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

May 24, 2018 Refer to NMFS No: WCR-2017-6803

Anne Morkill
Refuge Complex Manager
U.S. Fish and Wildlife Service
San Francisco Bay National Wildlife Refuge Complex
1 Marshlands Road
Fremont, California 94555

Re: Endangered Species Act Section 7(a)(2) Biological Opinion and Magnuson-Stevens Fishery Conservation and Management Act Essential Fish Habitat Response for the South Bay Salt Ponds Restoration Project Phase 2.

Dear Ms. Morkill:

Thank you for your letter of April 26, 2017 requesting initiation of consultation with NOAA's National Marine Fisheries Service (NMFS) pursuant to section 7 of the Endangered Species Act of 1973 (ESA) as amended (16 U.S.C. 1531 et seq.) for the Phase 2 of the South Bay Salt Ponds (SBSP) Restoration Project, located in the counties of Alameda, Santa Clara, and San Mateo, California. Thank you, also, for your request for consultation pursuant to the essential fish habitat (EFH) provisions in Section 305(b) of the Magnuson-Stevens Fishery Conservation and Management Act (MSA)(16 U.S.C. 1855(b)) for this action. The U.S. Fish and Wildlife Service (FWS) proposes to implement construction of Phase 2 actions and continue SBSP operations and maintenance activities.

The enclosed biological opinion is based on our review of FWS' proposed actions under Phase 2 of the SBSP over the next 12 years and describes NMFS' analysis of potential effects on threatened Central California Coast (CCC) steelhead (*Oncorhynchus mykiss*), the threatened Southern Distinct Population Segment (DPS) of North American green sturgeon (*Acipenser medirostris*), and their respective designated critical habitats in accordance with section 7 of the ESA. In the enclosed biological opinion, NMFS concludes the project is not likely to jeopardize the continued existence of these species; nor is it likely to adversely modify critical habitat. However, NMFS anticipates that take of CCC steelhead and the Southern DPS green sturgeon is reasonably certain to occur. An incidental take statement which applies to this project with non-discretionary terms and conditions is included with the enclosed biological opinion.

We completed pre-dissemination review of this biological opinion using standards for utility, integrity, and objectivity in compliance with applicable guidelines issued under the Data Quality Act (section 515 of the Treasury and General Government Appropriations Act for Fiscal Year 2001, Public Law 106-554). The biological opinion will be available through NMFS' Public Consultation

Tracking System [https://pcts.nmfs.noaa.gov/pcts-web/homepage.pcts].[1] A complete record of this consultation is on file at the NMFS North-Central Coast Office in Santa Rosa, California.

This letter also transmits NMFS' essential fish habitat (EFH) conservation recommendations as required by the Magnuson-Stevens Fisheries Conservation and Management Act (MSA) (16 U.S.C. 1801 *et seq*.). NMFS has reviewed the proposed project for potential effects on EFH and determined that the proposed project would adversely affect EFH for various federally managed fish species under the Pacific Coast Salmon, Coastal Pelagic Species, and Pacific Coast Groundfish Fishery Management Plans (FMPs). Therefore, EFH Conservation Recommendations are included in this opinion.

Please be advised that regulations (50 CFR 600.092) to implement the EFH provisions of the MSA require your office to provide a written response to this letter within 30 days of its receipt and prior to the final action. A preliminary response is acceptable if a final response cannot be completed within 30 days. Your final response must include a description of how the EFH Conservation Recommendations will be implemented and any other measures that will be required to avoid, mitigate, or offset the adverse impacts of the activity. If your response is inconsistent with our EFH Conservation Recommendations, you must provide an explanation for not implementing this recommendation at least 10 days prior to final approval of the action.

Please contact Brian Meux at (707) 575-1253 or via e-mail at Brian.Meux@noaa.gov if you have any questions concerning this section 7 and EFH consultation, or if you require additional information.

Sincerely,

[signature], for

Barry A. Thom
Regional Administrator

cc: Chris Barr, Don Edwards National Wildlife Refuge, Fremont, CA
John Bourgeois, California Coastal Conservancy, Oakland, CA
Frances Malamud Roam, U.S. Army Corps of Engineers, San Francisco, CA
Katherine Sun, U.S. Fish and Wildlife Service, Sacramento, CA
Brian Wines, San Francisco Regional Water Quality Control Board, Oakland, CA
Brenda Goeden, San Francisco Bay Conservation and Development Commission, San Francisco, CA
John Krause, California Department of Fish and Wildlife, Napa, CA
Dillon Lennebacker, AECOM, Oakland, CA
Dave Halsing, Environmental Science Associates (ESA), Oakland, CA
Copy to ARN File #151422WCR2017SR00137

[1] Once on the PCTS homepage, use the following PCTS tracking number within the Quick Search column: WCR-2017-6803.

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

South Bay Salt Pond Restoration Project Phase 2

NMFS Consultation Number: WCR-2017-6803

Action Agency: United States Fish and Wildlife Service

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?
Central California Coast steelhead (*Oncorhynchus mykiss*)	Threatened	Yes	No	Yes	No
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 Groundfish	Yes	Yes
Pacific Coast Salmon	Yes	Yes
Coastal Pelagic	Yes	Yes

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

Issued By: [signature], for

Barry A. Thom
Regional Administrator

Date: MAY 2 4 2018

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List of Acronyms

LIST OF ACRONYMS

BA	Biological Assessment
CCC	Central California Coast
CDFW	California Department of Fish and Wildlife
cSEL	cumulative sound exposure level
CY	cubic yards
dB	decibel
DO	dissolved oxygen
DPS	distinct population segment
EFH	Essential Fish Habitat
EPA	Environmental Protection Agency
ESA	Endangered Species Act
ft	foot
FMP	Fishery Management Plan
FTA	Federal Transit Administration
FWS	United States Fish and Wildlife Service
HTL	high tide line
ITS	incidental take statement
MHHW	mean higher high water
MLLW	mean lower low water
m	meter
MSA	Magnuson-Stevens Fishery Conservation and Management Act
MTL	mean tide line
NAVD88	North American Vertical Datum of 1988
NMFS	National Marine Fisheries Service
PBF	physical or biological features
PIT	passive integrated transponder
PPT	parts per thousand
RMS	root mean squared
RPM	reasonable and prudent measures
SBSP	South Bay Salt Ponds
SCVWD	Santa Clara Valley Water District
SEL	sound exposure level
SCC	State Coastal Conservancy
SPL	sound pressure levels
TL	total length
USGS	United States Geological Survey
WWTP	Wastewater Treatment Plant

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

The 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.

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

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

1.2 Consultation History

By letter dated March 23, 2017, NMFS received a request from the Executive Project Manager of the South Bay Salt Pond (SBSP) Restoration Project, on behalf of the United States Fish and Wildlife Service (FWS) and State Coastal Conservancy (SCC), for formal consultation pursuant to section 7 of the Endangered Species Act on Phase 2 of the South Bay Salt Pond Restoration Project. The letter also transmitted a February 2017 biological assessment that concluded the project may affect, and is likely to adversely affect, threatened Central California Coast (CCC) steelhead (*Oncorhynchus mykiss*) and the threatened Southern distinct population segment (DPS) of North American green sturgeon (*Acipenser medirostris*). Additionally, it was determined that the project may adversely affect Essential Fish Habitat (EFH) for various federally managed fish species within the Pacific Coast Groundfish, Pacific Coast Salmon, and Coastal Pelagic Species Fishery Management Plans (FMP).

At the request of NMFS, a conference call was held on April 20, 2017 to discuss the consultation process and scope. This conference call was attended by NMFS, FWS, SCC, ESA Associates, and AECOM. During the call, NMFS requested a federal action agency prepare a letter requesting initiation of formal consultation and clarify the relationship of this consultation with the existing biological opinion for Phase 1 of the SBSP issued by NMFS to the Army Corps of Engineers (Corps) on January 14, 2009. It was agreed upon that the FWS would be the Federal Action Agency to request section 7 consultation with NMFS and that a supplemental package containing the additional information would be prepared.

On April 26, 2017, the FWS transmitted to NMFS a letter requesting formal consultation for the SBSP Project Phase 2. FWS also transmitted with their request for consultation the same February 2017 biological assessment provided by the SBSP Executive Project Manager in March 2017. The SCC, NMFS, and FWS exchanged emails in late April and early May 2017 to clarify the scope of activities to be addressed in this consultation. By letter dated May 26, 2017, to NMFS, FWS indicated that they were considering NMFS' request to expand the scope of the consultation to include operations and maintenance (O&M) activities on all ponds, levees, and other related facilities within the San Francisco Bay National Wildlife Refuge's (Refuge) Alviso and Ravenswood complexes. FWS' letter also indicated that they would provide a package of supplemental information to NMFS.

On July 14, 2017, a conference call was held to discuss the contents of the supplemental information package and the scope of the consultation. During the call the Refuge agreed to conduct a single consultation that addresses the Phase 2 actions and all of the O&M activities within the SBSP project area on lands owned by FWS for a period of 12 years. This conference call was attended by NMFS, FWS, and SCC. By letter dated July 17, 2017, to FWS, NMFS summarized the results of the July 14, 2017 conference call including the agreed upon scope and duration for the SBSP Phase 2 consultation.

