river channel running through the bays with a linear trapezoidal shaped channel, reducing the variability of habitat and depth along its length. Both commercial and non-commercial development has altered the natural shoreline habitat of the estuary, substantially reducing fringing marshlands.

The Cumulative Effects section of this opinion describes how continuing or future effects such as the agricultural transformation of the land within the action area, increased runoff and non-point source contaminants, armoring of levees and shoreline modifications, and increased urbanization affect the species in the action area. These actions typically result in habitat fragmentation, and conversion of complex nearshore aquatic habitat to simplified habitats that incrementally reduces the carrying capacity of the rearing and migratory corridors.

2.7.6 Summary of Project Effects on Listed Salmonids and Green Sturgeon

2.7.6.1 Construction-Related Impacts

NMFS does not anticipate that any Sacramento River winter-run Chinook salmon or CV spring-run Chinook salmon will be present in the action area adjacent to the Lehigh Hanson facility at any time during the in-water work window (July 1 to November 30). Since no individuals from these two ESUs are anticipated to be exposed to the pile driving or removal of creosote treated pilings, there will be no behavioral modifications, injury, or death expected as a result of this component of the Project and no effect upon their respective populations. In contrast, individuals from the San Joaquin River basin populations of CCV steelhead (primarily adults) and individual sDPS green sturgeon (juveniles and adults) are expected to be present during the in-water work window in the action area adjacent to the Lehigh Hanson facilities during pile driving and the cutting off and removal of the creosote treated wooden pilings. Most fish will be exposed to levels of sound that will cause behavioral changes but will not result in injury or death. However, a small proportion of fish adjacent to the Lehigh Hanson facility are expected to be in proximity to the pile driving to be exposed to sound levels that can cause injury or death. NMFS anticipates that this will be a small number of fish.

Exposure to the release of contaminant tainted sediments contained in turbidity plumes related to the cutting off of creosote treated pilings is also expected to be limited and brief. Any turbidity plume is expected to dissipate and settle out of the water column quickly. Exposure to the contaminated sediments in the turbidity plume is expected to cause a slight diminishment in physiological status of the exposed fish as the contaminant is transformed within the liver and other organ systems of the exposed fish to less toxic metabolites which can be excreted. Exposed fish are expected to recover quickly on their own, through metabolic breakdown of the contaminants following the short exposure period. The likelihood of CCV steelhead exposure to the construction-related effects is greatest in the latter half of the in-water construction period (mid-September through the end of November) due to the increasing presence of adult fish swimming upriver to their spawning reaches in the San Joaquin River basin. Individuals from the sDPS of green sturgeon are present year-round in the action area, including the waters adjacent to the Lehigh Hanson facilities.

In contrast to the short-term construction effects, the long-term leeching of creosote-related contaminants (mostly PAHs) from the freshly cut creosote treated wooden pilings will expose adult and juvenile CCV steelhead and CV spring-run Chinook salmon from the San Joaquin River basin, as well as adult and juvenile sDPS green sturgeon, to these chemicals when they are present in the waters adjacent to the Lehigh Hanson facilities. A small number of these exposed fish are likely to have exposures of sufficient duration to result in temporary diminishment of their physiological status as the toxic materials are metabolized to less toxic compounds that can be excreted by the fish. An even smaller number of fish will have prolonged exposures that can lead to permanent physiological declines in their health such as manifested in reduced organ performance, reduced immune function or formation of neoplasias which may become malignant.

2.7.6.2 Shipping-Related Impacts

The long-term effects of the Project, which are related to the increases in shipping traffic to the Lehigh Hanson facilities in the Port of Stockton, are expected to result in a small level of adverse effects, including harm and mortality, to individual Sacramento River winter-run Chinook salmon, CV spring-run Chinook salmon, CCV steelhead, and sDPS of North American green sturgeon that are present in the action area. For Chinook salmon and steelhead, exposure and adverse effects will primarily be to juvenile life history stages. These effects include the impacts related to noise, ship-induced waves, and propeller entrainment as described in Section 2.5.2 of this opinion. In contrast, NMFS expects that most exposure and adverse effects to sDPS green sturgeon will be to adult life stages. Adult sturgeon are particularly vulnerable to ship strikes and propeller entrainment as described in Section 2.5.2.3.2 of this opinion.

2.7.7 Risks to Population Groups/ Diversity Groups

2.7.7.1 Construction–Related Impacts

Adult CCV steelhead encountering the effects of in-water construction adjacent to the Lehigh Hanson facility in Reach 1 will originate from the Southern Sierra Nevada Diversity Group. This includes CCV steelhead populations from the Stanislaus, Tuolumne, and Merced rivers below the first dam, as well as the Calaveras River watershed below New Hogan Dam. Individuals from these watersheds are likely to be present at some point in time during the in-water work window (July 1 through November 30). The probability of their presence increases after mid-September as adults start entering the basin's watersheds to reach their spawning grounds and are present in the action area adjacent to the Lehigh Hanson facility. The small number of fish that experience injuries and death associated with the pile driving and piling cutoff actions will belong solely to the Southern Sierra Nevada Diversity Group of the CCV steelhead. No other CCV steelhead population groups or diversity groups are expected to be present in this portion of Reach 1.

Over the long term, adults and juveniles from both the CCV steelhead population and CV spring-run Chinook salmon reintroduction population belonging to the Southern Sierra Nevada Diversity Group will have the potential to be exposed to the contaminants originating from the cutoff creosote treated pilings and their impacts on health. Exposure will occur during the fish's movements through the mainstem San Joaquin River as it passes through the Port of Stockton. The small number of fish that experience negative effects associated with the exposure to creosote related contaminants will belong solely to the Southern Sierra Nevada Diversity Group for these two species. No other populations or diversity groups of CCV steelhead or CV spring-run Chinook salmon are anticipated to be present in this portion of the action area at any time.

Adult and juvenile sDPS green sturgeon belong to one population group which primarily spawns in the Sacramento River mainstem. To date, there are no verified self-sustaining populations that spawn in other tributaries outside of the mainstem Sacramento River. Opportunistic spawning has been observed in the lower portions of the Feather River system and Yuba River system below the first dam impeding upstream passage. However these spawning events have not been consistently observed every year, and no verification that the individuals spawning in these tributaries to the Sacramento River are from unique, independent populations. Thus, all sDPS green sturgeon that have the potential to be present in the action area adjacent to the Lehigh Hanson facility belong to this one single population in the Central Valley. The pile driving-related effects are expected to injure or kill a very small number of fish, which will represent a small decline in the overall abundance of sDPS green sturgeon in the Central Valley. The number of fish exposed to the creosote contaminated sediments and pilings is expected to be a very small proportion of the entire green sturgeon population in the Central Valley. Exposure to the creosote released from the disturbance of sediments and the cutoff pilings is expected to temporarily diminish the health of exposed sDPS green sturgeon, however the vast majority of these fish are expected to recover fully after the contaminants are biotransformed to less toxic metabolites and excreted. Very infrequently will an exposed fish incur permanent health impairment from the exposures anticipated from this Project.

2.7.7.2 Shipping-Related Impacts

Shipping related impacts will occur within waters of the Delta and the San Francisco estuary where individuals from all existing populations of Sacramento River winter-run Chinook salmon, CV spring-run Chinook salmon, CCV steelhead and sDPS green sturgeon intermix and have the potential to be present within all or portions of the action area.

Sacramento River winter-run Chinook salmon are represented primarily by one spawning population below Keswick Dam. Although there are current efforts to re-establish a population of Sacramento River winter-run Chinook salmon in Battle Creek, this reintroduction population is still too nascent to be considered a self-sustaining population in its own right. Individuals from the single population will be exposed to shipping-related impacts in reaches 2 and 3 where their presence overlaps with the action area (shipping channel). Effects are greatest in Reach 2, where the shipping channel occupies a greater proportion of the available waterway for fish movement. However, only a fraction of the Sacramento River winter-run Chinook population will be found in Reach 2, as most fish remain in the Sacramento River migratory route and do not enter the action area until arriving in the western Delta and entering the San Francisco estuary at Chipps Island (i.e., Suisun Bay). Reach 3 of the action area (the federally maintained shipping channel) occupies only a small fraction of the waters available in the broad expanses of the bays. The likelihood of individuals from the Sacramento River winter-run Chinook salmon population overlapping with the alignment of the shipping channel (action area) is substantially reduced in relationship to the percentage of available habitat that can be occupied outside of the shipping channels. Thus, while a small number of Sacramento River winter-run Chinook salmon are displaced, predated upon, injured, or killed annually due to shipping–related impacts in the action area, the proportion of the entire annual population this represents is minimal.

In a similar fashion, the cumulative abundance of CV spring-run Chinook salmon and CCV steelhead populations are dominated by those individual populations originating in the Sacramento River basin and its tributaries. The Sacramento River basin contains three of the four Diversity Groups present in the Central Valley (Basalt and Porous Lava, Northwestern California, and the Northern Sierra Nevada diversity groups), and the majority of existing population groups for both species. As described for the Sacramento River winter-run Chinook salmon population, all of the populations from the Sacramento River basin will pass through the Delta into the San Francisco estuary, but only a fraction will be present in Reach 2, as most fish remain in the Sacramento River migratory route prior to entering Suisun Bay at Chipps Island and do not move through the Delta interior to the San Joaquin River and the action area. All members of the CV spring-run Chinook salmon and CCV steelhead populations will pass through the San Francisco estuary (Reach 3) during their migratory movements between the ocean and the Delta (adult and juvenile life stages). In contrast, individuals from the CV spring-run Chinook salmon and CCV steelhead populations that originate in the San Joaquin River basin (Southern Sierra Nevada Diversity Group) will have to move through all of Reach 2 and Reach 3 to gain access to the upper San Joaquin River basin above the Delta or the ocean depending on life stage. The majority of these fish will also pass through Reach 1, however, a fraction may pass through the South Delta via the Old and Middle river migratory routes and bypass a portion of Reach 1 leading to the Port of Stockton. Since most of the shipping-related impacts are expected to occur in reaches 1 and 2, there is a greater proportional impact to the populations of CV spring-run Chinook salmon and CCV steelhead from the Southern Sierra Nevada Diversity Group than occurs in the Sacramento River basin diversity groups. Overall, NMFS anticipates that a small number of CV spring-run Chinook salmon and CCV steelhead will be lost each year to shipping related impacts, with individuals potentially coming from any one of the existing populations in the Central Valley as they move through the action area. None of the populations existing in the three Diversity Group regions in the Sacramento River basin are expected to have a disproportionate vulnerability to the shipping-related impacts.

As described previously, the entire sDPS green sturgeon population belongs to one population group which primarily spawns in the Sacramento River below Keswick Dam. These fish are dispersed throughout the Delta and San Francisco estuary and are present in all three reaches of the action area as adults, sub-adults, and juveniles during different stages of their life histories. Overall, NMFS anticipates that a small number of sDPS green sturgeon will be lost each year to shipping-related impacts.

2.7.8 Risk to ESUs/DPSs

2.7.8.1 Sacramento River Winter-run Chinook Salmon

The Sacramento River winter-run Chinook salmon ESU is made up of one population, as previously described, with all individuals originating in the Sacramento River basin. The overall annual loss of individual Sacramento River winter-run Chinook salmon due to the Project will be small, and represents a minor fraction of the entire population of Sacramento River winter-run Chinook salmon present. Losses of adult and juvenile fish related to the Project will not substantively reduce the overall abundance of the Sacramento River winter-run Chinook salmon population. However, while impacts to the ESU’s abundance are low, the Project does not improve the status of the ESU or enhance its recovery. Since very few adult fish are expected to be lost, reproductive productivity is not expected to be altered in a meaningful way for the ESU. The loss of these few adults represents a small fraction of the potential adult escapement spawning stock, but the loss still represents a diminished potential in productivity. Likewise, since the entire ESU is represented by one spawning population, any losses will come from this one population, and will not represent a loss of spatial structure or diversity. However, like abundance or productivity, the Project does not improve spatial structure or diversity, which is needed to achieve the recovery goals for Sacramento River winter-run Chinook salmon. The Recovery Plan (NMFS 2014) criteria includes 3 self-sustaining populations of Sacramento River winter-run Chinook salmon be established in the Basalt and Porous Lava Diversity Group region that are at a low risk of extinction; currently there is one with heavy support from the conservation hatchery. The Project impacts related to construction and shipping are unlikely to affect the establishment of these groups since the loss of individual fish will be very small compared to the current population size. However, no components of the Project would enhance the creation of these additional populations, and thus enhance the potential for recovery for the Sacramento River winter-run Chinook salmon ESU.

In summary, when added together with the status of the species, the environmental baseline, the cumulative effects, the minimal and more adverse effects of the action, the Project is not likely to reduce appreciably the likelihood of both the survival and recovery of Sacramento River winter-run Chinook salmon in the wild by reducing its numbers, reproduction, or distribution.

2.7.8.2 CV Spring-run Chinook Salmon

The CV spring-run Chinook salmon ESU is represented by multiple population groups, all but one of which are currently in the Sacramento River basin and within the three Diversity Groups previously described. There is one experimental population within the San Joaquin River basin that is still nascent and has not become self-sustaining. Only one of the population groups in the ESU is considered viable with a low risk of extinction (Butte Creek), while nine are needed according to the recovery criteria (NMFS 2014).