By letter dated September 8, 2017, FWS transmitted to NMFS a package of supplemental information to the previously submitted biological assessment for the SBSP Project. The supplemental information included the Refuge's planned O&M activities throughout the project area.

On October 27, 2017, a conference call with NMFS, FWS, SCC, and AECOM was conducted to further discuss consultation scope, project information, and timing.

On December 15, 2017, a conference call occurred with representatives of FWS, SCC, and AECOM to discuss general O&M and Phase 2 construction activities. NMFS and FWS clarified that the duration of future O&M actions to be addressed in this consultation would be the 12-year period agreed to in July 2017. SCC provided to NMFS an ESA Section 10 research permit application submitted to the NMFS West Coast Region permit program by FishBio (a consultant firm) for a proposed passive integrated transponder (PIT) tagging study in Pond A8. FWS requested NMFS include this study plan in the project description for the SBSP Phase 2 Project.

On December 26, 2017, FWS sent an email to NMFS with additional information to reflect the current condition of several SBSP facilities including the following: fish screen between Ponds A16/A17 has been repaired and operating consistently without issue since April 2017. As of June 2017 all 8 gates of the A8 notch were opened as planned, which has created a muted tidal system throughout the A5/A7/A8S/A8 pond system and there is no proposed change with the Pond A8 complex' current operation with this consultation. Ponds A5 and A7 water control structures have broken and do not function as intake and outlets as originally designed, rather two-way flow occurs year-round. FWS is hesitant to repair the structures due to expensive costs, and anticipates removing the structures in a future section 7 consultation with approval from appropriate agencies.

On January 10, 2018, FWS sent a letter to NMFS with detailed information on pile driving, cofferdam installation, dewatering, and minimization measures associated with SBSP construction activities. Detailed dimensions of pilot channel excavation, PG&E boardwalk dimensions, habitat islands, water control structures, and order of construction were also provided.

Between February 3 and February 8, 2018, further information was provided in emails regarding pond bottom elevations and average pond depths. Further information on the seasonal operation of proposed water control structures in the Ravenswood Ponds (R3, R5/S5), and the expected water quality and water depth conditions within the ponds was also provided. In addition, FWS service confirmed by email on February 8, 2018 that all activities pertaining to vegetation removal, predator control, mosquito abatement, and pesticide and herbicide use will occur as described and effects analyzed in the FWS/NMFS consultation for the Don Edwards National Wildlife Refuge Comprehensive Conservation Plan in Alameda, Santa Clara, and San Mateo Counties (June 29, 2017, NMFS letter of concurrence to FWS; PCTS # SWR-2012-2631).

On February 27, 2018, SCC and FWS provided further information and clarification on the seasonal operation of water control structures throughout the action area to maintain protections to juvenile steelhead. With this submittal, sufficient information was provided to NMFS on February 27, 2018, to initiate formal consultation.

A site visit to Ravenswood Ponds, involving NMFS, FWS, and SCC was conducted on February 28, 2018 to further discuss the project Phase 2 construction and planned pond operation.

NMFS shared a draft project description with FWS via email to clarify the details of the project on March 16, 2018. FWS, SCC, AECOM, and ESA provided a response via email on March 22, 2018 that confirmed and clarified project description details.

A conference call with representatives of NMFS, FWS, and SCC was held on May 10, 2018 to discuss the project's fish monitoring program. During the call, FWS committed to conducting fish monitoring in the managed ponds, breached ponds, and adjacent sloughs of the Mountain View and Ravenswood ponds included in Phase 2 actions on a quarterly basis for a minimum of 3 years and develop an adaptive management process to determine if monitoring goals have been achieved.

1.3 Proposed Action

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

The SBSP Restoration Project is a comprehensive plan to restore and enhance 15,100 acres of wetlands in South San Francisco Bay (South Bay) while providing for flood management and wildlife-oriented public access and recreation within ponds formerly owned by Cargill

Corporation Inc. Immediately after the 2003 acquisition and subsequent transfer of those ponds from Cargill, the landowners, the FWS and California Department of Fish and Wildlife (CDFW), began implementation of the Initial Stewardship Plan (ISP), which was designed to maintain open water and unvegetated pond habitats with enough water circulation to preclude salt production and maintain habitat values and conditions until the long-term restoration actions of the SBSP Restoration Project could be implemented. Phase 1 of the SBSP began in 2010 and construction activities were completed in 2014, and operations and maintenance actions associated with Phase 1 actions are ongoing.

For Phase 1 of the SBSP, compliance with section 7 of the ESA was addressed through the Corps' issuance of a 10-year permit under section 404 of the Clean Water Act (CWA). NMFS and the Corps conducted a formal consultation in 2008-09 that evaluated FWS' Phase 1 actions in the Alviso and Ravenswood Pond Complexes, as well as, Phase 1 actions conducted by the CDFW in the Eden Landing Pond Complex. The consultation also assessed the effects of O&M activities by both FWS and CDFW on their respective lands. A biological opinion was completed by NMFS and issued to the Corps on January 14, 2009, for the Corps' permitting of Phase 1 actions by FWS and CDFW.[2] The duration of the Corps permit is 10 years and expires in 2019.

With the Corps' 10-year permit expiring in 2019 and Phase 2 actions ready for implementation, FWS elected a different approach for section 7 compliance for the second phase of the SBSP program. As discussed above in the Consultation History section of this opinion, NMFS and FWS agreed to conduct a formal consultation that would address FWS Phase 2 actions on federal lands within the Refuge, including O&M, for a period spanning 12 years (2018-2030). The previous biological opinion issued by NMFS in 2009 to the Corps also included actions by CDFW on state refuge lands at Eden Landing. However, as of April 2017, when the FWS requested initiation of consultation with NMFS, CDFW was not prepared to submit an application to the Corps for their Phase 2 projects at Eden Landing. Thus, CDFW Phase 2 actions and O&M activities on state refuge lands will be addressed via a future ESA section 7 consultation with the Corps on the issuance of a new permit under Section 404 of the CWA in 2019.

The subject of this consultation is FWS' proposed implementation of Phase 2 actions and O&M activities over a 12-year period from 2018 through January 2031 on all ponds, levees, and other related facilities within the Refuge's Alviso and Ravenswood complexes. The project period of 12 years will allow for the completion of Phase 2 construction actions; many that must to occur in a particular construction sequence, as described below. Activities include: 1) restoration and enhancement of wetlands and other habitats, 2) providing public access and recreation, and 3) maintaining or improving flood risk management in the project area, and 4) fish monitoring and applied studies. Phase 2 construction and O&M actions are located solely within the boundaries of the Don Edwards National Wildlife Refuge, which is owned and managed by FWS. FWS has proposed some new O&M actions associated with constructed Phase 2 projects, and this project

[2] South Bay Salt Pond Restoration Project Phase 1 actions and a 10-year operations and maintenance permit were addressed in one section 7 consultation with NMFS (NMFS Tracking # SWR-2007-8128 and SWR-2008-2283, respectively).

includes new O&M actions associated with Phase 2 construction activities, in addition to ongoing O&M actions that are continuing from the implementation of Phase 1 actions.

1.3.1 Phase 2 Construction

Work in the Alviso Pond Complex will occur in three pond clusters (Figure 1): Alviso Mountain View Ponds (A1, A2W), Alviso Island Ponds (A19, A20, A21), and Alviso A8 Ponds (A8/A8S). The Alviso Mountain View Ponds are currently exposed to muted tidal conditions, and will be breached in Phase 2 at multiple locations for transition to tidal marsh habitat. The Alviso Island Ponds are currently open to full tidal range, and will be further opened to the surrounding waters in order to increase habitat connectivity, tidal flow, and accelerate transition of the ponds to tidal marsh. Work in the Alviso A8 Ponds includes the installation of two habitat transition zones, which are compacted sediment fill that creates a gradual incline from the pond bottom to the levee top to increase erosional protection and create transitional tidal marsh habitat. Work in the Ravenswood Pond Complex will occur in Ponds R3, R4, R5, and S5, which are currently isolated from tidal waters. Pond R4 will be breached for transition to tidal marsh habitat. Water control structures will be installed in the levees of Ponds R3, R5, and S5 to create managed pond habitat to benefit multiple bird species.

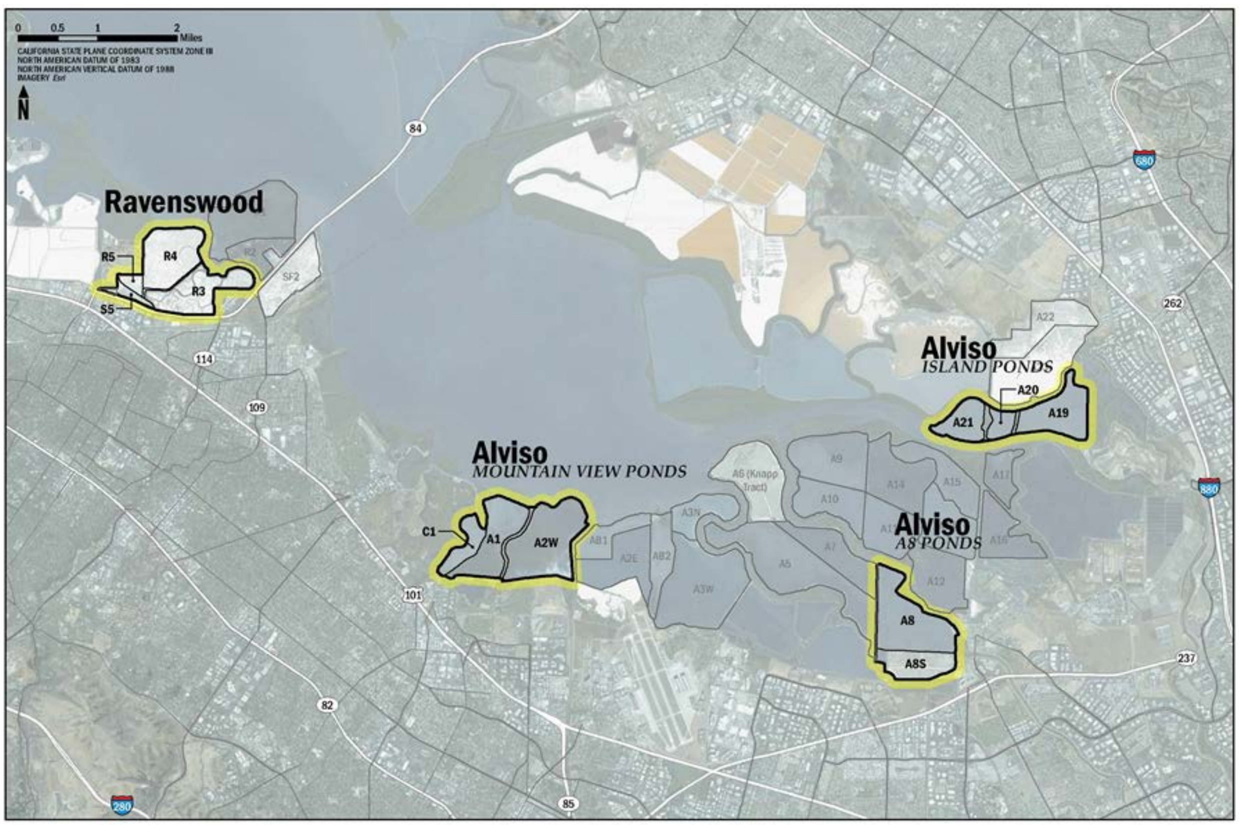

Figure 1. Map of salt ponds where Phase 2 actions will occur (AECOM 2017).

1.3.1.1 Alviso-Mountain View Ponds (Ponds A1 and A2W)

FWS proposes to restore the Mountain View Ponds to tidal marsh with an open tidal regime by connecting them to the South Bay, adjacent streams, and sloughs through levee breaches, habitat enhancement features, flood risk management components, and public access and recreational features. The construction period is anticipated to occur over three work seasons.

Levee Breaching and Bridges

Ponds A1 and A2W will undergo six levee breaches to connect the ponds with surrounding sloughs, allowing tidal inundation, sediment accretion, vegetation establishment. Two levee breaches will occur in Pond A1: one will be located at the northwest corner of the pond on the western levee connecting to the bay, and the other will be located along the eastern levee connecting to Permanente Creek/Mountain View Slough. The Pond A1 northwest corner breach will include the removal of one of the 48-inch tide gates. There will be four levee breaches in Pond A2W: two will be located on the western levee into Permanente Creek/Mountain View Slough, and two breaches will be on the eastern levee into Stevens Creek/Whisman Slough. The exact locations of these breaches will be determined using the locations of historical slough traces and minimizing impacts to existing tidal marsh from excavation of the breach channel. The tide gate between Pond A2W and Stevens Creek will be removed, and the siphon between A1 and A2W will be demolished or capped and closed. Any removal of remnant water control structures will be replaced with fill for levee stabilization.

Each of the six breaches will have similar construction methods and dimensions. Breaching will be accomplished from the levee crests using excavators, and material will be hauled to locations receiving fill for reuse in the project area. The bottom elevation of the breach channels will be approximately 2 feet NAVD88. The average pond bottom elevations in Pond A1 and A2W are respectively 0.88 and 0.35 NAVD88 (MHHW is approximately 8 feet NAVD88). The bottom width of the breaches will be approximately 60 feet, and the breach side slopes will be approximately 2:1 (horizontal: vertical). Estimated length and width of breach channels are provided in Table 1. The designed width of the channel bottoms are expected to erode after breaching and the final channel width for the breaches is anticipated to be from 100 to 200 feet (depending on breach cut length) at equilibrium.

Pond Cluster	Pond	Breach Location	Breach Cut Length (feet)	Breach Bottom Width (feet)	Bottom Elevation (feet NAVD88)	Average Depth (feet)	Total Breach Area		Connecting Water Body
							(square feet)	(acres)	
Island	A19	NW	150	50	4	4	9,510	0.22	Mud Slough
	A19	NE	90	50	4	5	6,120	0.14	Mud Slough
Mountain View	A1	NW	110	60	0	6	8,010	0.18	Charleston Slough
	A1	SE	110	60	2	6	8,430	0.19	Permanente Creek/Mountain View Slough
	A2W	NW	200	60	2.5	5	14,440	0.33	Permanente Creek/Mountain View Slough
	A2W	SW	230	60	2	5	17,170	0.39	Permanente Creek/Mountain View Slough
	A2W	NE	90	40	3	6	5,380	0.12	Stevens Creek/Whisman Slough
	A2W	SE	210	40	3	6	11,820	0.27	Stevens Creek/Whisman Slough
Ravenswood	R4	NE	470	200	2	4	92,360	2.12	Ravenswood Slough
	R3	WCS-4 Channel	230	10	1	4	6,980	0.16	Ravenswood Slough
	R4	R4 Interior Pilot Channels (2 Channels)	2,890	50	2	3	176,470	4.05	NA

Table 1. Breach locations, dimensions, and elevations for Phase 2 actions (FWS 2018).

Single-span pre-cast bridges will be installed over each of the two breaches on the eastern levee of Pond A2W to accommodate Pacific Gas and Electric (PG&E) vehicle and public access, and will include armoring for erosion and scour protection of bridge abutments. Bridge superstructure will be cast-in-place concrete deck on precast 2.5-foot deep I-girders that are set on cast-in-place concrete abutments with wing walls that will be cast on top of driven concrete piles with vibratory and/or impact hammer. Each bridge would be approximately 60 feet long and 19 feet wide (footprint 1,140 square feet), which will result in a maximum 40-foot channel bottom width through the breach opening. The bridge deck underside elevation will be 9 feet NAVD88.

The installation of the two bridges in Pond A2W will require 32 14-inch concrete piles for construction of the foundation abutments (eight piles per abutment). Piles will be driven in dry conditions within temporary sheet pile cofferdams, preferably using a vibratory hammer and using an impact hammer if needed (maximum 300 strikes per pile, four piles driven per day). Cofferdams will be approximately 150 feet long per abutment, and made from 24-inch steel sheet piles and supporting H-piles that will be driven with a vibratory hammer. Cofferdams will be installed using exclusion nets and closing cofferdams at low tide if practicable. If water remains in cofferdams after closing, then dewatering will occur. Pumped water will be discharged downstream of the construction area and possibly directed to Pond A2W or the lower end of Stevens Creek/Whisman Slough.

Levee Improvement

Levee improvements will occur along the western side of Pond A1, the eastern side of Pond A2W, and the Coast Casey Forebay levee to improve flood protection that will be lost by levee breaches. The total combined length of levees that will be raised, topped, regraded, or otherwise improved is approximately 11,000 linear feet. Approximately 4,400 feet of the A1 west levee would be raised; approximately 1,000 feet of the Coast Casey Forebay levee would be raised; and the east levee of Pond A2W would be topped off in places, regraded, and improved over a

5,200-foot length. Levee improvements will require clearing of vegetation, debris, and grooving. Fill would be placed in approximately 6-inch-thick lifts and compacted either through a vibratory hand tamper or a roller. Some material will be sourced from offsite excavation projects. Onsite sources will include excavated material from levee lowering, channel excavation, and breaching activities. Levee crests destined for trail access would be finished with an approximately 12-inch layer of aggregate base (*e.g.*, decomposed granite with timber or concrete edging) where the trails are part of the Bay Trail system or where there are agency compliance obligations.

A portion of the Pond A1 west levee will be widened to accommodate a trail and viewing platform. Viewing platforms include benches, signs, and educational panels that will be constructed of metal and wood and placed on cast-in-place concrete footings. The top elevation will be 11 feet NAVD88 north of the viewing platform, and 14.7 NAVD88 at and to the south of the viewing platform to match the raised Coast Casey Forebay Levee.

PG&E Boardwalk and Tower Footing Improvements and Additions
Conversion of salt pond to tidal marsh habitat will increase tidal depths and require PG&E to upgrade sixteen transmission line tower foundations and raise the access boardwalks located under the power lines. The project will elevate the existing PG&E access boardwalks in Pond A2W and construct a new section of boardwalk outside of Pond A1 to connect Pond A2W's outboard levee with the existing boardwalk outside of the Palo Alto Flood Control Basin. The replacement boardwalk will be constructed to a height of ten feet above the pond bottom and will be five feet wide. All work will occur between June 1 and September 30, and will be completed prior to levee breaching.