The majority of the CV spring-run Chinook salmon population emigrating through the Delta and San Francisco estuary originates in the Sacramento River basin. Only a small fraction of these fish will be affected by the Project as described in the previous section. Annual losses of juvenile CV spring-run Chinook salmon related to the Project's shipping-induced impacts will be a small proportion of the entire ESU moving through the Delta each year. Thus, the amount of loss associated with the Project should not have a demonstrable impact on the abundance of juvenile CV spring-run Chinook salmon out-migrating from the ESU. Likewise, the very small numbers of adult fish that may be lost to ship-related effects will not noticeably alter the abundance or productivity of the ESU. However, the Project does not improve the status of the ESU's abundance or productivity or chances of recovery either. Likewise, the Project does not improve the status of the spatial structure or diversity of the ESU. The Project represents a chronic, yet very small negative strain on the ESU's viability.

Losses of fish from the Southern Sierra Nevada Diversity Group are unlikely to alter the viability of the entire ESU, but they may impede the ability of the ESU to recover over the long term. The Recovery Plan (NMFS 2014) requires that 2 self-sustaining populations of CV spring-run Chinook salmon be established in the Southern Sierra Nevada Diversity Group region with a low risk of extinction. One of these is the experimental population below Friant Dam, the other population can be in any one of the candidate watersheds (i.e., Stanislaus, Tuolumne, or Merced rivers below the rim dams, or any of the watersheds above the main dams). The disproportionate loss of individuals from the Southern Sierra Nevada Diversity Group in relation to the effects of the Project impedes the progress needed to re-establish these self-sustaining populations in the San Joaquin River basin, and thus hinders the attainment of the goals necessary to meet the Recovery Plan's criteria for de-listing of the ESU.

In summary, when added together with the status of the species, the environmental baseline, the cumulative effects, the minimal and more adverse effects of the action, the Project is not likely to reduce appreciably the likelihood of both the survival and recovery of CV spring-run Chinook salmon in the wild by reducing its numbers, reproduction, or distribution.

2.7.8.3 CCV steelhead

Similar to the CV spring-run Chinook salmon ESU, the CCV steelhead DPS is represented by multiple populations throughout the Central Valley in both the Sacramento River and the San Joaquin River basins. And like the CV spring-run Chinook salmon ESU, the majority of these populations are also located in the Sacramento River watershed and its tributaries. Very few populations of CCV steelhead remain in the San Joaquin River basin. For almost all of the populations comprising the CCV steelhead DPS, the extinction risk is either high or unknown. For the CCV steelhead DPS, the Recovery Plan (NMFS 2014) criteria includes the establishment of 9 populations at a low risk of extinction in the Central Valley.

Similar to the CV spring-run Chinook salmon ESU, the majority of the CCV steelhead population migrating through the Delta and San Francisco estuary originates in the Sacramento River basin. Only a small fraction of these fish will be affected by the Project as described previously. The cumulative annual loss of juvenile fish related to the Project (construction and shipping) from all of these populations will be small compared to the entire DPS population of juvenile CCV steelhead moving through the Delta each year. Thus, the amount of loss associated with the Project should not have a demonstrable impact on the abundance of juvenile CCV steelhead out-migrating from the DPS. Likewise, the very small numbers of adult fish that may be lost to construction or ship-related effects will not noticeably alter the abundance or productivity of the DPS. However, while annual losses are small, the Project does not improve the status of the DPS's abundance or productivity either. Likewise, the Project does not improve the status of the spatial structure or diversity of the DPS. The Project represents a chronic, yet very small negative strain on the DPS's viability.

Similar to CV spring-run Chinook salmon, losses of fish from the Southern Sierra Nevada Diversity Group are unlikely to alter the viability of the entire DPS, but they may impede the ability of the DPS to recover over the long term. The Recovery Plan (NMFS 2014) requires that 2 self-sustaining populations of CCV steelhead be established in the Southern Sierra Nevada Diversity Group region with a low risk of extinction. There are currently three Core 2 populations in the Southern Sierra Nevada Diversity Group region residing in the Stanislaus, Tuolumne, and Merced rivers below the rim dams and one Core 1 population in the Calaveras River below the New Hogan Reservoir dam, all of which are represented by very low population numbers. The disproportionate loss of individuals from the Southern Sierra Nevada Diversity Group in relation to the effects of the Project impedes the progress needed to re-establish these self-sustaining populations in the San Joaquin River basin, and thus hinders the attainment of the goals necessary to meet the Recovery Plan's criteria for de-listing of the ESU.

In summary, when added together with the status of the species, the environmental baseline, the cumulative effects, the minimal and more adverse effects of the action, the Project is not likely to reduce appreciably the likelihood of both the survival and recovery of CCV steelhead in the wild by reducing its numbers, reproduction, or distribution.

2.7.8.4 sDPS Green Sturgeon

Like the Sacramento River winter-run Chinook salmon ESU, the sDPS of North American green sturgeon is represented by one spawning population in the Sacramento River, with occasional opportunistic spawning in the Feather and Yuba rivers. The overall cumulative annual loss of individual sDPS green sturgeon due to the Project will be small, and represents a minor fraction of the entire population of the sDPS green sturgeon present which includes juveniles, sub-adults and adults. The majority of these losses will be due to interactions with shipping, primarily ship strikes and propeller entrainment. However, while the cumulative numbers of fish lost may be small compared to the entire population, the fraction that is lost represents an important segment of the population, adult fish typically of reproductive age. The loss of adult sDPS green sturgeon can have measurable effects on future population levels. Since sturgeon are a long lived species with late sexual maturity, the loss of any sexually mature adult, particularly large females, can have substantial negative effects on the future abundance and productivity of the DPS. Large females have large numbers of eggs, and represents a sizeable source of potential progeny during each spawning event. This coupled with the potential for multiple spawning events during the long lifetime of an adult, represents a sizeable loss of reproductive potential over many years. This is offset to some degree by the recruitment of subadult fish into the reproductive population as they mature sexually and the reduction of loss through the banning of commercial and recreational fishing upon the sDPS green sturgeon population. The low level of loss of adult sDPS green sturgeon each year to ship strikes however, still represents a constant negative pressure on the viability of the population.

The Recovery Plan for sDPS green sturgeon (NMFS 2018) requires a running yearly average of at least 813 spawners annually for 3 generations (approximately 66 years) with an effective population size of at least 500 adult individuals in any given year. The census population is required to remain at or above 3,000 adult individuals for 3 generations. The sDPS population should have successful spawning in at least 2 rivers within their historical range with annual presence of larvae for at least 20 years. Continued losses of adults to ship strikes and propeller entrainment hinder the achievement of the Recovery Plan goals by constantly reducing the number of adults in the population, thus prolonging the time it will take to reach the delisting criteria.

In summary, although the Recovery Plan for sDPS green sturgeon (NMFS 2018) ranked the threat of ship propeller strikes as a low risk to the recovery of the species with a low level of data sufficiency, the additional information provided by recent studies regarding the impact of commercial shipping upon sturgeon populations in other regions of the world is a concern to NMFS regarding the future of the sDPS green sturgeon population. The small numbers of fish lost annually from the sDPS green sturgeon population due to the effects of the Project will not substantially reduce the viability of the entire DPS, but it will slow the recovery of the species through the additional loss of reproductive age individuals. Therefore, when added together with the status of the species, the environmental baseline, the cumulative effects, the minimal and more adverse effects of the action, the Project is not likely to reduce appreciably the likelihood of both the survival and recovery of sDPS green sturgeon in the wild by reducing its numbers, reproduction, or distribution.

2.7.9 Summary of Project Effects on Designated Critical Habitat

Within the action area, there is designated critical habitat for Sacramento River winter-run Chinook salmon, CV spring-run Chinook salmon, CCV steelhead, and sDPS green sturgeon. Reach 1 of the action area (the San Joaquin River – Stockton DWSC from the Port of Stockton to Prisoners Point) contains designated critical habitat for CCV steelhead and sDPS green sturgeon; it does not include designated critical habitat for Sacramento River winter-run Chinook salmon or CV spring-run Chinook salmon. The lower end of Reach 2 of the action area (San Joaquin River – Stockton DWSC from Prisoners Point to the Chipps Island, including New York Slough) contains designated critical habitat for Sacramento River winter-run Chinook salmon (waters surrounding Browns, Kimball, and Winter islands and Delta waters west of Sherman Island) as well as designated critical habitat for CCV steelhead and sDPS green sturgeon along its entire length. The waters of Suisun Bay, San Pablo Bay, and the northern part of San Francisco Bay (Reach 3) are designated as critical habitat for all four species.

The Project will temporarily degrade the functionality of designated critical habitat PBFs during pile driving and the passage of ships along the alignment of the shipping channels within the action area. The Project is anticipated to have adverse impacts upon the freshwater rearing sites, freshwater migration corridors, and estuarine areas for designated critical habitat for the three listed salmonid species. The Project will have adverse effects upon freshwater and estuarine areas of the designated critical habitat for sDPS green sturgeon. Effects of the Project upon designated critical habitats has been assessed in Section 2.5.3 of this opinion. These will be temporary effects, as once the pile driving stops, or the ships have moved through a particular reach of the shipping channel, environmental conditions will return to the pre-disturbance state within a short period of time, (i.e., sound associated with the pile driving will stop, ship-induced waves will attenuate and diminish to back ground levels).

However, the frequency of ship passage can create a pseudo-persistent disturbance within the ship channel where it overlaps with areas of critical habitat. The more frequent the disturbance, the less time there is to have biotic and abiotic factors return to baseline conditions. When the period between the passages of ships through a given area of the ship channel is shorter than the period it takes for suspended sediments to settle out of the water column or aquatic biota to return to the habitat it was displaced from, then the effects of shipping become a constant disturbance with permanently-altered habitat characteristics.

The frequency of shipping related to the Project is on the order of one transit every 5 days as previously described (6 trips per month) which is much longer than the period of time it would take to have shipping disturbed habitat conditions return to baseline. However when coupled with environmental baseline shipping traffic from the Port of Stockton, the frequency of shipping traffic is approximately 1.4 ship transits per day. This frequency is still less than the frequency shown to cause large scale permanent alterations in habitat that would negatively impact its function as designated critical habitat (see Section 2.5.2.2) although some transitory effects are anticipated. At the levels anticipated for the Project, these disturbances would temporarily impact the ability of the designated critical habitat for CCV steelhead habitat to provide freshwater rearing and migratory corridors in the action area. It would also negatively impact the ability of estuarine areas for the listed salmonids to provide unobstructed migration. Likewise for designated critical habitat for sDPS green sturgeon, impacts would be temporary, but would also affect freshwater and estuarine areas by creating obstructions to migration and degrading water quality.

These transitory effects are limited to the immediate vicinity of the shipping channel in reaches 1 and 2 where the ship-induced effects are greatest. Farther from the channel alignment in reaches 1 and 2, the natural channels, sloughs, side channels and mid-channel islands break up the effects of ship-induced waves providing habitat that is slightly disturbed to non-disturbed. This habitat, which is within the area designated as critical habitat for CCV steelhead and sDPS green sturgeon, is unaffected by the Project and provides habitat equivalent to the environmental baseline conditions. Overall the designated critical habitat for CCV steelhead and sDPS green sturgeon within reaches 1 and 2 of the action area retain their functionality and provide the values of habitat for the conservation of the species.

Within Reach 3 of the action area, the ship channel alignment comprises a very small proportion of the habitat required for migration corridors, food resources, and water quality at the designation scale for all four listed species. The extent of effects related to shipping-induced impacts does not extend very far away from the channel alignment. Thus, most of the designated critical habitat for Sacramento River winter-run Chinook salmon, CV spring-run Chinook salmon, CCV steelhead, and sDPS green sturgeon within Reach 3 of the action area remains unaffected by the Project and retains its current condition and functionality of migration corridors, water quality and food resources to support fish.

In summary, the anticipated effects of the Project upon designated critical habitat when added together with the status of the critical habitat, the environmental baseline, the cumulative effects, the minimal and more adverse effects of the action, the Project is not likely appreciably diminish the value of designated critical habitat as a whole for the conservation of the species.

2.8 Conclusion

After reviewing and analyzing the current status of the listed species and critical habitat, the environmental baseline within the action area, the effects of the Project, the effects of other activities caused by the Project, and cumulative effects, it is NMFS' biological opinion that the issuance of permits by the USACE for the Lehigh Southwest Stockton Terminal Project is not likely to jeopardize the continued existence of Sacramento River winter-run Chinook salmon, CV spring-run Chinook salmon, CCV steelhead, and sDPS of North American green sturgeon. The Project is not likely to result in the destruction or adverse modification of designated critical habitat for Sacramento River winter-run Chinook salmon, CV spring-run Chinook salmon, CCV steelhead, or the sDPS of North American 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 opinion, NMFS determined that incidental take is reasonably certain to occur as follows:

2.9.1.1 Construction Related Incidental Take

NMFS anticipates incidental take of CCV steelhead and sDPS green sturgeon in the action area through the implementation of the proposed Project's construction actions. Construction actions will take place at the Lehigh Hanson Berth 2 facilities in the Port of Stockton, which is located in the uppermost section of Reach 1 of the action area. Because of the proposed timing of the in-water work for the construction phase of the Project, actual numbers of fish adversely affected by the construction actions are expected to be low. Only adult CCV steelhead and juvenile and adult sDPS green sturgeon will be present in Reach 1 of the action area in any substantial numbers during the construction period. However, they may not always be present at the Lehigh Hanson construction site during actual construction due to the variability in their spatial and temporal distribution within the action area. Only very small numbers of individual juvenile CCV steelhead from the Southern Sierra Nevada diversity group are expected to be present in the action area adjacent to the Berth 2 location during the construction period.

However, while individual fish will be present in the area adjacent to the Lehigh Hanson facilities, NMFS cannot, using the best available information, precisely quantify and track the amount or number of individuals that are expected to be incidentally taken (injure, harm, kill, etc.) per species as a result of the Project. This is due to the variability and uncertainty associated with the response of listed species to the effects of the Project, the varying population size of each species, annual variations in the timing of spawning and migration, individual habitat use within the action area, and difficulty in observing injured or dead fish. However, it is possible to estimate the extent of incidental take by designating as ecological surrogates, those elements of the Project that are expected to result in incidental take, that are more predictable and/or measurable, with the ability to monitor those surrogates to determine the extent of take that is occurring.

The most appropriate threshold for incidental take, is an ecological surrogate of habitat disturbance, which includes the factors (e.g., pile driving associated with the Project) causing fish to relocate and rear in other locations and reduce the carrying capacity of the existing habitat. NMFS will describe (1) the causal link between the surrogate and take of the species; (2) why it is not practical to express the amount of anticipated take or to monitor take related impacts in terms of individuals of the listed species; and (3) sets a clear standard for determining when the amount or extent of the taking has been exceeded.

The behavioral modifications of fish responses that result from the habitat disturbance are described below. NMFS anticipates annual take during the 2 years of construction activities in Phases 2 and 4, will be limited to the following forms:

Incidental take of adult CCV steelhead, and juvenile and adult sDPS green sturgeon is expected to occur during the 5-month construction period occurring between July 1 and November 30 as a result of exposure to the noise generated by pile driving activities. Quantification of the number of fish exposed to the pile driving associated noise and turbidity is not currently possible with available monitoring data. All fish present during construction activities are expected to be exposed to pile driving noise disturbance. Only the level of acoustic noise generated during the pile driving phases of the Project can be accurately and consistently measured, thus providing a quantifiable metric for determining incidental take of listed fish. Therefore, the measurement of acoustic noise generated during the impact pile driving of the concrete piles described in the proposed Project, will serve as a physically measurable surrogate for the incidental take of listed fish species. The numbers and types of piles to be installed, as well as the anticipated number of strikes per pile, were described previously in section 2.5.1.1 and 2.5.1.1.1.

Adjusted source sound metrics for 18-inch concrete piles driven in 10 meters of water (unattenuated):

- The $SEL_{accumulated}$ is 193.6 dB at 10 meters (33 feet) and the calculated distance to each of the applicable thresholds is as follows:
  - Distance to 206 dB-peak = 1 meter (3.3 feet)
  - Distance to 150 dB-RMS = 185 meters/ 607 feet
  - Distance to 187 dB-$SEL_{accumulated}$ = 27 meters/ 89 feet (for fish > 2 g)
  - Distance to 183 dB-$SEL_{accumulated}$ = 34 meters/ 112 feet (for fish < 2 g)

If any of sound thresholds at the specified distances (derived from the NMFS spreadsheet values) are exceeded, the proposed Project will be considered to have exceeded anticipated take levels, triggering the need to reinitiate consultation on the Project.

For the incidental take associated with the continued exposure of the aquatic habitat to contaminants leaching from cut off creosote treated wood piles, NMFS will use the number of wooden piles to be removed that are located in-water as the environmental surrogate for estimating the magnitude of exposure. The number of piles left in the sediment provides a measure of the size of the contaminant source. Since all of the wooden piles have the same diameter (14-inches) and presumably have the same likelihood of leaching creosote derived contaminants, the greater the number of piles, the larger the reservoir of potential contaminants that can leach out. The Project states that 56 creosote piles will be cut off at the mudline and the stumps left in the water. If the number of creosote piles left in the water is greater than this, the proposed Project will be considered to have exceeded anticipated take levels, triggering the need to reinitiate consultation on the Project.

2.9.1.2 Shipping-Related Incidental Take

Several of the stressors examined in the effects section are related to the expected increase in the frequency of shipping in the federally maintained shipping channels leading to the Lehigh Hanson facilities, which are associated with the Project. Incidental take associated with the noise produced by shipping, the changes to fish community structure along navigational channels, the creation of turbulence and turbidity associated with ship wakes, and the stranding of fish along shorelines adjacent to the shipping channels is linked to the frequency of ships moving through the ship channels. Increases in vessel traffic lead to increases in these stressors. Finally, the risk of ship strikes and propeller entrainment to fish increases with the frequency of ship traffic. The greater the number of ship transits, the greater the risk of a fish interacting with a ship's hull or its propeller, all other factors remaining equal.

For the incidental take associated with the increase in ship traffic, NMFS used the following parameters to assess the potential impacts to salmonids and green sturgeon related to the frequency of shoreline disturbances and the modelled magnitude of propeller entrainment:

- Maximum number of annual ship visits to the Lehigh Hanson facilities annually = 36 visits
- Maximum number of ship visits to the facilities per month = 3
- Typical ship dimension calling on the Lehigh Hanson facilities
    - 50,000 dwt
    - Length 190 m (624 ft)
    - Beam 32 m (106 ft)
    - Draft 11-12 m (36-39 ft) (used to estimate propeller diameter)
    - Propeller diameter 7-7.6 m (23-25 ft) (used for entrainment calculations)

If the number of expected annual or monthly ship visits to the Lehigh Hanson facilities are exceeded, or the draft of the typical ship exceeds what was modeled, then the proposed Project will be considered to have exceeded anticipated take levels, triggering the need to reinitiate consultation on the Project.

2.9.2 Effect of the Take

In the opinion, NMFS determined that the amount or extent of anticipated take, coupled with other effects of the Project, is not likely to result in jeopardy to the species or destruction or adverse modification of critical habitats.

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).

1. Measures shall be taken by the USACE or their permittees to minimize or avoid deleterious impacts of pile driving and the removal of creosote treated piles during construction actions upon listed CCV steelhead or sDPS green sturgeon.

2. The USACE and its Permittee shall coordinate with, and support studies by Federal, State, and local agencies which develop information regarding salmonid and green sturgeon usage, movements, and behaviors within the waters of the Delta and San Francisco Estuary in relation to shipping channels.

3. The USACE and its permittee shall prepare and provide NMFS with plans and reports describing how impacts of the incidental take on listed species in the action area will be monitored and documented.

2.9.4 Terms and Conditions

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

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

    a. Impact hammers may be used from July 1 to September 15 of the in-water work window to drive pilings without the use of additional methods to start the piles. From September 16 through November 30, piles shall be started with a vibratory hammer and driven until resistance, then an impact pile driving hammer can be used to set the pile to the required tip depth or load bearing criteria required by the engineering designs.

    b. Acoustic monitoring shall occur throughout the duration of pile driving activities in accordance with the Federal Highway Working Group's (FHWG) Underwater Noise Monitoring Plan template.

    c. Initial acoustic sound measurements shall be taken at the standard reference distance and depth to verify the initial pile characteristics are valid.

    d. Sound measurements shall be taken in the field at the distances determined in the NMFS spreadsheet calculations for 183 dB and 187 dB SEL effects and at the distance estimated for 150 dB RMS behavioral effect for the first and last piles driven each day. The USACE and its permittee shall immediately notify NMFS if thresholds measured at the specified distances are exceeded. Pile driving activities shall be suspended until NMFS, USACE, and its permittee have determined an appropriate corrective action.

    e. The USACE and its permittee shall implement the EPA guidelines for the removal of creosote treated piles from aquatic environments. Guidelines available at:

       EPA Creosote Treated Pile Removal Guidelines

    f. The entire creosote treated pile shall be removed unless it is shown that complete removal is impossible after multiple attempts using the techniques described in the EPA guidelines. USACE and permittee shall provide documentation of the multiple extraction attempts and their failures to NMFS at the address in Term and Condition 3.a below prior to resorting to cutting off the piling.

    g. Creosote treated piles shall be removed using a vibratory hammer. This is the preferred method in the EPA guidelines and shall be used before any other method is attempted.

    h. Cutting off of creosote treated piles shall be considered the last resort technique of removal after trying vibratory, direct pull, and/or clamshell bucket extraction. Documentation of failed attempts using other methods are required to be provided to

NMFS before piles can be cut off.

i. If piles must be cutoff, the piling shall be cutoff below the mudline. A minimum of 1 foot below the mudline is required for piles in more than 10 feet of water (MLLW), and a minimum of 2 feet below the mudline is required in waters shallower than 10 feet (MLLW).

j. Hand excavation is required to remove the sediment surrounding the creosote treated pile if it is to be cutoff below the mudline.

k. Sediment curtains are required to surround the in-water work area in which the creosote treated piles are being extracted to minimize or eliminate the spread of suspended sediments to areas outside of the work area.

l. During any in-water construction activities, the permittee shall monitor the waters surrounding the Lehigh Hanson Berth 2 for the observation of any dead, moribund, or erratically behaving salmonid or sturgeon species within 185 meters (607 feet) of the Project work area. Any observation of such fish will be immediately reported to NMFS within 24 hours at the email address provided in Term and Condition 3.a below. Any dead fish shall be collected in accordance with Term and Condition 3 and held for personnel from the NMFS CCV Office, or NOAA Office of Law Enforcement to retrieve or sent to the address provided.

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

a. The USACE and its permittee shall provide support to install, operate, and maintain acoustic receiver stations within the San Joaquin River, New York Slough, Suisun Bay, Carquinez Strait, San Pablo Bay, and the northern and southern portions of San Francisco Bay adjacent to the federally maintained navigational channels to monitor the movements, usage, and behavior of acoustically-tagged salmonids and green sturgeon within, and adjacent to these channels.

b. The USACE and its permittee shall coordinate with Federal, State, and local agencies in the implementation of acoustic tag studies within the Delta and San Francisco estuary to maximize the potential of these studies to add to the knowledge of the movements and usage of different habitats by listed salmonid species and green sturgeon to further development of habitat suitability modeling.

c. The USACE and its permittee shall develop a vessel passage monitoring plan which shall assess the impacts of shipping operations within the Stockton DWSC, and the federal navigation channels within the San Francisco Bay estuary to listed species. Impacts shall include both acoustic sound measurements of ship traffic and direct physical impacts from ship strikes and propeller entrainment. A draft study proposal shall be provided to NMFS for review no later than 6 months after receipt of this opinion at the email address in 3.a below. Upon acceptance of the study plan, the plan shall be implemented. Annual reports shall be sent to NMFS by March 31 for the previous calendar year. Take shall be reported to NMFS in accordance with Term and Condition 3.a.

d. The USACE and its permittee shall promote the use of the Sturgeon Carcass Sighting flyer to report the sightings of sturgeon carcasses observed in the Delta and San Francisco estuary to the California Sturgeon Research email site: CAsturgeonresearch@gmail.com.

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

a. Any information that is required to be submitted to NMFS per the Terms and Conditions of this biological opinion shall be sent electronically to the NMFS CCVO at the following e-mail address:

ccvo.consultations@noaa.gov

Any observations of mortalities or abnormal behavior shall immediately be reported to NMFS per the instructions in Term and Condition 3.a. within 24 hours. This information shall include species observed, life history stage, location (including GPS coordinates if available), number of fish observed, time of day, as well as any other relevant details that are available. If possible, mortalities shall be collected, frozen, individually labeled with appropriate information. Any dead specimen(s) should be placed in a cooler with ice and either held for pick up by NMFS personnel or an individual designated by NMFS to do so, or sent to:

NMFS Southwest Fisheries Science Center
Fisheries Ecology Division
110 Shaffer Road
Santa Cruz, California 95060

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 project on listed species or critical habitat or regarding the development of information (50 CFR 402.02).

1. The USACE and their permittee should use species recovery plans to help ensure that any mitigation measures proposed by them in the future will address the underlying processes that limit fish recovery by identifying high priority actions in the Central Valley and San Francisco estuary areas.

   The following Delta Recovery Actions represent actions from the NMFS Recovery Plan for winter-run Chinook salmon, CV spring-run Chinook salmon, and CCV steelhead (NMFS 2014) which identified the USACE as a potential partner and collaborator:

   - **Del 1.4.** Landscape level restoration of ecological functions in the Delta.
   - **Del 1.6.** Provide access to new floodplain habitat in the South Delta for salmonids from the San Joaquin River system.
   - **Del 1.7.** Restore, improve, and maintain salmonid rearing and migratory habitats

in the Delta.

- **Del 1.13 -1.17.** Restoration of tidal marsh habitat within the Delta at multiple locations.
- **Del 2.1.** Flood control improvements on the McCormick-Williamson Tract.
- **Del 2.2 – 2.11**. Riparian and tidal marsh habitat restoration actions throughout the Delta – sites with secondary priority action status.
- **Del 2.15**. Use alternatives to rip-rap for providing bank stabilization along Delta waterways.
- **Del 2.16.** Increase monitoring for and enforcement of illegal rip-rap applications in the Delta.

The final recovery plan for federally listed Central Valley salmonids is available at: NMFS Recovery Plan for Winter-run Chinook salmon, CV Spring-run Chinook salmon, and CCV Steelhead

The following are Recovery Actions and Research Priorities from the NMFS Recovery Plan for sDPS green sturgeon (NMFS 2018) which are San Francisco Bay Delta Estuary (SFBDE) centric.

- **Research Priority 2a (Priority 2).** Evaluate the effects of habitat modification and/or restoration (e.g., levee alteration, channel reconnection, floodplain connectivity measures) on green sturgeon recruitment and growth.
- **Recovery Action 5a (Priority 2).** Improve compliance and implementation of Best Management Practices (BMPs) to reduce input of point and non-point source contaminants within the Sacramento River Basin and San Francisco Bay Delta Estuary.
- **Monitoring Priority 3 (Priority 2***)*. Monitor trends in the annual production and habitat use of juvenile sDPS green sturgeon in the Sacramento River Basin and SFBDE.
- **Monitoring Priority 6 (Priority 3).** Use telemetry to monitor sDPS use of estuaries and coastal environments.