Working from the land-side of the existing boardwalk at the southern end of Pond A2W, the planks of the existing boardwalk would be removed, and the old piles pulled. Using hand tools to drive the 4-inch square plastic piles, PG&E crews would manually drive the support footings into the bay floor to an approximate depth of 12 feet, and spaced 10 feet apart. All work would be conducted by hand, and equipment used to install the boardwalks, including generators and chainsaws, will be mobilized to the boardwalk locations on foot. Some of this work may be done by a crew working from the existing boardwalk, but much of the demolition and removal would be done from a small boat and the use of an 8-foot by 10-foot raft. In the areas closest to shore, where water may be too shallow for a barge, some work may also be done while standing on temporary trellises or other work platforms, which would be placed on the pond bottom. This will include some foot traffic on the pond bottom and along the edge of the pond.

Using similar methods to raising the existing boardwalks within Pond A2W, a new section of boardwalk would be added bayward of Permanente Creek/Mountain View Slough and connect the end of the Pond A2W boardwalk with the end of an existing boardwalk located northwest of Pond A1. The additional boardwalk will be approximately 2,350 feet long and 3 feet wide, increasing the overwater structure by 7,050 square feet (0.16 acre) in this area. The total cross-sectional area of the 4-inch square piles to support this new boardwalk is approximately 700 square feet (0.015 acre). The total volume of the piles to support the new boardwalk would be approximately 280 cubic yards, of which approximately 186 cubic yards would be below the Bay floor (piles must be placed 12 vertical feet below the Bay floor), and the remaining 93 cubic yards would be in the water column at high tide.

Following the completion of boardwalk replacement and prior to breaching of the perimeter levees, 16 tower foundations in Pond A2W will be reinforced with additional concrete placed around the legs and four feet higher on the tower legs to protect the metal portions of the towers from corrosion. Each tower has four legs, and the total combined area of the new concrete foundations is estimated to be 540 square feet (0.013 acres), and the total combined volume of the concrete is 2,160 cubic feet (80 cubic yards). The duration of construction for the tower foundation improvements will be approximately 20 weeks from June 1 to November 30.

PG&E will construct a cofferdam around each of the footings, dewater the space between the cofferdam and the existing foundations, build a form for pouring additional concrete, pour the concrete with new rebar cage, and remove the cofferdam. The cofferdams would be installed at low tide to allow access to the foundation footing. The cofferdams would generally be composed of wood. These would be placed around each footing. Mud would be removed by hand, and the cofferdam pushed down to expose the solid piling, usually 3 feet below the mud line. The mud would be returned to the base of the footing after the cement is poured. The dewatering would be done by pumping the enclosed pond water out of the cofferdam. All concrete will be mixed by hand at each tower site. The cofferdam would be removed once the concrete is dry. Footing repairs can be done within a work area extending approximately 2 feet from the footing. In very shallow water or at low tides, rubber mats could be used for short periods to gain temporary access to perform work, and would be placed to help protect the vegetation around the boardwalk being built. New concrete would either be mixed at each tower location, or hauled in with a wheelbarrow to each location and removed in wheelbarrows for disposal. Some concrete deliveries could be made by helicopter.

Habitat Transition Zones

Habitat transition zones (HTZs) will be installed inside the southern edges of ponds A1 and A2W. HTZs provide transitional tidal marsh habitat from the pond bottom to the top of the levee, and to provide some additional erosion protection for the landfill and adjacent levees from waves, high tides, and sea level rise. HTZs involve the reuse and placement of material to create transitional habitats from the pond or marsh bottom to the adjacent upland habitat along portions of the upland edge. The construction period is anticipated to occur during one work season, and all work will be completed prior to levee breaching.

Fill placement will begin atop the levee and crews will work outward toward the center of the pond. The HTZs will have a top elevation of approximately nine feet NAVD88. In Pond A2W, the slope would be 30:1 (horizontal:vertical). The slope of these features in Pond A1 will vary from 10:1 to 40:1 (horizontal:vertical). The intent of this variation is to execute a pilot project that would provide observational data about the habitat value, erosion protection, and sea-level rise adaptation that would result from varying HTZ slopes. HTZ slope protection would be maintained by establishment of native vegetation through seeding, planting, and invasive plant control. The A1 transition zone will extend the entire 3,700-foot distance along the southern border of the pond. In Pond A2W the transition zone will only cross the 3,200-foot central portion of the pond’s southern border, so that potential future connections with the existing mitigation marshes to the south (the Mountain View mitigation marsh and the Stevens Creek mitigation marsh) will not be precluded. The HTZs will be constructed primarily of upland fill material from offsite projects. Table 2 has fill amounts for Ponds A1 and A2W. Fill placement may involve clearing and grubbing of debris and vegetation from construction areas, and brief stockpiling of material along the existing levee roads and bare ground prior to placement and subsequent compaction.

Habitat Islands

Similar to the above construction activities, habitat islands will be constructed prior to levee breaching. Up to ten habitat islands will be constructed throughout A1 and A2W (up to five in each pond) using fill from existing levees and imported fill material to provide isolated nesting areas for birds. As the ponds transition to marsh, it is expected that the habitat islands will eventually become marsh mounds that may require active native plant management, and replacement of non-natives with natives. The material for the habitat islands would be placed by long-reach excavators working from existing levees or by using an excavator and small barges in the pond to place and compact fill material. Each habitat island will be approximately 85 feet wide and 280 feet long, and an average of 23,800 square feet (0.55 acres). Total area for all ten islands would be approximately 238,000 square feet (5.5 acres). Fill area and volume of habitat islands are included in Table 2. To attract birds and prevent invasive plant recruitment, the top surface of the proposed habitat islands would be treated with a combination of rock, shell, and sand approximately 18 inches thick. As managed ponds, FWS has the ability to passively draw water levels down during island construction using the existing 48-inch tide gates. Construction of habitat islands would be done over several months within a single construction season.

Construction Equipment for Ponds A1 and A2W

Construction would be accomplished using conventional construction equipment including excavators, bulldozers, dump trucks, compaction rollers, water tankers, refueling tanks, pile-driving equipment, pumps, sheet piles, cranes, barges, skiffs, paving equipment, other construction equipment, and vehicles for transportation in and out of the project site. Helicopters may be needed in areas where new PG&E boardwalks are constructed. Fill material would be transported to the project area by haul trucks. Temporary fill would also be used at staging locations if required.

FILL PURPOSE	VOLUME (CUBIC YARDS)	VOLUME BELOW MHHW (CUBIC YARDS)	TOTAL FOOTPRINT AREA (ACRES)	FOOTPRINT AREA BELOW MHHW (ACRES)
Coast Casey Forebay Levee Improvement	27,400	12,050	2.3	1.5
Pond A1 West Levee Improvement	89,100	40,320	12.7	8.3
10 Habitat Islands	53,500	40,600	5.1	5.1
Bridge Piles, Abutments	540	100	0.1	0.0
Pond A1 Habitat Transition Zone	77,100	73,480	16.9	15.9
Pond A2W Habitat Transition Zone	80,000	77,120	15.7	15.7
Total	**327,640**	**243,670**	**52.8**	**46.4**

Table 2. Fill Volumes for Alviso Mountain View Ponds A1 and A2W (AECOM 2017).

1.3.1.2 Alviso-Island Pond Cluster (Ponds A19, A20, and A21)

The Island Ponds cluster contains Ponds A19, A20, and A21. This cluster is located between Coyote Creek and Mud Slough near the eastern end of the Alviso Pond Complex. The Island Ponds were breached in 2006 and have full tidal connectivity. A19 and A20 will be further opened to the surrounding waters in order to increase habitat connectivity, tidal flow, and accelerate transition of the ponds to tidal marsh. These goals will be achieved by breaching three new locations, widening existing breaches, removing and lowering levees, and installing ditch blocks and sediment to fill borrow ditches. Construction is anticipated to be completed with one work season.

Two new levee breaches will be constructed in the north levee of Pond A19 that will connect Pond A19 with Mud Slough. Breach channels will be approximately 150 feet long through the levee and marsh. The northwest breach will be 90 feet wide, and the northeast breach will be 50 feet wide. The existing westernmost breach along Pond A19's southern levee will be widened to approximately 150 feet across. Breach channels will have a bottom elevation of 3.5 feet NAVD88 with 3:1 (horizontal:vertical) side slopes. Pond A19's bottom elevation is approximately 4.3 feet NAVD88. Estimated length and width of breach channels are provided in Table 1.

The majority of the levees between Ponds A19 and A20 will be removed (Pond A19's western levee and Pond A20's eastern levee), to match the approximate 6.6 ft NAVD88 elevation of the existing strip of marsh between the two ponds. One section of each of A19 and A20 levees will remain for birds as high tide refugia, roosting, and nesting areas at an elevation of approximately 12 ft NAVD88. A large majority of Pond A19's northern levee and a southwest section of Pond A19 levee will be lowered to approximately 7 ft NAVD88 (approximately MHHW), with sections left at the current elevation of approximately 12 ft NAVD88 to provide high-tide refugia, roosting, and nesting areas. Areas to be lowered will be cleared before construction and then hydroseeded with native plant seed mix after lowering is completed. Approximately 25,500 cubic yards (CY) of material from existing levees around Ponds A19 and A20 will be removed and reused in the restoration as described below.