The final recovery plan for sDPS green sturgeon is available at: NMFS Recovery Plan for sDPS Green Sturgeon

2. The USACE should continue to work cooperatively with other State and Federal agencies, private landowners, governments, and local watershed groups to identify opportunities for cooperative analysis and funding to support salmonid and sturgeon habitat restoration projects within the San Francisco estuary, Sacramento River Basin, Delta, and San Joaquin River Basin.

3. The USACE should make all monitoring data collected by implementation of the proposed Project publicly available in order to facilitate integration with concurrent ecological monitoring efforts related to anadromous fish in the California Central Valley.

4. The Corps should support and promote aquatic and riparian habitat restoration within the Delta and other watersheds, especially those with listed aquatic species. Practices that avoid or minimize adverse effects to listed species should be encouraged.

5. The Corps should make set-back levees integral components of their authorized bank protection or ecosystem restoration efforts.
6. The Corps should conduct or fund studies to identify set-back levee opportunities, at locations where the existing levees are in need of repair or where set-back levees could be built in the future. Removal of the existing riprap from the abandoned levee should be investigated in restored sites and anywhere removal does not compromise flood safety.

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

2.11 Reinitiation of Consultation

This concludes formal consultation for Lehigh Southwest Stockton Terminal Project.

As 50 CFR 402.16 states, reinitiation of consultation is required and shall be requested by the Federal agency or by the Service 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 identified action is subsequently modified in a manner that causes an effect to the listed species or critical habitat that was not considered in the biological opinion, or (4) a new species is listed or critical habitat designated that may be affected by the action.

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

Section 305(b) of the MSA directs Federal agencies to consult with NMFS on all actions or proposed actions that may adversely affect EFH. Under the MSA, this consultation is intended to promote the conservation of EFH as necessary to support sustainable fisheries and the managed species' contribution to a healthy ecosystem. For the purposes of the MSA, EFH means "those waters and substrate necessary to fish for spawning, breeding, feeding, or growth to maturity", and includes the physical, biological, and chemical properties that are used by fish (50 CFR 600.10). Adverse effect means any impact that reduces quality or quantity of EFH, and may include direct or indirect physical, chemical, or biological alteration of the waters or substrate and loss of (or injury to) benthic organisms, prey species and their habitat, and other ecosystem components, if such modifications reduce the quality or quantity of EFH. Adverse effects on EFH may result from actions occurring within EFH or outside of it and may include site-specific or EFH-wide impacts, including individual, cumulative, or synergistic consequences of actions (50 CFR 600.810). Section 305(b) of the MSA also requires NMFS to recommend measures that can be taken by the action agency to conserve EFH. Such recommendations may include measures to avoid, minimize, mitigate, or otherwise offset the adverse effects of the action on EFH [CFR 600.905(b)]

This analysis is based, in part, on the EFH assessment provided by the USACE and descriptions of EFH for Pacific Coast groundfish (Pacific Fishery Management Council [PFMC] 2019a), coastal pelagic species (CPS, PFMC 1998), and Pacific Coast salmon (PFMC 2014); contained in the fishery management plans (FMPs) developed by the PFMC and approved by the Secretary of Commerce.

The proposed Project area is within the region identified as EFH for Pacific salmon in Amendment 18 of the Pacific Coast Salmon FMP (PFMC 2014), Pacific Coast groundfish in Appendix B of the Pacific Coast groundfish FMP (PFMC 2019a), and coastal pelagic species in Amendment 8 of the FMP for coastal pelagic species (PFMC 1998). The USACE is receiving this consultation under the MSA for potential impacts to the EFH of Pacific salmon, Pacific Coast groundfish, and coastal pelagic species as a result of implementing the Project in the San Joaquin Delta, Suisun Bay, San Pablo Bay, and the Central San Francisco Bay.

The PFMC has identified and described EFH, Adverse Impacts and Recommended Conservation Measures for salmon in Amendment 18 to the Pacific Coast Salmon FMP (PFMC 2014). Freshwater and estuarine EFH for Pacific salmon in the California Central Valley includes waters currently or historically accessible to salmon within the Central Valley ecosystem as described in Myers et al. (1998). Sacramento River winter-run Chinook salmon (*Oncorhynchus tshawytscha*), Central Valley spring-run Chinook salmon (*O. tshawytscha*), and Central Valley fall-/late fall-run Chinook salmon (*O. tshawytscha*) are species managed under the Salmon Plan that occur in the U.S. Geological Survey hydrologic unit codes (HUCs) described in Amendment 18 and occur in the San Joaquin Delta, Suisun Bay, San Pablo Bay, and Central San Francisco Bay.

The PFMC identified and described EFH for Pacific Coast groundfish in Appendix 2, part B of Amendment 19 (PFMC 2019a), and the adverse effects of non-fishing actions and recommended conservation measures in Appendix D of Amendment 19 (PFMC 2019b), and a description of the EFH and adverse effects and recommended conservation measures for coastal pelagic species in Appendix D to Amendment 8 of the Coastal Pelagic Species FMP (PFMC 1998).

3.1 Essential Fish Habitat Affected by the Project

The MSA defines EFH as "those waters and substrate necessary to fish for spawning, breeding, feeding, or growth to maturity." NMFS interpreted this definition in its regulations as follows: "waters" include aquatic areas and their associated physical, chemical, and biological properties that are used by fish, and may include areas historically used by fish where appropriate; "substrate" includes sediment, hard bottom, structures underlying the waters, and associated biological communities; "necessary" means "the habitat required to support a sustainable fishery and the managed species' contribution to a healthy ecosystem"; and "spawning, breeding, feeding, or growth to maturity" covers the full life cycle of a species. In addition to the general description for EFH, the implementing regulations for the EFH provisions of the MSA (50 CFR part 600) recommend that the FMPs include specific types or areas of habitat within EFH as "habitat areas of particular concern" (HAPC) based on one or more of the following considerations: (1) the importance of the ecological function provided by the habitat; (2) the extent to which the habitat is sensitive to human-induced environmental degradation; (3)

whether, and to what extent, development activities are, or will be, stressing the habitat type; and (4) the rarity of the habitat type.

The description of EFH for CPS is contained in appendix D of Amendment 8 of the CPS FMP (PFMC 1998). The CPS fishery includes four finfish [Pacific sardine, Pacific (chub) mackerel, northern anchovy, and jack mackerel] and the invertebrate, market squid (*Loligo opalescens*). CPS finfish are pelagic and located in the water column near the surface, generally above the thermocline and are not associated with the substrate. For the purposes of EFH, the four CPS finfish are treated as a single species complex, because of similarities in their life histories and similarities in their habitat requirements. The east-west geographic boundary of EFH for each individual CPS finfish and market squid is defined to be all marine and estuarine waters from the shoreline along the coasts of California, Oregon, and Washington offshore to the limits of the exclusive economic zone (EEZ) and above the thermocline where sea surface temperatures range between 10°C to 26°C (50ºF to 78.8ºF). The southern boundary of the geographic range of all CPS finfish is consistently south of the US-Mexico border, indicating a consistency in sea surface temperatures at or below 26°C, the upper thermal tolerance of CPS finfish. Therefore, the southern extent of EFH for CPS finfish is the United States-Mexico maritime boundary. The northern boundary of the range of CPS finfish is more dynamic and variable due to the seasonal cooling of the sea surface temperature. The northern EFH boundary is, therefore, the position of the 10°C (50ºF) isotherm which varies both seasonally and annually. Within the action area, EFH for the CPS extends landwards from the Golden Gate to the western Delta at Sherman Island.

The Pacific Coast Groundfish FMP manages 90-plus species over a large and ecologically diverse area. The overall extent of groundfish EFH for all fisheries management units species is identified as all waters and substrate within the following areas:

- Depths less than or equal to 3,500 m (1,914 fathoms) to MHHW or the upriver extent of saltwater intrusion, defined as upstream and landward to where ocean-derived salts measure less than 0.5 parts per thousand (ppt) during the period of average annual low flow.
- Seamounts in depths greater than 3,500 m as mapped in the EFH assessment geographic information system (GIS).
- Areas designated as HAPCs not already identified by the above criteria.

Designated HAPCs for Pacific Coast groundfish include:

1) Estuaries: The inland extent of the estuary HAPC is defined as MHHW, or the upriver extent of saltwater intrusion, defined as upstream and landward to where ocean-derived salts measure less than 0.5 ppt during the period of average annual low flow. The seaward extent is an imaginary line closing the mouth of a river, bay, or sound; and to the seaward limit of wetland emergents, shrubs, or trees occurring beyond the lines closing rivers, bays, or sounds. This HAPC also includes those estuary-influenced offshore areas of continuously diluted seawater. This definition is based on Cowardin et al. (1979).

2) Kelp canopies: The canopy kelp HAPC includes those waters, substrate, and other biogenic habitat associated with canopy-forming kelp species (e.g., *Macrocystis* spp. and *Nereocystis* sp.).

3) Seagrass: The seagrass HAPC includes those waters, substrate, and other biogenic features associated with eelgrass species (*Zostera* spp.), widgeongrass (*Ruppia maritima*), or surfgrass (*Phyllospadix* spp.).

4) Rocky Reefs: The rocky reefs HAPC includes those waters, substrates and other biogenic features associated with hard substrate (bedrock, boulders, cobble, gravel, etc.) to MHHW. A first approximation of its extent is provided by the substrate data in the groundfish EFH assessment GIS. However, at finer scales, through direct observation, it may be possible to further distinguish between hard and soft substrate in order to define the extent of this HAPC.

5) Areas of Interests: Off of California this include all seamounts, including Gumdrop Seamount, Pioneer Seamount, Guide Seamount, Taney Seamount, Davidson Seamount, and San Juan Seamount; Mendocino Ridge; Cordell Bank; Monterey Canyon; specific areas in the Federal waters of the Channel Islands National Marine Sanctuary; specific areas of the Cowcod Conservation Area.

Within the action area, the upstream extent of EFH for Pacific Coast groundfish is approximately Jersey Point on the San Joaquin River. This is the upstream extent of the 0.5 ppt isohaline gradient in an average water year. All waters to the west in the estuary are considered as EFH for Pacific Coast groundfish. The only HAPC that overlaps with the action area (shipping channels) is estuarine waters from Jersey Point to the Golden Gate.

The geographic extent of freshwater EFH for Pacific salmon is identified as all water bodies currently or historically occupied by Council-managed salmon as described in Amendment 18 of the Pacific Coast Salmon Plan. In the estuarine and marine areas, salmon EFH extends from the extreme high tide line in nearshore and tidal submerged environments within state territorial waters out to the full extent of the Exclusive Economic Zone (EEZ) (200 nautical miles or 370.4 km) offshore of Washington, Oregon, and California north of Point Conception. The proposed Project occurs in the areas identified as "freshwater EFH", as it is above the tidal influence where the salinity is above 0.5 parts per thousand from the Port of Stockton, downstream in the San Joaquin River to Jersey Point, and as estuarine EFH from Jersey Point to the Golden Gate.

Based on the considerations for defining HAPCs, the Council designated five habitats for Pacific salmon as HAPCs: (1) complex channels and floodplain habitats; (2) thermal refugia; (3) spawning habitat; (4) estuaries; and (5) marine and estuarine submerged aquatic vegetation (SAV). No HAPCs occur in the action area or will be affected by the Project except for estuaries. It is not expected that estuarine and marine SAVs will be found within the shipping channels, and ships will only traverse the action area while in the shipping channels.

3.2 Adverse Effects on Essential Fish Habitat

The proposed Project is considered to have multiple non-fishing activities that affect EFH for Pacific salmon as described in Amendment 18 to the Pacific Coast Salmon FMP and for Pacific Coast groundfish in Appendix D to the Pacific Coast groundfish FMP. NMFS does not consider that any aspect of the Project will have an effect on temperature distribution in the waters of the action area that would have an adverse impact on EFH for CPS. The two major impacts on EFH that have been identified for the Project are related to the generation of high intensity sound and the effects of commercial shipping on aquatic habitat. NMFS considers that the effects on Pacific Coast salmon and Pacific Coast groundfish will be the same. The effects of sound and shipping have already been analyzed in the Effects of the Action, Section 2.5, of the opinion and are anticipated to be the same for non-listed Pacific Coast salmon and Pacific Coast groundfish. The following actions are considered to have potential adverse effects on the EFH in the action area:

1) High Intensity underwater sounds – A number of human activities can introduce high levels of sound into the aquatic environment. Some of these sounds are incidental to the purpose of the activity, such as the intense impulsive sounds produced when a pile is driven by an impact hammer or the lower level continuous sounds produced by a cargo ship. The proposed Project has components that will create high intensity underwater sound in the action area which includes freshwater EFH for Pacific Coast salmon and estuarine EFH for both salmon and Pacific Coast groundfish. The adverse effects of pile driving and pile removal has been described in section 2.5.1.1 of the opinion, and the adverse impacts of noise associated with shipping has been described in section 2.5.2.1 of the opinion.