To accelerate the transition to tidal marsh habitat, ditch blocks and the placement of fill in the borrow ditches will occur in the western portion of Pond A19. Filling borrow ditches using material from levee breaching and other on-site activities is intended to direct tidal flows to drain borrow ditches into the pond interior on an outgoing tide to prevent fish stranding and promote the re-establishment of the historic tidal drainage system. No imported fill material will be brought into the Island Ponds. Approximately six ditch blocks and associated borrow ditch fill will be constructed in Pond A19 by placing fill below the mean higher high water (MHHW) elevation into the existing internal borrow ditches and compacting it. Ditch blocks will have a top elevation of approximately 4.5 feet NAVD88, and borrow ditch fill will be constructed to connect with the existing adjacent pond bottom. Excavators and vibratory hand tampers will be used for placement and initial compaction, and a roller will also compact fill. As above, approximately 25,500 CY of fill from levee modifications will be placed in Pond A19 and A20. Approximately 2.4 acres of cut below MHHW, and 6.6 acres of fill below MHHW will occur in Island Ponds during Phase 2 actions.

Construction crews would typically consist of fewer than a dozen people. Equipment used will be similar to Mountain View ponds, including an amphibious excavator. Movement of the excavator between the perimeter levees of Ponds A19 and A20 would occur at low tide utilizing mats.

1.3.1.3 Alviso (Pond A8)

Construction at Pond A8 will create two habitat transition zones at the southwest and southeast corners of Pond A8S where the pond bottom intersects the levee. Pond A8 is one large pond that includes former salt ponds A5/A7/A8S/A8, described above. The construction period is anticipated to occur during one work season. The waters of Pond A8 are managed with an existing armored notch structure equipped with eight 5-foot wide weirs (or gates) that can be opened independently of each other.

Fill placement will begin atop the levee and crews will work outward toward the center of the pond. This will be done by building the tops of the transition zones to approximately nine feet NAVD88 where it will meet the existing levee top, and placing fill in the pond bottom, which has an elevation of approximately -0.9 ft NAVD88. The resulting slope will be approximately 30:1 (horizontal:vertical). The length of each transition zone will be approximately 2,075 feet, and designs include a separation in the middle to ensure access for a potential future connection with the combined creek mouths of San Tomas Aquino and Calabasas Creek. Establishing the transition zones will require approximately 174,000 CY of primarily onsite or imported fill that will be placed below MHHW elevation in a 24-acre area. Fill placement may involve clearing and grubbing of debris and vegetation from construction areas, and brief stockpiling of material along the existing levee roads and bare ground prior to placement and subsequent compaction.

Construction equipment will include haul trucks, bulldozers, water trucks, compaction rollers, other construction equipment and vehicles for transportation in and out of the project site.

1.3.1.4 Ravenswood Ponds (Ponds R3, R4, R5, and S5)

All four Ravenswood Ponds in this project (R3, R4, R5, and S5) are currently hydraulically isolated from tidal waters, and are seasonally wet ponds that collect rainwater during the wet season but dry out to become salt pannes during the dry season. The restoration goals for the Ravenswood Ponds are: (1) to restore Pond R4 to tidal marsh with an open tidal regime by excavating a breach and channel into Ravenswood Slough; (2) to improve Pond R3 as an enhanced managed pond for small shorebirds; and (3) to convert Ponds R5 and S5 to enhanced managed ponds for waterfowl by installing water control structures, lowering internal levees, and making border levee improvements. In addition, public access and recreational features will be installed and enhanced. The construction at the Ravenswood Ponds is anticipated to occur over a period of at least three work seasons.

Levee Breaching and Lowering, and Channel Excavation

A breach channel will be excavated in the levee and external fringing marsh in the northeastern corner of Pond R4 (295 acres) to connect it with Ravenswood Slough and open the pond to full tidal range. The breach location was selected to promote the development of tidal marsh habitat and reduce wave scour within Pond R4 that would inhibit marsh development. The proposed breach location also minimizes impacts to existing fringe marsh habitat located on outside the levee in Ravenswood Slough. The breach channel will be 470 feet long and 200 feet wide, with a bottom channel elevation of approximately 2 feet NAVD88 with side slopes of 3:1 (horizontal:vertical). The average bottom elevation of Pond R4 is approximately 4.9 feet NAVD88 (MHHW is approximately 8 ft NAVD88). Estimated length and width of breach channels are provided in Table 1.

Before levee breaching will occur, interior channels within Pond R4 will be excavated to direct the new tidal flows into the pond's interior by creating and extending channels from portions of former slough traces. Interior channels will direct tidal flows to the pond interior on an outgoing tide that will prevent fish stranding and promote the re-establishment of the historical tidal drainage system. The proposed pilot channels will together be roughly 2,900 feet long and will be excavated through the existing pond bed (approximately 4.1 acres). The interior channel bottom elevation will be 2 feet NAVD88 to roughly match the elevation of the existing channels within Pond R4. The bottom width of the channel cut will be approximately 50 feet wide with side slopes of 2:1 (horizontal:vertical) (See Table 1 for channel dimensions). The moved sediment will be used to enhance levees, and construct habitat transition zones and ditch blocks. Ditch blocks will be built in the existing internal borrow ditches west of the R4 breach to direct tidal flows through numerous small channels to the historic slough trace at the pond interior. The source material for the ditch blocks will be from a combination of imported fill material and local material from levee lowering or breaches.

Approximately 1000 feet of levee in the northwestern corner of Pond R4 will be lowered after in-pond construction activities are completed. The levee lowering along Ravenswood Slough will be lowered intermittently in approximate 200 foot sections along the levee to allow for high tide refugia for marsh species. Both sections will be lowered approximately 2 feet to approximately 8 feet NAVD88 with side slopes of approximately 2:1 (horizontal:vertical). This modification is intended to improve habitat connectivity between Pond R4 and adjacent sloughs, and provide high tide refugia for salt marsh harvest mouse and other species. Material from the lowered levee would be used to raise levees or construct habitat transition zones onsite.

Levee breaching and associated excavation of a channel to connect to Ravenswood Slough will be accomplished from levee crests using long-reach and/or aquatic excavators and hauling material using trucks to onsite locations. Excavated material will be used for ditch blocks, levee improvement, or habitat transition zones.

Remove Internal Levees in Ponds R5 and S5

Ponds R5 and S5 are seasonal ponds created by rainwater currently closed to tidal circulation, and will be converted into a single enhanced managed pond (hereafter called Pond R5/S5) through removal or modification of levees within and between the ponds. Pond S5 will be a managed pond allowing a muted tidal range into and out of the R5/S5 Pond Complex. The entire internal levee within Pond S5 (approximately 370 feet), and most of the internal levee between Ponds R5 and S5 will be removed with an excavator (approximately 1,400 linear feet) and lowered to an elevation of 4.5 feet NAVD88 to match the surrounding pond bottoms. The center portion of the R5/S5 levee would be left in place and resurfaced to improve its suitability for use as a habitat island for bird roosting and nesting. The habitat island surface would be approximately 1.77 acres with a relatively flat top at elevation 9 feet NAVD88 (above the MHHW elevation) with side slopes of 2:1 (horizontal:vertical) down to the adjacent pond bottom. Sand, shell, or other suitable topping would be added to the island to enhance its utility for birds and to help control invasive vegetation. Removed levee material would be reused onsite to improve levees, fill borrow ditches or construct habitat transition zones.

Levees will be improved between Ponds R3 and R4, and R4 and R5. Approximately 4,700 feet of improved levee will be constructed on existing levees, including fill of a remnant salt works channel located in between R3 and R4 that is called the All-American Canal. The berm-like levees along both sides of the All-American Canal would be raised and strengthened, and the canal would be filled in, creating a single levee. Constructing this improved R3/R4 levee will replace flood risk protection currently provided by outboard levees on Pond R4. Levee improvements at the western end of the canal would extend north along the Ponds R4/R5 border and south along the R3/S5 border to isolate Ponds R5 and S5 from the others so that they can be managed separately. The improved levee would consist of a 60-foot-wide crest with side slopes at approximately 3.5:1 (horizontal:vertical) on the north side and 4.5:1 (horizontal:vertical) on the south side. The crest of the R3/R4 levee would be at elevation 11 feet NAVD88. The improved levee would become wider as it transitions to meet the sections of improved levee that would form the eastern borders of Ponds R5 and S5. The R5/S5 levee improvement will also be the foundation for a new public access trail and viewing platform (described below). Most of the material for the improvements would come from offsite sources, though some may be from onsite excavation activities.