2) Vessel Operations - The growth of the marine transportation industry is accompanied by land-use changes, including over-water or in-water construction, and loss and degradation of aquatic habitat and wetlands through actions such as filling, dredging, channelization, and diking and damming. Activities associated with the operation and maintenance of commercial, industrial and recreational vessels can directly and indirectly impact EFH. Impacts from vessel operation can result from hydrodynamics due to vessel-induce wake and wave generation, anchor chain and propeller scour; noise and chemical pollution due to vessel operation and waste discharge; and the inadvertent transport of invasive plant and animal species. Impacts can also result from vessel abandonment and dereliction. The severity of vessel-induced impacts on coastal and inland waterway habitats depends on the geomorphology of the impacted area, current velocity, sediment composition, vegetation type and extent of vegetative cover, as well as vessel type and dimensions, number of vessels, speed, vessel direction, proximity to the shoreline, and timing. The adverse effects of vessel operations have been discussed in sections 2.5.2.1 through 2.5.2.3 of the biological opinion.

3.3 Essential Fish Habitat Conservation Recommendations

NMFS determined that the following conservation recommendations are necessary to avoid, minimize, mitigate, or otherwise offset the impact of the Project on EFH. In order to avoid or minimize the effects to EFH, NMFS recommends the following conservation measures described in Amendment 18 to the Pacific Coast Salmon FMP (PFMC 2014) and in Appendix D of Amendment 19 for Pacific Coast groundfish (PFMC 2019b).

1) High Intensity underwater sounds

Noise

- When possible, avoid driving piles when MSA-managed species are most abundant, especially the younger life stages and spawning adults.
- Avoid driving piles with an impact hammer when possible. Alternatives include vibratory hammers or press-in pile drivers. Limit impact driving to the minimum necessary for proofing the piles. (Incorporates by reference Term and Condition 1.a. from the biological opinion)
- In cases where an impact hammer must be used, drive the piles as far as possible with a vibratory or other method that produces lower levels of sound before using an impact hammer.
- When driving piles in intertidal or shallow subtidal areas, do so during periods of low tide. Sound does not propagate as well in shallow water as it does in deep water.
- Develop and carry out a plan to monitor the sound levels during pile driving to verify that the assumptions in the analysis were correct and to ensure that any attenuation device is properly functioning. A report on the hydroacoustic monitoring should be provided to NMFS according to the individual project requirements, but no later than 60 days after completion of the pile driving. (Incorporates by reference Term and Condition1.b, 1.c., and 1.d. from the biological opinion)

Sedimentation, siltation, turbidity

- Minimize the suspension of sediments and disturbance of the substrate when removing piles. Measures to help accomplish this include, but are not limited to, the following: Remove piles with a vibratory hammer, rather than the direct pull or clamshell method.
- Remove the pile slowly to allow sediment to slough off at, or near, the mudline.
- Shake or vibrate the pile to break the bond between the sediment and pile. Doing so causes much of the sediment to slough off the pile at the mudline, thereby minimizing the amount of suspended sediment.
- Place a ring of clean sand around the base of the pile. This ring will contain some of the sediment that would normally be suspended.

2) Vessel Operations

Sedimentation, siltation, and turbidity

- Limit vessel speed near shorelines to reduce waves that erode the shore. Designate all sensitive EFH areas (e.g., eelgrass beds) as no-wake zones.

Release of contaminants

- Ensure that commercial ships and port facilities have acceptable contaminant spill response plans and equipment in place.
- Use dispersants that remove oils from the environment rather than dispersants that simply move them from the surface to the ocean bottom.
- Establish no discharge zones to prevent sewage from entering EFH.

- Use appropriate methods for containment of wastewater, surface water collection, and recycling to avoid the discharge of pollution during the maintenance and operation of vessels.
- Promote education and signage on all vessels to encourage proper disposal of solid debris at sea.
- Encourage the use of innovative cargo securing and stowing designs that may reduce solid debris in the marine environment from the transportation of commercial cargo.
- Conduct vessel hull cleaning on land, and capture all run-off from such operations to ensure it does not enter waterbodies.
- Encourage natural resource managers to provide outreach materials on the potential impacts resulting from releases of invasive species into the natural environment.
- Develop appropriate early detection and rapid response eradication methods for invasive organisms consistent with Federal guidelines as specified by the National Invasive Species Management Plan.
- Provide and display educational materials on the potential impacts resulting from the release of invasive species into the natural environment to increase public awareness and engender broad cooperation amongst user groups and stakeholders.

Noise effects

- Incentivize ship designs that include technologies capable of reducing noise generated and transmitted to the water column, such as the use of muffling devices already required for land-based machinery that may help reduce the impacts of vessel noise.
- Assess the effects of proposed and existing vessel traffic and associated underwater noise for potential impacts to sensitive areas.
- Exclude vessels or limit high intensity use and low-frequency sonar in known sensitive marine areas.

Vessel strikes

- Limit vessel speed in confined navigation channels to reduce closure speed on aquatic organisms and reduce likelihood of ship – organism encounters.

3.4 Statutory Response Requirement

As required by section 305(b)(4)(B) of the MSA, the USACE must provide a detailed response in writing to NMFS within 30 days after receiving an EFH Conservation Recommendation. Such a response must be provided at least 10 days prior to final approval of the action if the response is inconsistent with any of NMFS' EFH Conservation Recommendations unless NMFS and the Federal agency have agreed to use alternative time frames for the Federal agency response. The response must include a description of the measures proposed by the agency for avoiding, minimizing, mitigating, or otherwise offsetting the impact of the activity on EFH. In the case of a response that is inconsistent with the Conservation Recommendations, the Federal agency must explain its reasons for not following the recommendations, including the scientific justification for any disagreements with NMFS over the anticipated effects of the action and the measures needed to avoid, minimize, mitigate, or offset such effects (50 CFR 600.920(k)(1)).

In response to increased oversight of overall EFH program effectiveness by the Office of Management and Budget, NMFS established a quarterly reporting requirement to determine how many conservation recommendations are provided as part of each EFH consultation and how many are adopted by the action agency. Therefore, we ask that in your statutory reply to the EFH portion of this consultation, you clearly identify the number of conservation recommendations accepted.

3.5 Supplemental Consultation

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

4 Data Quality Act Documentation and Pre-Dissemination Review

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

4.1 Utility

Utility principally refers to ensuring that the information contained in this consultation is helpful, serviceable, and beneficial to the intended users. The intended users of this opinion are the USACE. Other interested users could include USFWS, CDFW, DWR, and Lehigh Hanson. Individual copies of this opinion were provided to the USACE and USFWS. The document will be available within two weeks at the NOAA Library Institutional Repository [https://repository.library.noaa.gov/welcome]. The format and naming adheres to conventional standards for style.

4.2 Integrity

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

4.3 Objectivity

Information Product Category: Natural Resource Plan

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

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

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

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

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Figure 1. Project vicinity map (Anchor QEA 2019).

Net Change in In-Water Fill **(permanent impacts)**

Project Component	Number of Piles	Total Area	Total Volume
Proposed for Removal			
Existing Wooden Rail Trestle	66	70.62 sf	57.82 cy
Proposed for Installation			
Berth 2 Rehabilitation	164	295 sf	349.04 cy
Rail Trestle Replacement	30	56 sf	51.7 cy
Net Total	**128**	**280.38 sf**	**342.92 cy**

Existing and Proposed Overwater Coverage **(permanent impacts)**

Project Component	Overwater Coverage Area
Proposed for Removal	
Existing Wooden Rail Trestle Deck	4,800 sf
Proposed for Installation	
Proposed Rail Trestle Deck	3,800 sf
Proposed Berth 2 Fender (Floats and Piles)	277 sf
Net Total	**-723 sf**

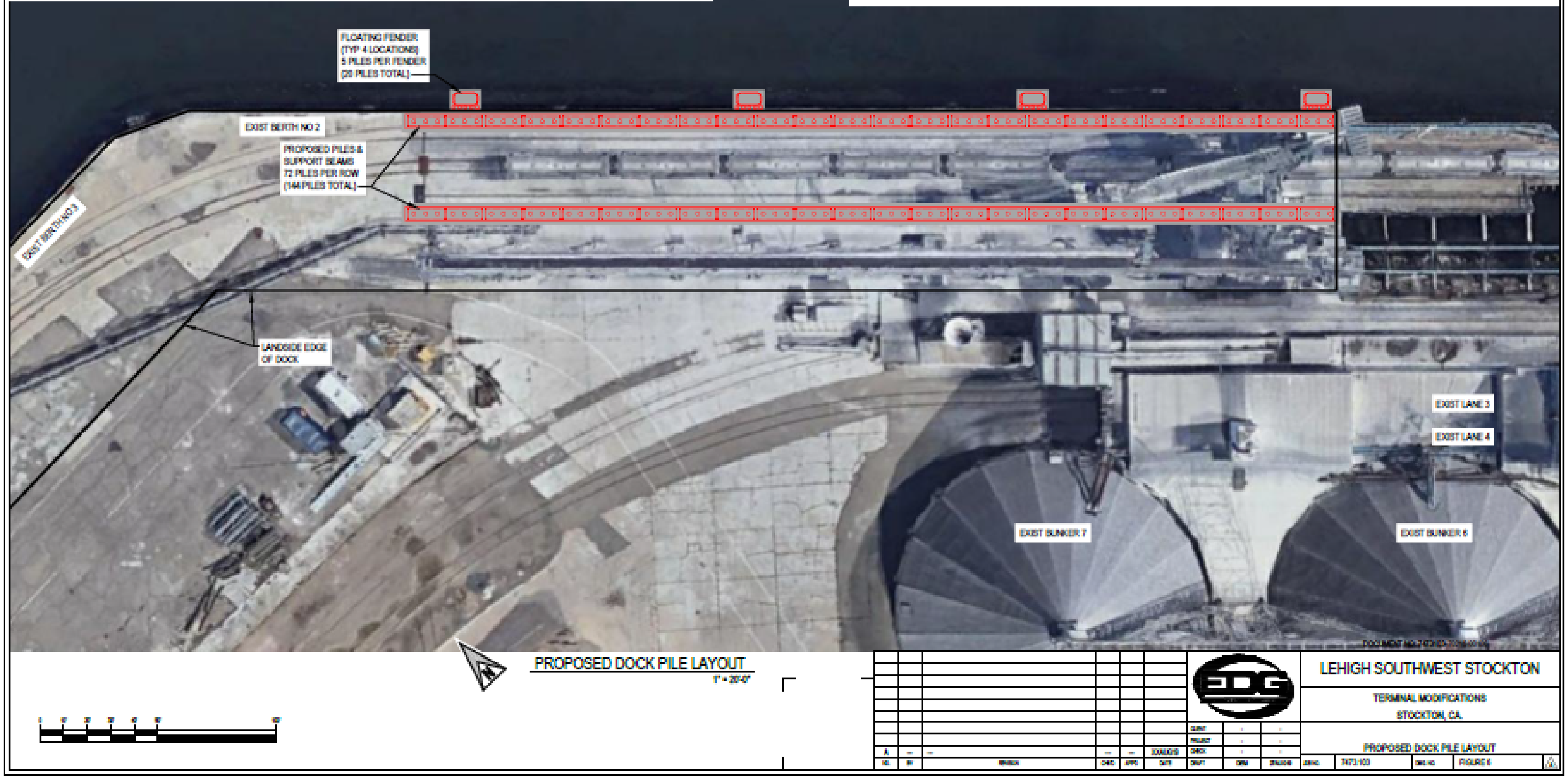

Figure 2. Plan view of proposed new dock piling layout for ship unloader gantry and floating fender system (Anchor QEA 2019).

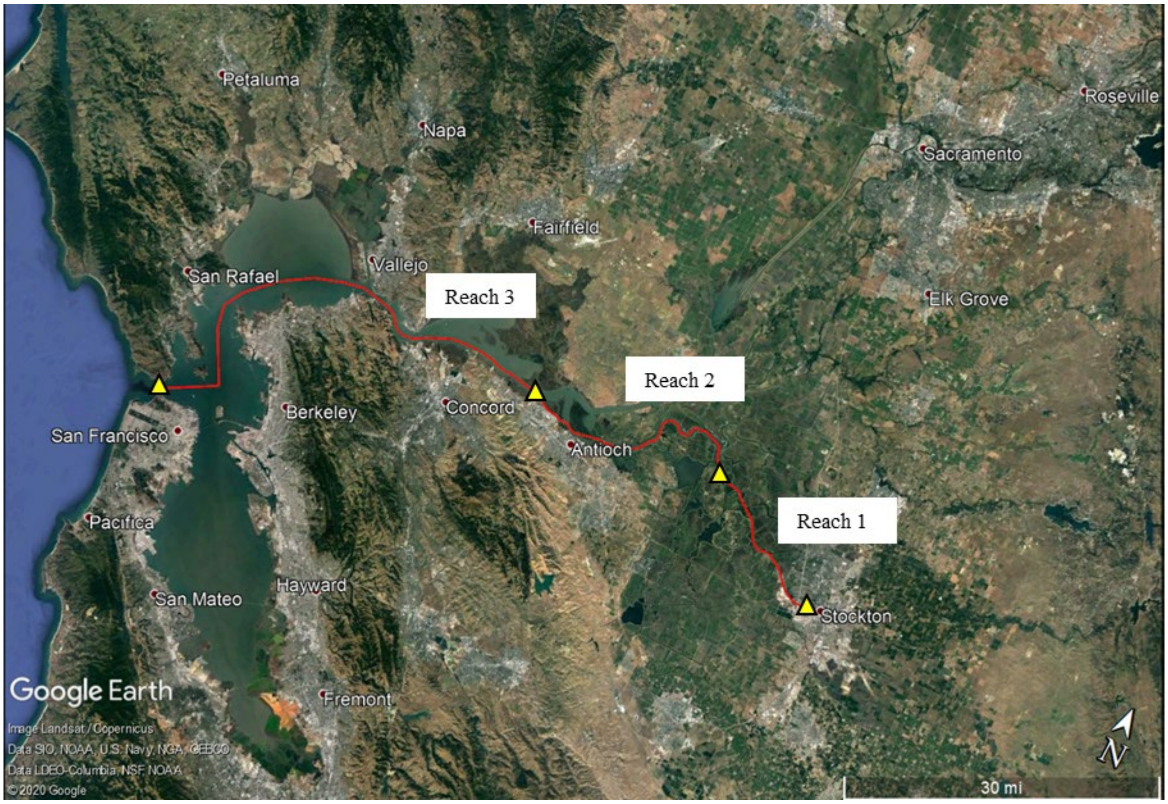

Figure 3. Map of Action Area for the Lehigh Hanson Project. Red line follows the alignment of the federally maintained shipping channel.