Habitat Transition Zones

Two habitat transition zones will be constructed and vegetated in Pond R4. One will be located on the western side of Pond R4 abutting the Bedwell Bayfront Park border (approximately 2,500 feet long). The other habitat transition zone will extend northward into Pond R4 along the entire 5,100 linear foot length of the improved R3/R4 levee (the former All American Canal). The top elevation of the habitat transition zones will be at 9 feet NAVD88 along the levees or the high ground of the park and have side slopes of 30:1 (horizontal:vertical) with varying steeper slopes at end transitions. The transition zones will be constructed primarily of upland fill material brought in from off-site locations. The amounts of fill are included in Table 3 below.

FILL PURPOSE	VOLUME (CUBIC YARDS)	VOLUME BELOW MHHW (CUBIC YARDS)	TOTAL FOOTPRINT AREA (ACRES)	FOOTPRINT AREA BELOW MHHW (ACRES)
R5/S5 East Levee and All American Canal Levee Improvement	182,400	46,090	17.5	7.0
All American Canal HTZ	76,300	69,460	14.9	12.0
Bedwell Bayfront Park HTZ	50,200	47,240	9.1	8.3
Ditch Block west of R4 Breach	1,000	1,000	0.3	0.3
Water Control Structures	400	400	0.2	0.2
Total	**310,300**	**164,190**	**41.9**	**27.8**

Table 3. Fill amounts for Ravenswood Ponds Phase 2 actions (AECOM 2017).

Water Control Structures

Six derelict water control structures will be removed and four new ones will be installed within the Ravenswood Complex. During removal of water control structures, all associated support structures will be demolished and disposed off-site or recycled as appropriate. If a new water control structure will not replace the old one, then sediment fill will be placed and compacted for levee reinforcement in its place. Pond R3 will have two water control structures replaced: one between R3 and Ravenswood Slough, and one between R3 and S5. One water control structure in Pond R4 will be removed, and one will be installed between R4 and R5. Ponds R5 and S5 will be converted into a single enhanced managed pond (R5/S5) through removal or modification of levees within and between the ponds. Removed water control structures in R5/S5 include one between R3 and S5, one between R5 and S5, and one at the eastern terminal end of the All-American Canal. A water control structure will be installed between S5 and Flood Slough. The installed water control structures will be constructed of circular high density polyethylene (HDPE) 36-inch or 48-inch pipes (culverts) that will allow water to pass through levee structures through combination slide/flap gates at both ends to allow two-way flow control. The number of pipes, pipe size, and invert elevations for each water control structure are listed in Table 4.

Construction of the water control structures could occur in the wet or the dry. If the contractor decides to perform construction in the dry, some localized dewatering would be required. Dewatering of pond bottom would be accomplished by evaporating the pond beds to provide access to excavate pilot channels. Limited, local dewatering using portable, generator-powered pumps will take place as needed during the installation of water control structures. Trenches will be cut by excavators. To stabilize the substrate on both ends of each culvert for post-construction operation, geotextile fabric and bedding material will be installed in the immediate area. Pipe bridges will be built over both ends of each structure to allow maintenance and operations access. The pipe bridges would be built precast/pre-stressed concrete voided slab decks on pile caps, supported on 32 16-inch concrete piles. The use of a vibratory hammer is preferred, but may be conducted with an impact hammer (maximum 300 blows per pile, and four piles driven per day). Concrete piles will be driven within de-watered temporary cofferdams, which will be constructed of 24-inch steel sheet piles that will be installed with vibratory methods at low tide.

SITE	NO. OF PIPES	INSIDE DIAMETER (INCHES)	PIPE LENGTH (FEET)	INVERT ELEVATION NAVD88 (FEET)	PILE QUANTITY*	TOTAL AREA** (SQUARE FEET)
Pond R5/S5 to Flood Slough	2	48	183	2	8	3,790
Pond R5/S5 to Pond R4	2	48	78	3.5	8	1,650
Pond R5/S5 to Pond R3	1	36	67	4.5	8	690
Pond R3 to Ravenswood Slough	1	36	62	2	8	640
Total	6	N/A	390	N/A	32	6,770
Notes: *All piles are 16-inch diameter and approximately 20 feet long. **Total Area includes pipe-culvert, gates and bridges at each control structure						

Table 4. Water Control Structures installed in Ravenswood Ponds will be culvert pipes with combination slide/flap gates. Pipe quantities, dimensions, and bottom (invert) elevations are given.

Recreational and Public Access Features
A trail and viewing platform will be constructed along the improved eastern levees of Ponds R5 and S5 and linked to the existing trails outside of these ponds. The trail will be approximately 2,750 feet long and 10 feet wide. Surfacing materials will be decomposed granite with timber or concrete edging. The viewing platform will be constructed near the central point of this trail, at the junction with the former All-American Canal levee, and will include benches, signs, and educational panels that will be constructed of metal and wood and placed on cast-in-place concrete footings.

Earthwork activities will be sequenced such that activities that will be efficient to perform in dry conditions will be completed first (*e.g.*, levee improvements, installation of hydraulic controls, pilot channel excavation, and internal levee lowering). Levee lowering and breaching along the outer boundaries of the ponds designed to establish hydraulic connection with adjacent sloughs will be performed after the internal pond activities are completed. Breaching will not occur until all necessary water control structures and in-water habitat enhancement features are completed.

Construction equipment for Phase 2 actions described above will include dump trucks, bulldozers, water trucks, compaction rollers, vibratory plates, water tankers, refueling tanks, pile-driving equipment, pumps, sheet piles, cranes, excavators (amphibious and/or terrestrial, fitted with long reach attachments), skiff, barge (for construction access to the project site), vehicles for transportation in and out of the project site, and other construction equipment. Depending on soil conditions within the ponds, temporary heavy equipment mats or wooden mats with gravel cover will be employed (before pond breaching) to provide access and establish working conditions to excavate pilot channels at the pond bottom. Temporary fill will also be used at staging locations if required. Upland and offsite fill material would be transported to the project area by trucks.

1.3.2 Operations and Maintenance of the SBSP Restoration Project

FWS proposes to continue existing operations and maintenance (O&M) activities and implement new O&M activities at Phase 2 constructed projects over a 12-year work period at all Refuge properties. New O&M activities after Phase 2 actions are complete will address habitat transition zones at the A8, Mountain View and Ravenswood Ponds, and water control structures in the Ravenswood Pond Complex. Habitat transition zones will need periodic vegetation management, pest control, and rebuilding with sediment. Water control structures at Ravenswood will primarily be used to manage R3, R5 and S5 for various types of bird habitat, water quality control, and may be drawn down during the rainy season.

Ongoing O&M activities from Phase 1 of the SBSP will continue on Refuge lands and waters in the same manner as they have in the past. Water control structures will be used to manage water levels and circulation at managed ponds; levees and water control structures will be maintained for flood risk management and managed pond purposes; small amounts of riprap for stabilization may be utilized; trails, docks, access facilities and boat launches will be maintained for management and recreational use; inlet and outlet channels through tidal marsh to these structures will require periodic dredging; trash racks and fish screens will be cleaned; habitat islands will need periodic vegetation control and rebuilding with sediment; and FWS will need to respond to emergency situations. Each of the above activities will require access by land or sea and may also require staging areas and storage/stockpile areas. O&M will be conducted according to the best management practices (BMPs) described below.

In Refuge ponds that have been breached, ongoing tidal marsh restoration processes will continue to reduce the need to maintain many miles of levees and berms. Breached levees around marsh restoration areas will generally be allowed to erode and become part of a reduced O&M requirement.

1.3.2.1 New Managed Pond Operations in Ravenswood Complex

Water control structures will be used both to manage water levels and flows in and out of Ponds R5/S5 (67 acres), and R3 (270 acres) from San Francisco Bay and between ponds to benefit bird habitat and to meet water quality objectives (Table 5). The water levels in Pond R4 will not be controlled due to the open breach and levee lowering to restore the pond to tidal marsh habitat. Minimal seasonal variation in water depth is anticipated at these locations. Pond R4 will be breached for open tidal exchange and development of tidal marsh. The breach and pond interior channel depths of R4 are expected to average 3 to 4 ft and approximately 6 ft deep at MHHW, and drained at mean lower low water (MLLW). MHHW is approximately 8 ft NAVD88 with an approximate tidal range of 7 ft at the Ravenswood ponds.

The design objective for the combined R5/S5 pond is a muted tidal connection with Flood Slough for two-way flow, managed primarily for waterfowl. The installed water control structure between R4 and R5 will be operated for year-round, two-way flow. The bottom of pipe elevation of that culvert will be 3.5 feet NAVD88, which is near the mean tide line at approximately 3-4 ft NAVD88 and Bay water is expected to flow in and out during most tidal cycles. The culvert between R5/S5 and Flood Slough will allow two-way flow with a bottom of pipe elevation (2 ft NAVD88), 1-2 ft below the mean tide line. Elevation and other information about the culverts is given in Table 4 above. During winter months, the Refuge may operate one gate in Pond R5/S5 as outflow only and the other gate open to two-way flow to slightly decrease water levels and increase storage capacity for large storm events. Winter inflows into R5/S5 are expected to be lower due to the presence of rainwater in the pond. Expected average and max summer inflows into Pond R5/S5 from Flood Slough are 63 cfs and 353 cfs, respectively. Average and max winter inflows are 23 cfs and 118 cfs, respectively. The average depth of Pond R5/S5 will be approximately two to three feet deep.