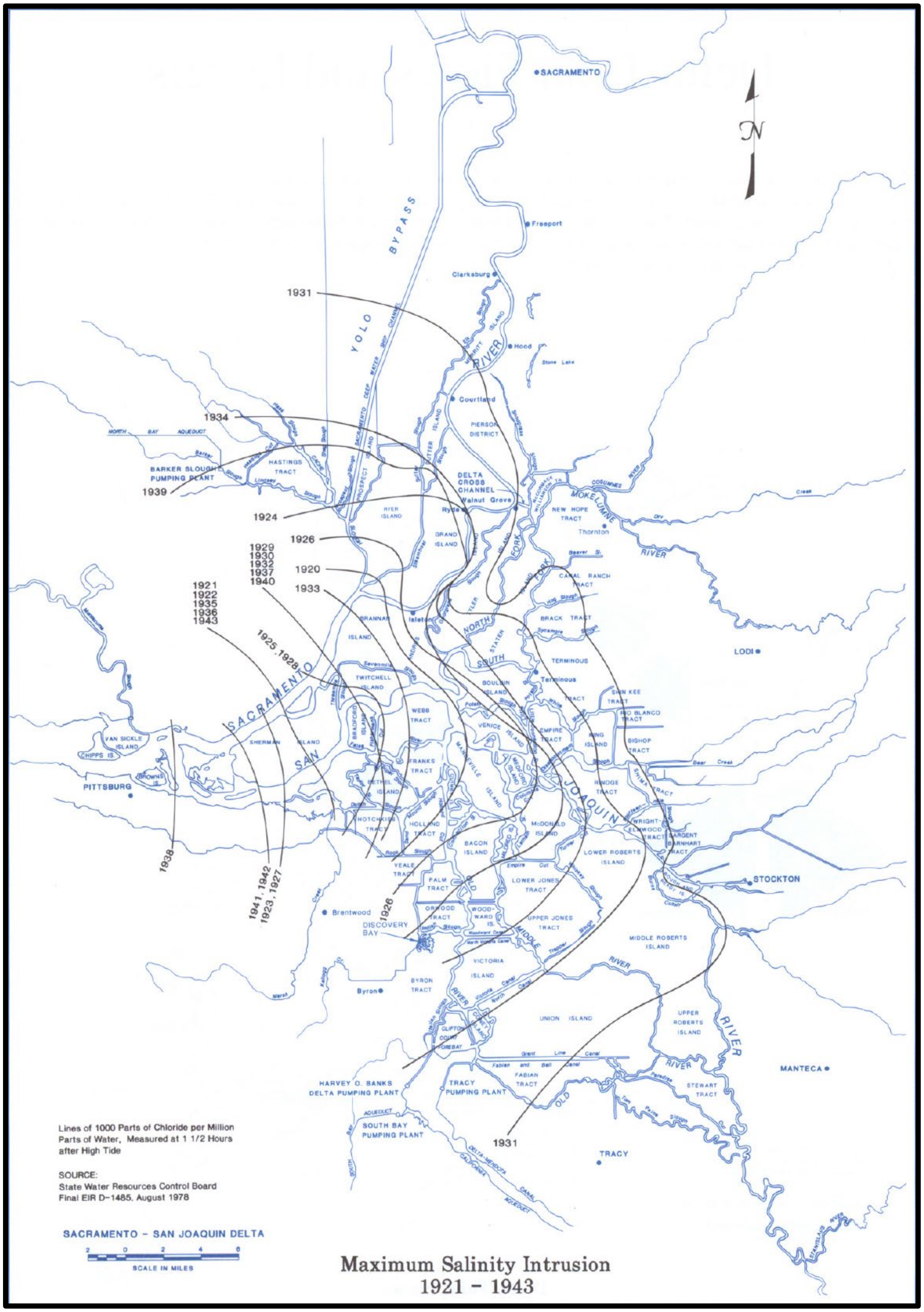

Figure 4. Maximum salinity intrusion for the years 1921 through 1943 (Pre-project conditions in Central Valley –Shasta and Friant Dams non-operational; Sacramento-San Joaquin Delta Atlas, DWR).

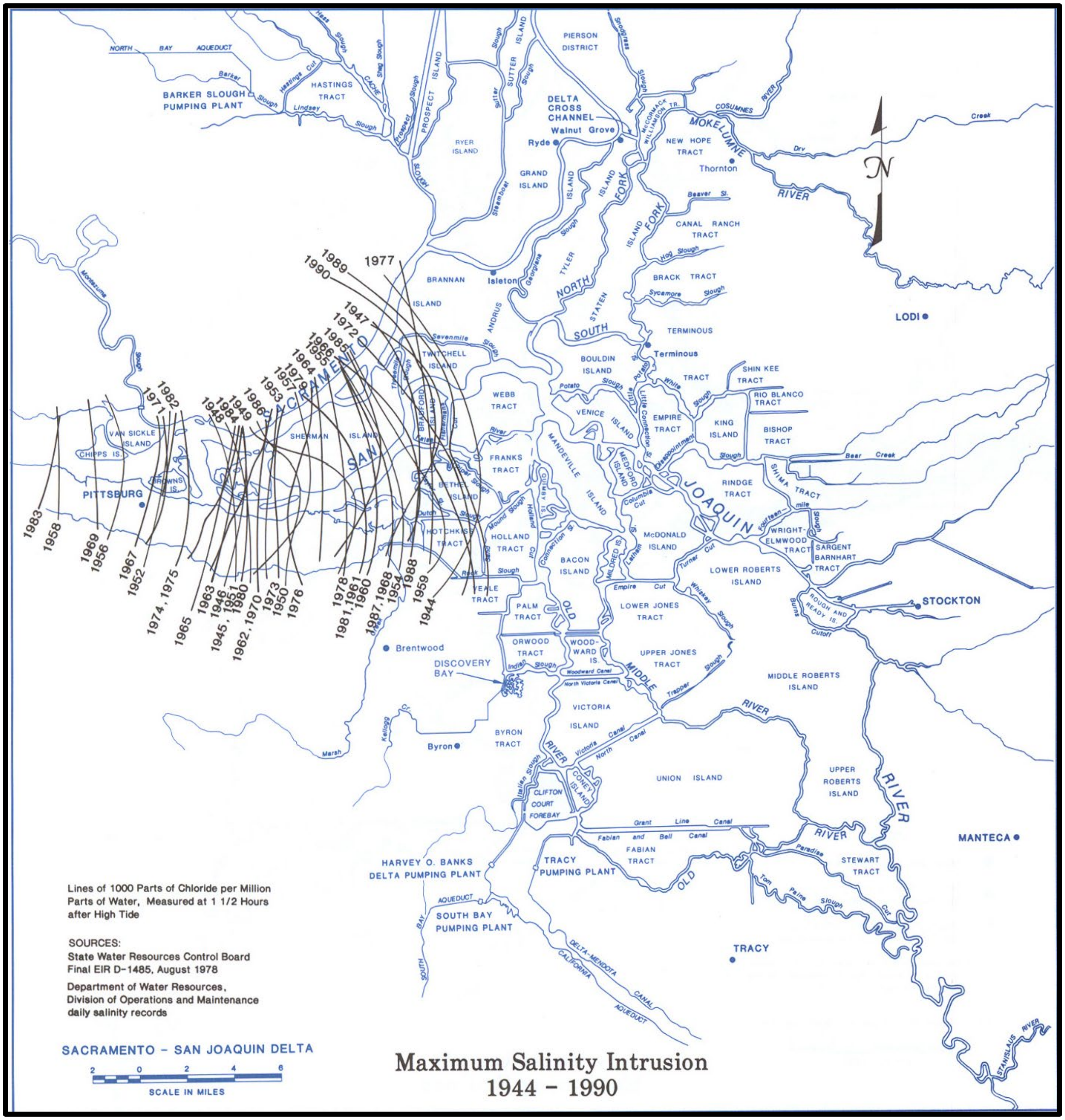

Figure 5. Maximum salinity intrusion for the years 1944 through 1990 (SWP and CVP era; Sacramento-San Joaquin Delta Atlas, DWR).

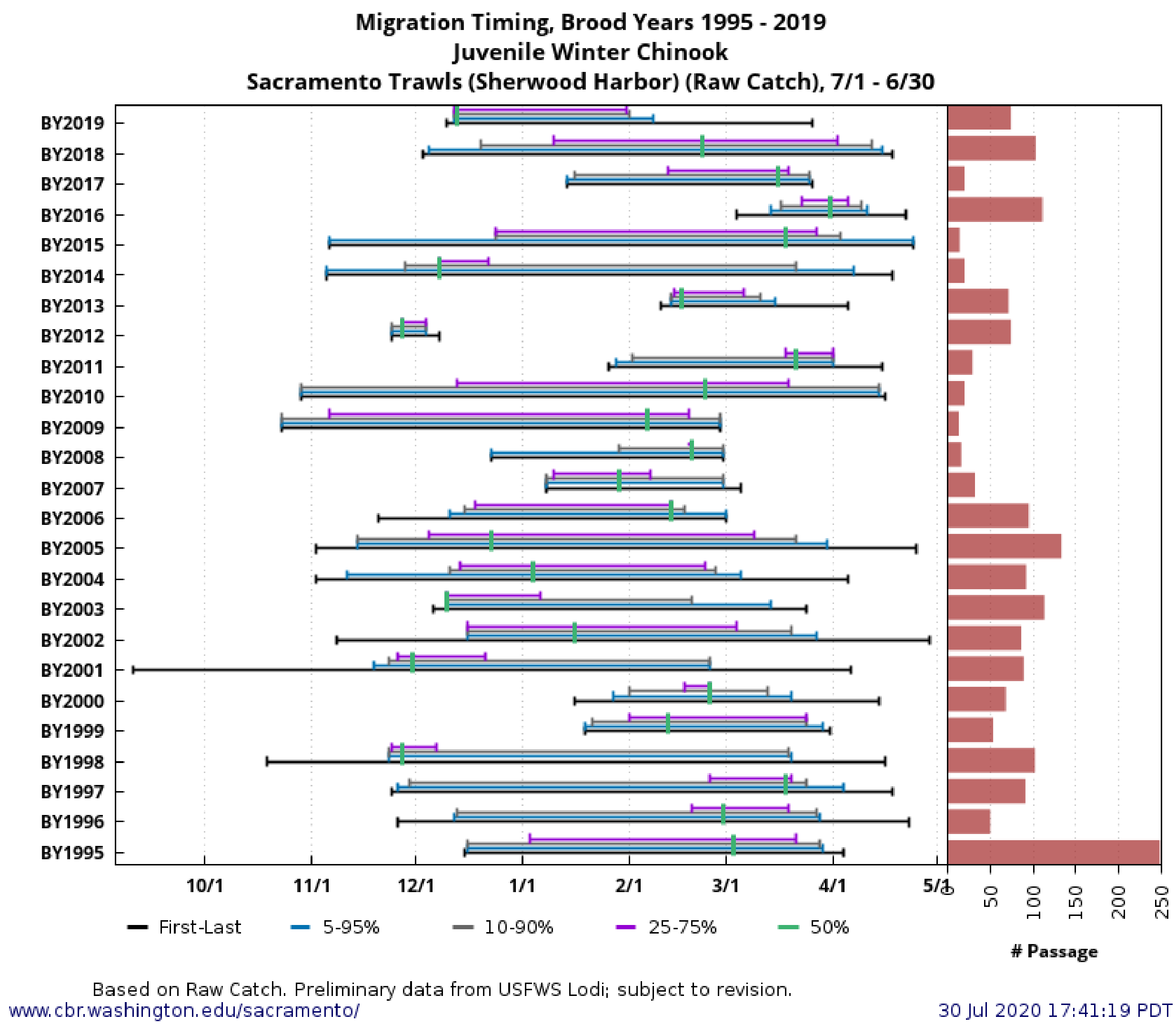

Figure 6. Migration timing of juvenile winter-run Chinook salmon observed in the Sacramento Trawls (Sherwood Harbor). ([SacPas website 2020)](SacPas website 2020)