The water levels of Pond R3 will be actively managed for snowy plover habitat. During winter and spring months both water control structures will be used to drain the pond by operating the gates as outlets only. Water will not be able to enter R3 on a rising tide, but will be able to exit on an ebbing tide. During summer and fall the gates will also be operated for small amounts of two-way flow to refresh the water in the borrow ditches and slough traces to get small amounts of water exchanging for invertebrate prey production in the remnant channels and borrow ditches. The average pond bottom elevation in R3 is approximately 2 ft NAVD88. The bottom of pipe elevations for R3's water control structures are 2 ft NAVD88 between R3 and Ravenswood Slough, and 4.5 ft NAVD88 between R3 and R5/S5. The remnant channels and borrow ditches vary in depth but are expected to average approximately 3 feet deep.

Water Control Structure #	Pond Location	Intake Waterbody	Summer/Fall Operations (June 1 – January 31)	Winter/Spring Operations (February 1 – May 31)
WCS-1	Pond R5/S5	Flood Slough	Two-way flow	Two-way flow, or outlet only
WCS-2	Pond R5/S5	Pond R4	Two-way flow	Two-way flow, or outlet only
WCS-3	Pond R3	Pond R5/S5	Minimal two-way flow	Outlet only
WCS-4	Pond R3	Ravenswood Slough	Minimal two-way flow	Outlet only

Table 5. Water control structures that will be installed in Ravenswood Ponds during Phase 2 actions, and their associated seasonal operation.

1.3.2.2 Ongoing Pond Operations in Alviso and Ravenswood Complexes

FWS proposes to continue to manage the ponds within Refuge boundaries consistent with Phase 1 practices to provide habitat for bird species and improve water quality. Bay waters will continue to be circulated through water control structures, and existing levees will be maintained. The operation of each pond system is generally described below. Further details regarding proposed operations are presented in Table 6 and in the projects' biological assessment (BA) and Supplemental BA (AECOM 2017, AECOM and ESA 2018).

Normal summer pond operations focus on maintaining full tidal circulation while maintaining discharge salinities by preventing local stagnant areas which may create areas of higher salinity or algal blooms. Water levels in some ponds are lowered during the summer to improve shorebird nesting and foraging habitat. Some ponds are maintained as a higher salinity pond during summer to favor brine shrimp development for foraging waterbirds. Some ponds are often mostly dry during the summer to provide nesting habitat for shorebirds (*e.g*., snowy plover), with only high salinity water in the borrow ditches and some standing water to provide foraging habitat. Water levels are managed at specific levels in ponds depending on their elevation and tidal range to avoid wave erosion of the berms. Normal winter pond operations focus on maintaining water surface levels lower in winter months to reduce potential overtopping in anticipation of heavy winter rains and high tides. Deeper water levels are managed in several ponds to support roosting and foraging for wintering waterfowl and to provide waterfowl hunting opportunities.

Most water control structures in the action area have the ability to be operated as intakes and/or outlets between the tidal channels and sloughs of the South Bay and the interior of managed pond complexes. As intakes, water will be withdrawn from the South Bay or adjacent tidal sloughs and conveyed into the managed pond complex. All intakes are operated tidally, where water flows through the intake during the incoming flood tide. Structures that are operated as "intake-only" allow the flood tide to enter the managed pond, but a flap gate (or similar structure) prevents water from flowing back out of the managed pond as the tide recedes. Structures that are operated for "two-way flow" are open at both ends and allow water to flow in and out of the managed ponds with the tidal cycle. "Outlet-only" structures prevent the inflow of water from the South Bay or slough and serve to drain the managed ponds.

For the protection of steelhead in the Guadalupe River and Coyote Creek watersheds, water control structure operation will be limited. Table 6 includes operation of the water control structures in the action area during the project period. If alternative management scenarios require water control structures to be operated as intake-only year-round, fish screens will be installed before October 15 and prior to their year-round use. Refuge maintenance workers conduct daily inspections of all water control structures throughout the refuge. Inspections include visual checks to ensure that the gates are functioning and not clogged, and that flow moves throw pipes unrestricted. Inspections also include dissolved oxygen (DO), salinity, and pH testing in pond water adjacent to water control structures with a handheld meter per Regional Water Quality Control Board (RWQCB) requirements. If water quality thresholds are reached, then management measures according to the Adaptive Management Plan (AMP, described below) will be implemented (*e.g.*, increase tide gate opening for increased exchange, clean debris).

Alviso Pond Complex Operations
Alviso Pond A3W is a managed pond system consisting of Ponds B1 (142 acres), B2 (170 acres), A3W (560 acres), A2E (310 acres), and A3N (163 acres). The Pond A3W system is interconnected through a series of gated and ungated culverts ranging from 24 to 48 inches in diameter. Water enters the system through culverts in from the Bay to Pond B1, and exits from A3W to Guadalupe Slough. Objectives for existing water control structures are the following: maintain tidal circulation through ponds B1, B2, A2E, and A3W; maintain discharge salinities to Guadalupe Slough at less than 40 parts per thousand (ppt); maintain water levels in Pond A3N to cover the pond bottom by leaving the internal A3N/A3W gate fully open year-round; and maintain water surface levels lower in winter to reduce potential overtopping and erosion of A3W and A2E levee adjacent to Moffett Field. Winter operation (Feb 1- May 31) involves operating the two gates (48 inches, 36 inches) between the Bay and B1 for two-way flow, and the three 48-inch gates between A3W and Guadalupe Slough as outlet-only. Water levels in B1 and B2 will be lowered during the summer to less than one foot deep to improve shorebird nesting and foraging habitat.

The Pond A8 system functions as one large muted tidal managed pond system that includes 1,400 acres of former pond areas A5, A7, A8, and A8S that underwent internal levee breaching during SBSP Phase 1 to allow internal circulation between these ponds. Pond A8 has a reversible armored structure with eight tide gates (each 60-inches wide) called the “notch,” which began operation in July 2010 with one gate open during dry season months, and is now fully open year-round as of June 2017. All gravity intake flow occurs during incoming tides, and all outflow occurs when the tide is below 8.1 ft MLLW. Ponds A5 and A7 each have one water control structure (each structure is comprised of two 48-inch culvert pipes) located on the outboard levees that are non-functional and two-way flow occurs year-round. A portion of the levee adjacent to Pond A8 was reconfigured as part of the Lower Guadalupe River Flood Protection Project to act as an overflow. The 1,000-foot long overflow weir at Pond A8 will allow high flood flows to exit Alviso Slough into Pond A8 when water levels reach approximately 10.5 ft NAVD88. The water levels have not overtopped the weir since 2004.

The Pond A14 system consists of Ponds A9 (385 acres), A10 (249 acres), A11 (263 acres), and A14 (341 acres). The objectives of the Alviso Pond A14 systems are to maintain tidal circulation through ponds A9, A10, A11 and A14, while maintaining discharge salinities to Coyote Creek at less than 40 ppt. During summer and fall months (June 1-January 31) the normal flow through the system proceeds from the water control structure (two 48-inch gates) at A9 near the confluence of Alviso Slough and Coyote Creek Slough, then flows through internal water control structures and levee cuts into A10, A11, and an outlet to Coyote Creek Slough from A14. All gravity intake flow occurs at high tide, and all outflow occurs when the tide is below 6.2 ft MLLW. During winter months (February 1-May 31) the A9 and A14 gates will be outlet-only. No water flow will occur in the A14 system from February through May besides rainfall, and A9 water levels are expected to be very low in spring months.

Ponds A12 (309 acres), A13 (269 acres), and A15 (249 acres) will be managed as high salinity ponds (80-120 ppt) to favor brine shrimp development. Ponds A12 and A13 operate as a single unit, with inflow from A11 during summer months, and A12/A13 outflows to either A14 or A15. Pond A15 operates as a separate pond, with inflow from A14 during summer months or by gravity from a 48-inch gate between A15 and Coyote Creek Slough during June 1-January 31. During winter months (February 1-May31) the A15 gate will be outlet-only to Coyote Creek Slough.

Pond A16 (243 acres) is managed for shallow water habitat. A fish screen is located at an intake-only gate between Ponds A16 and A17 (Intralox traveling screen), and is being operated by FWS to prevent fish from entering Pond A16. Pond A17 is a breached pond and has a fully tidal connection with Coyote Creek. The fish screen will require ongoing maintenance to keep screens aligned and performing as designed. In addition, there is a water control structure between Pond A16 and Artesian Slough that is outlet-only year-round.

Ponds A23 (445 acres) and A22 (275 acres) are managed for snowy plover habitat. There is one 48-inch gate between a donut levee and Mud Slough that can exchange water only at very high tides. The donut levee connects primarily with Pond A22, and minimally with A23. This gate is the only water control structure and entry/exit point for water for these two ponds. The gate is outlet-only during winter months (February 31-May 31). During summer there will be minimal two-way flow for bird foraging habitat within channels and the borrow ditch.