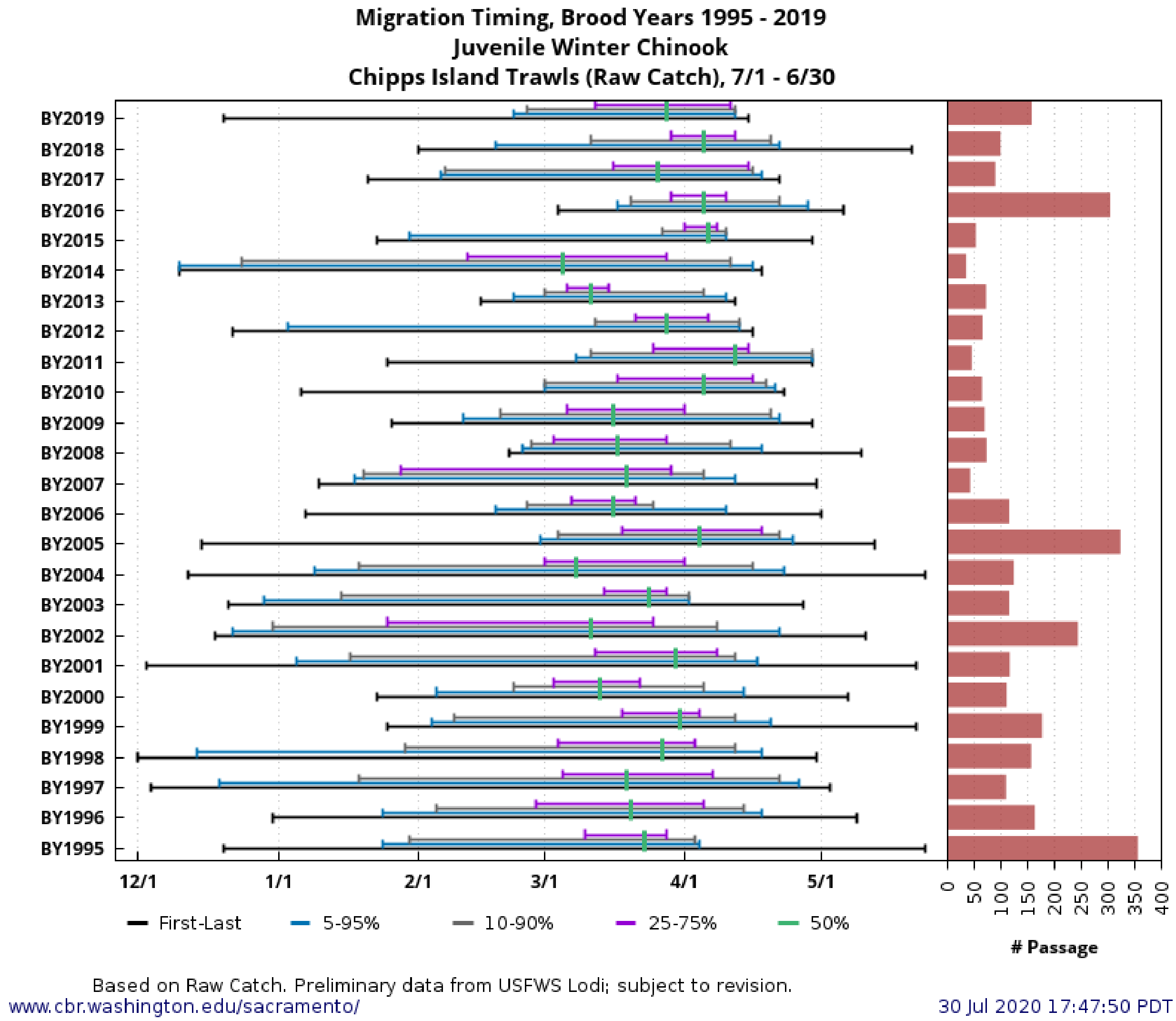

Figure 7. Migration timing of juvenile winter-run Chinook salmon observed in the Chipps Island Trawl (western Delta). ([SacPas website 2020)](SacPas website 2020)

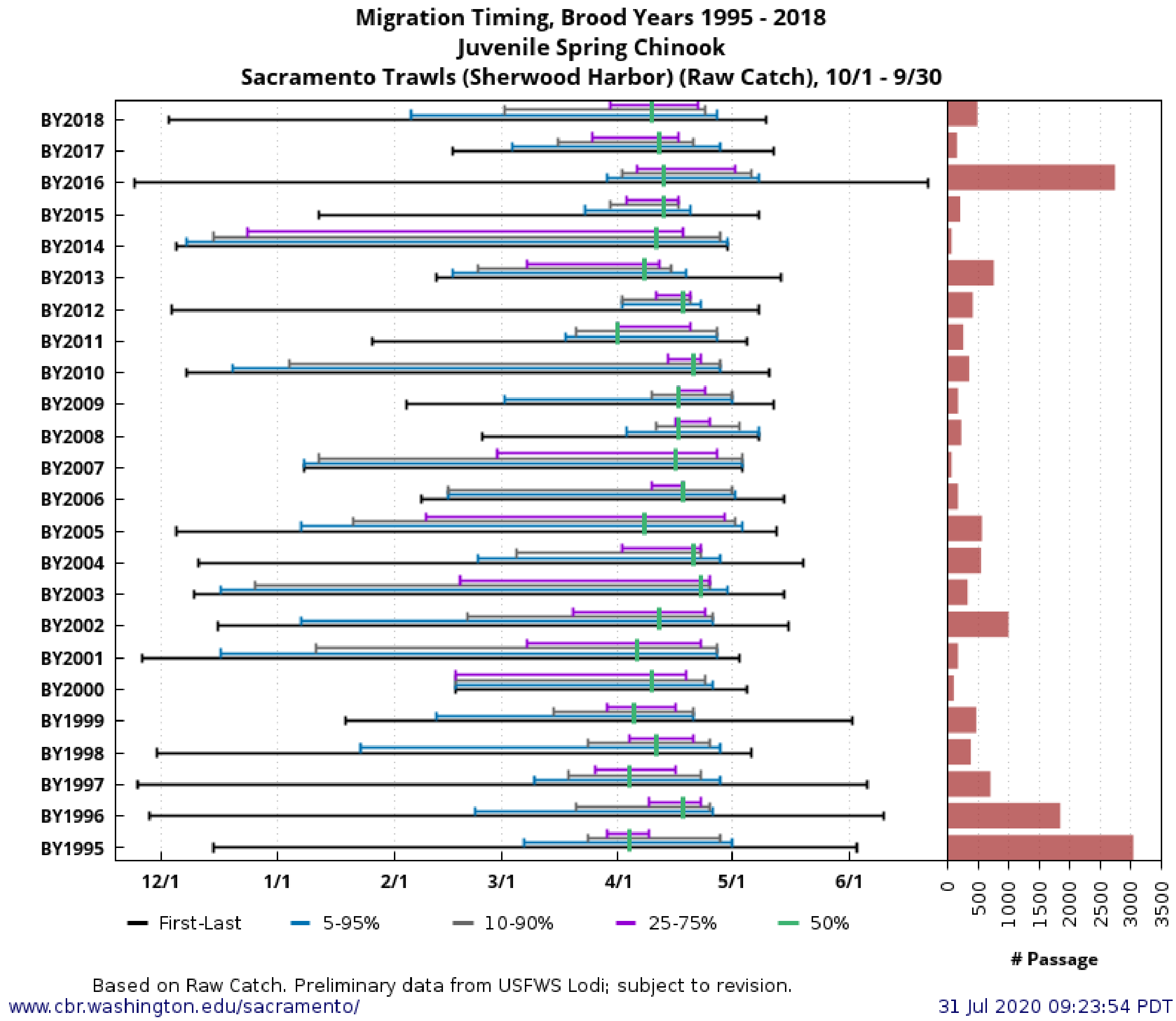

Figure 8. Migration timing of juvenile spring-run Chinook salmon observed in the Sacramento Trawls (Sherwood Harbor). (SacPas website 2020)

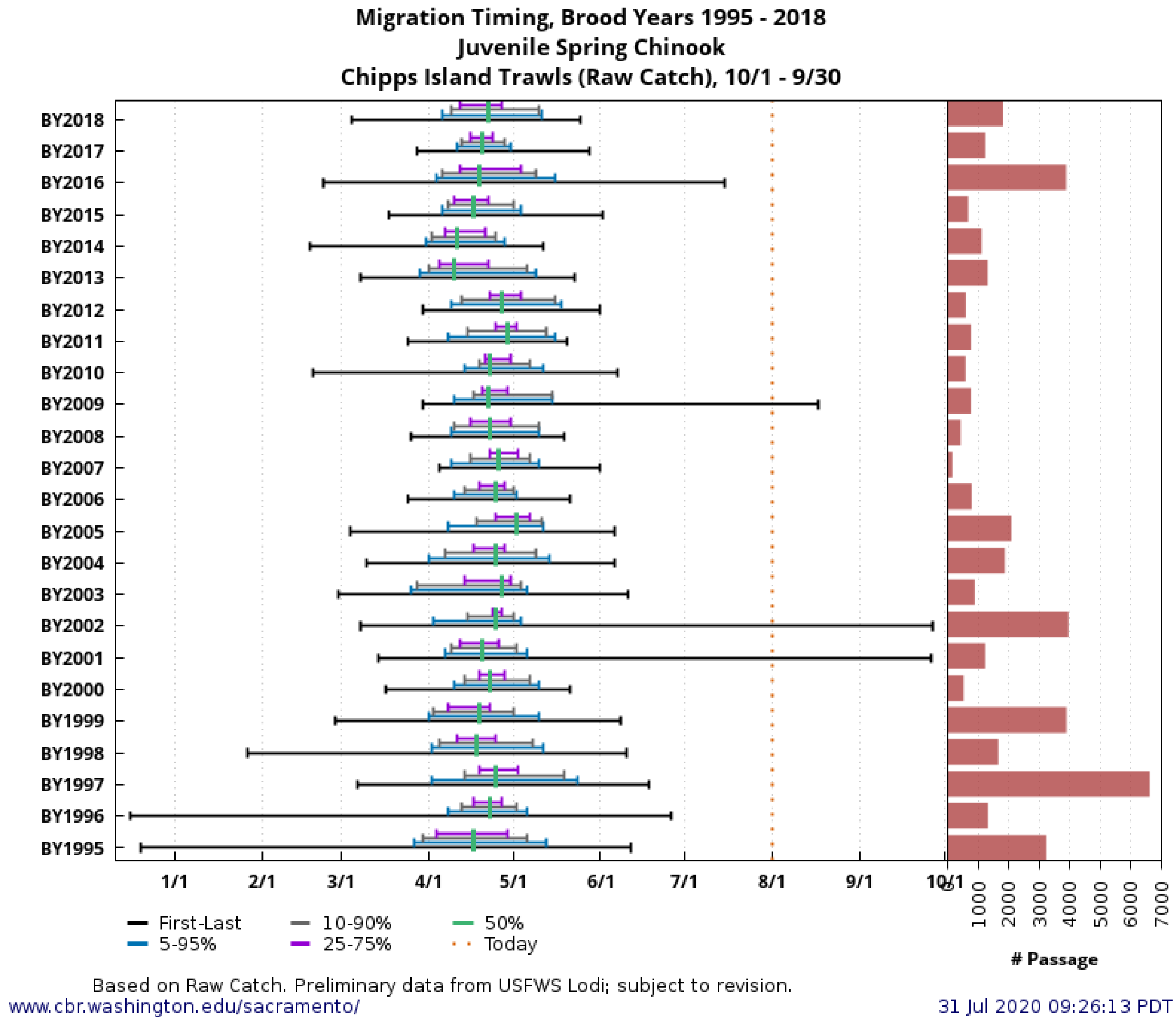

Figure 9. Migration timing of juvenile spring-run Chinook salmon observed in the Chipps Island Trawl (western Delta). ([SacPas website 2020)](#)

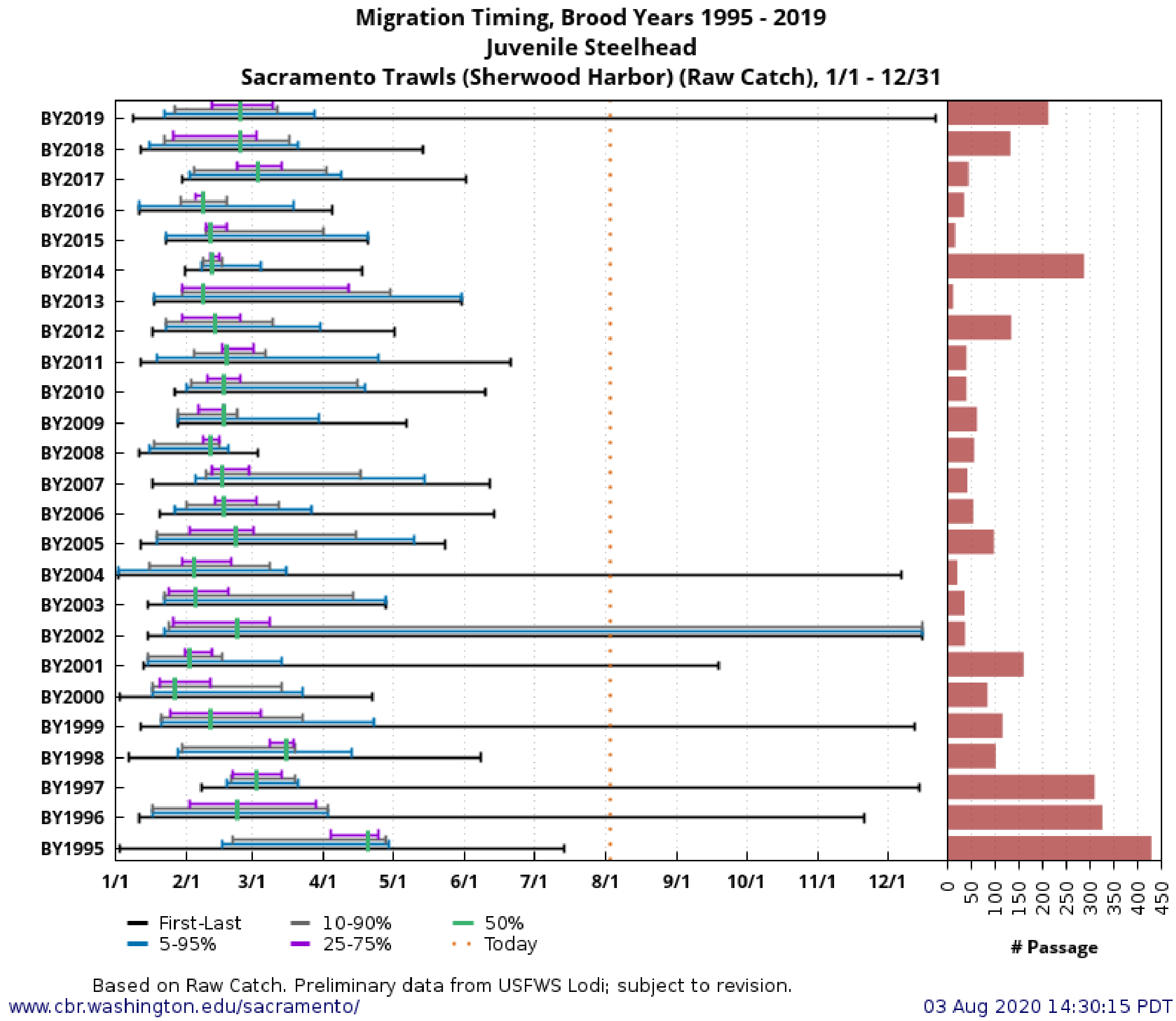

Figure 10. Migration timing of juvenile CCV steelhead observed in the Sacramento Trawls (Sherwood Harbor). (SacPas website 2020)

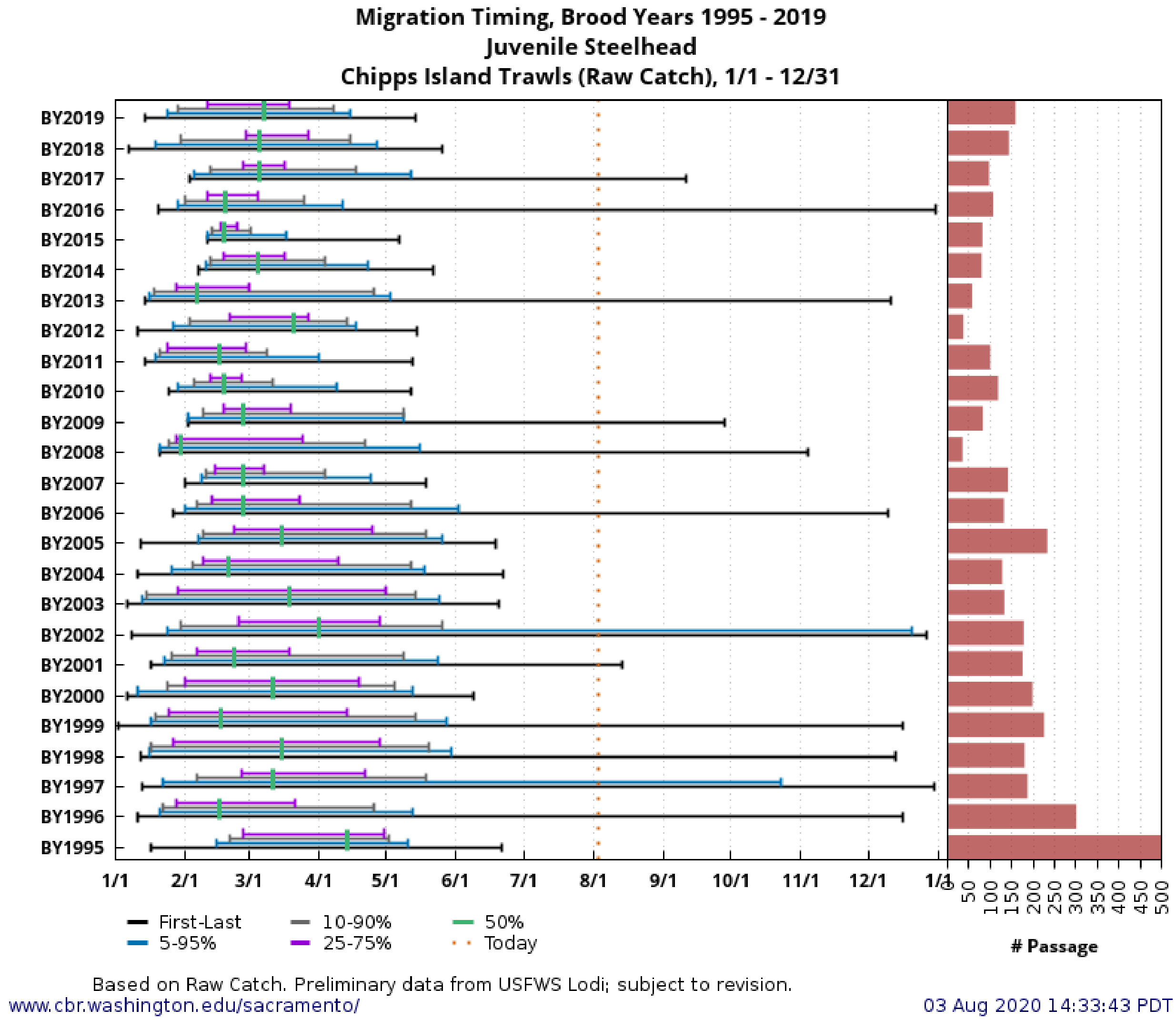

Figure 11. Migration timing of juvenile CCV steelhead observed in the Chipps Island Trawl (western Delta). (SacPas website 2020)

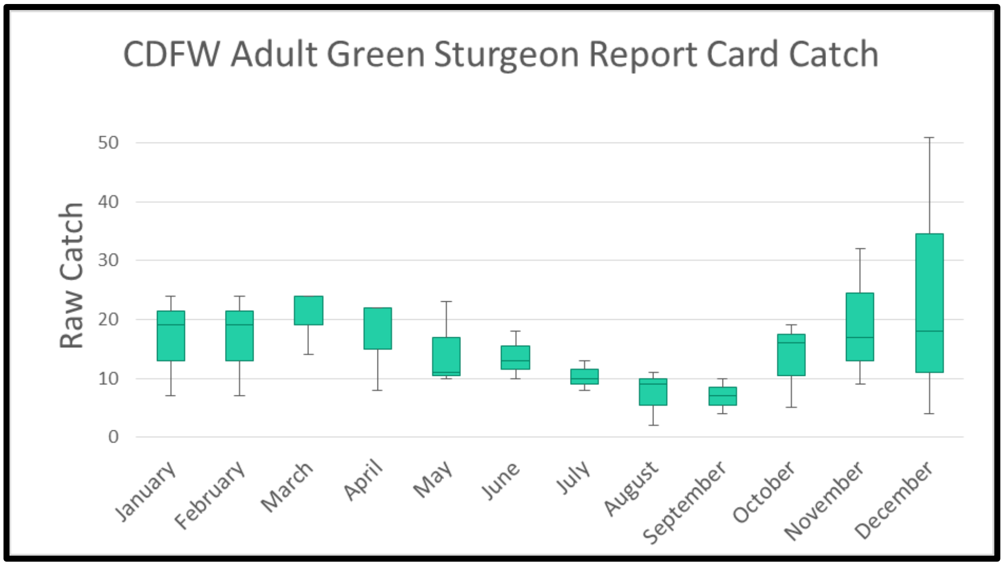

Figure 12. CDFW adult raw catch data for green sturgeon in the Delta from 2008-2014. This data indicates presence year round (Gleason et al. 2008, DuBois et al. 2009-2015). The monthly median is marked by a horizontal line splitting each box. The upper and lower whiskers show the maximum and minimum values for each month over all years.

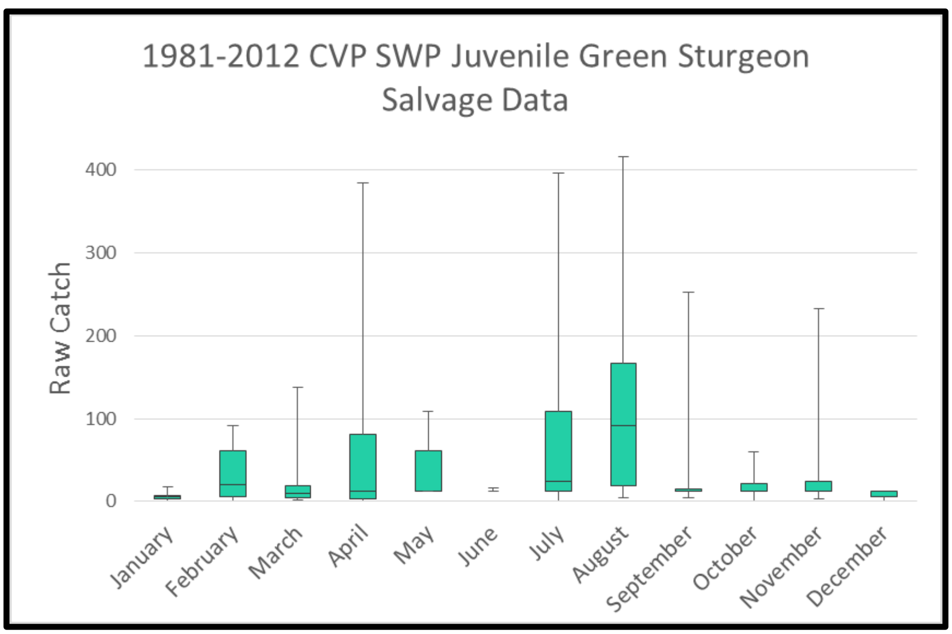

Figure 13. Monthly raw salvage data for juvenile green sturgeon by month at the SWP and CVP export facilities (1981-2012). The monthly median is marked by a horizontal line splitting each box. The upper and lower whiskers show the maximum and minimum values for each month over all years.

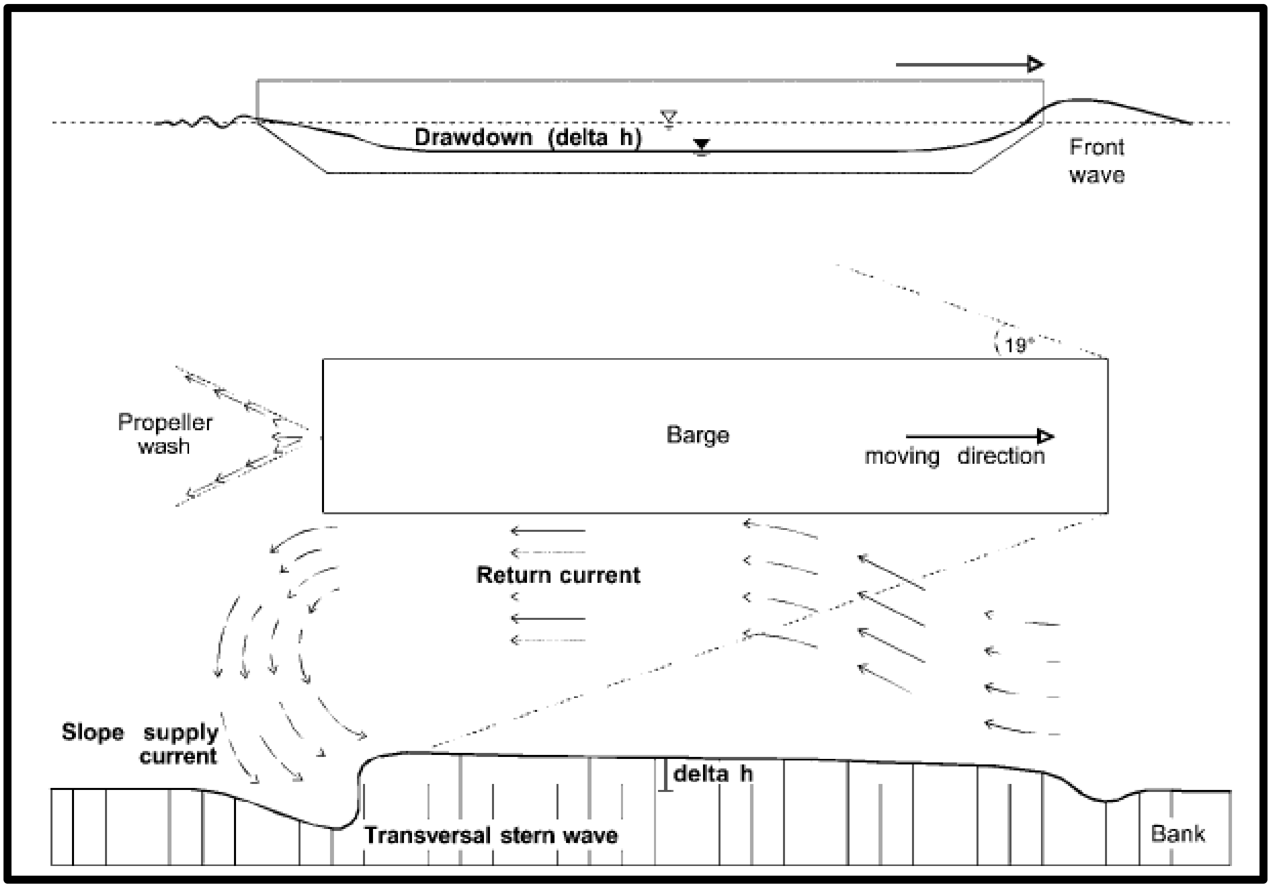

Figure 14. Navigation induced physical forces in a restricted waterway (from Wolter and Arlinghaus 2003).