Ravenswood Pond Complex Operations

Pond SF2 is managed to maintain shallow water muted tidal conditions to provide foraging habitat for shorebirds and waterfowl with a 155-acre pond including 30 nesting islands (cells 1, 2, and 4), and an 85-acre seasonal wetland for snowy plover nesting (cell 3). Water flows into and out of Pond SF2 through water control structures at the northern (cell 1) and southern ends (cell 4) of the bayfront levee. Weirs with adjustable flashboard risers are used to control flow in and out of cells 2 and 3. The seasonal wetland area (cell 3) has one intake and one outlet structure. During summer (June 1-January 31), Pond SF2 southern water control structure to the Bay is outlet-only from cell 4 and the northern water control structure to the Bay is primarily intake-only into cell 1, with some two-way flow occurring at times. During winter months (February 1-May 31), both cell 1 and cell 4 water control structures will be operated for two-way flow to create muted tidal conditions in SF2.

Ponds R1 (450 acres) and R2 (140 acres) are managed for muted tidal conditions for shorebird and waterfowl. There are two 72-inch gates located between R1 and Ravenswood Slough, and water moves from R1 to R2 through an internal water control structure. During summer months, R1 and R2 are passively drawn down through evaporation and subsequently provide snowy plover nesting habitat. During winter months, primarily October through January, one of the two 72-inch gates between R1 and the Bay is opened approximately 20 inches for minimal two-way flow to cover the pond bottoms in R1 and R2 for waterfowl hunting season.

Water Control Structure #	Pond Location	Intake Waterbody Location	Summer/Fall Operations	Winter/Spring Operations
A3W-1, A3W-2 (two culverts)	B1	San Francisco Bay	No restrictions June 1 to Jan 31	Two-way flow from Feb 1 to May 31
A3W-10	A3W	Guadalupe Slough	No restrictions	Outlet only Feb 1 to May 31
A7-1	A5	Guadalupe Slough	Two-way flow year-round	Two-way flow year-round
A7-7	A7	Alviso Slough	Two-way flow year-round	Two-way flow year-round
Armored Notch	A8	Alviso Slough	All eight gates open; two-way flow year-round	All eight gates open; two-way flow year-round
A14-1	A9	Alviso Slough	No restrictions June 1 to Jan 31	Outlet only Feb 1 to May 31
A14-13	A14	Coyote Creek	No restrictions June 1 to Jan 31	Outlet only Feb 1 to May 31
A14-10	A15	Coyote Creek	No restrictions June 1 to Jan 31	Outlet only Feb 1 to May 31
A16-5, A16-5b (two culverts)	A16	Artesian Slough	Outlet only year round	Outlet only year round
A16-1	A16	A17, Coyote Creek	Fish screen installed	Fish screen installed
A23-1	A23 and A22	Mud Slough	No restrictions June 1 to Jan 31	Outlet only Feb 1 to May 31
WB-1, WB-1A (two culvert)	R1	Ravenswood Slough	No restrictions June 1 to Jan 31	Two way flow or outlet only Feb 1 to May 31
WB-4	R2	Ravenswood Slough	No restrictions June 1 to Jan 31	Two way flow or outlet only Feb 1 to May 31
SF2-1	SF2	San Francisco Bay	No restrictions June 1 to Jan 31	Two-way flow or outlet only from Feb 1 to May 31
SF2-2	SF2	San Francisco Bay	No restrictions June 1 to Jan 31	Two-way flow or outlet only from Feb 1 to May 31

Table 6. Managed pond water control structures in the Refuge. Operational measures to protect juvenile steelhead.[3] For more details, see above and FWS 2016 annual report (FWS 2017).

[3] Restrictions on operations will be revisited if studies evaluating juvenile salmonid behavior indicate that juveniles do not enter ponds, or if juveniles do enter ponds they find egress in a timely manner. Studies will be conducted at

1.3.2.3 Ongoing O&M Activities

Ongoing O&M activities may include the use of levee fortification and maintenance, channel maintenance, habitat island maintenance, material storage, dock and other structure maintenance, PG&E O&M activities, and water-based equipment. Each of these activities is described below.

Levee Improvements and Maintenance

Maintenance is expected to occur every five years to add additional fill material in areas where settlement occurs. Most of the maintenance would be accomplished during low tide and from the levee crest. Material dredged from inside salt ponds or imported clean fill will be placed on levee tops and/or levee sides in the minimum amount necessary to repair or protect levees. In limited instances, levee fortification may be accomplished by dredging muds from the outside, bay, or slough side of the levee for placement on the salt pond levee. Dredged sediment deposition occurs on approximately 5 percent of the salt pond levees a year. The levee tops are disked and graded prior to maintenance. Levees containing the existing railroad track will be maintained by Union Pacific Railroad to allow the continued use of the tracks in the Alviso Pond Complex using the activities described above.

Rock riprap will be placed in the minimum amount necessary to protect existing levees. In some instances, riprap is required because of continued localized erosion from high wave energy and is maintained on a continuing basis. The amount placed will be the minimum required to provide protection and will be placed from the levee toe upwards onto the levee or to stabilize structures. It is anticipated that riprap will be used to maintain outboard levees of ponds that do not have outboard marsh habitats and that are likely to be restored to tidal circulation in the future.

Habitat transition zones may require O&M activities in order to ensure slope stability and improve habitat quality. Proposed O&M actions includes the following: placement of material to repair areas of significant erosion and/or protect levees; weed and pest removal (described below); active revegetation with native plant species; addition of soil amendments; light grading; addition of coarse woody debris; and removal of trash or significant wrack areas that create a hazard to slope stability or trail user safety.

Channel Maintenance

Periodically in managed ponds, inlet and outlet channels that allow water to flow into or out of water control structures will need to be maintained. This typically will involve dredging of any accumulated sediment that is preventing the free flow of water. Additionally, periodic inspection and maintenance of restored internal channels and associated infrastructure such as water control structures, internal managed pond berms and canals will be required to ensure that the ponds are operating as intended. This could include removal of accumulated sediments, repair of water control structures and placement of materials on internal levees as needed to maintain pond function.

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the earliest opportunity based on environmental and permitting limiting factors. If FWS proposes revision of any operational restrictions, Section 7 consultation with NMFS shall be reinitiated to address these changes, and no operational changes will be made until the reinitiated consultation has been completed.

Habitat Island Maintenance
Habitat islands are expected to settle or erode over time due to the weak and soft condition of the bay mud. Maintenance is expected to be required within about 5 to 10 years to raise the nesting island elevation, unless it is determined that lower subsided nesting island elevations are used successfully by birds. The habitat islands are designed to test the effectiveness of both island shape and spacing. Once the results of this testing are complete, the islands may be recreated in a different configuration. Habitat islands may require weed removal as often as quarterly, and the placing of fill material (*e.g*., sand, gravel, and/or oyster shells) before the onset of the nesting period in some years.

Material Storage
Ongoing maintenance requires the temporary storage of shoreline protection or levee surface materials in certain previously approved or designated areas. The Refuge's existing management plans includes the continued practice of using existing dredged material stockpile locations, thus ensuring that disturbance occurs in the same area. As the material is removed and then replaced with new material on each pass (typically once every 5 to 10 years), the material is new bay fill each time it is placed.

Water Control Structures and other Built Structures
Water control structures, docks, boat launches, existing marine crossings, existing bridges, bridge foundations and abutments within the network of levees, intake channels, tide gates, pipes, ditches, pumps, piers, trestles, walkways, fences, bulkheads, platforms and other facilities will be used, maintained, and replaced on an in-kind, as needed basis, that does not result in a significant enlargement or increase of square footage (*i.e.*, not more than 100 feet) over that of the existing. If required, maintenance may require the installation and use of new pipes, culverts, intake structures, electrical distribution lines for the operation, and pumping facilities that will involve the minimum dredging or fill necessary. Water control structures will be checked weekly for obstruction to flow passage and preventative maintenance such as visual functionality of gates, seals; and removal of debris. Portable pumps, such as diesel-powered pumps, may be used occasionally for operations and maintenance activities, such as supplementing gravity flows through the water control structures or dewatering cells or canals for maintenance. Operations and maintenance activities will be conducted during low tides, and by maintaining low storage conditions in managed ponds.

Equipment Used
A general list of this equipment would include excavators (amphibious and/or terrestrial, fitted with long-reach attachments or dragline excavators), floating dredges, haul trucks, bulldozers, water trucks, compaction rollers, low-bed truck, conventional hand-tools and other common construction equipment, skiffs, boats, floating dredges, and amphibious equipment (*e.g*., amphibious dredge or vegetation removal equipment) and pickup vehicles for transportation in and out of the project site. Access through San Francisco Bay, sloughs, and other channels will be required for water-based equipment.

1.3.3. Conservation Measures

The following measures are a subset of those proposed to avoid and/or minimize adverse effects on listed species and critical habitat. A complete list of conservation measures and BMPs proposed by FWS for Phase 2 of the SBSP are available in the project's biological assessment, and the supplemental to the biological assessment. The measures listed below reduce impacts to listed fish within the tidal sloughs, bays, and marshes of the action area. These measures will be implemented, when appropriate, for each project action.

1. Construction activities in, or directly adjacent to tidal waters, where steelhead are likely to be present, will be performed during low tide between June 1 and November 30 to the maximum extent practicable.
2. NMFS personnel will be immediately notified of any observed listed fish mortality events.
3. Levee breaching will not occur between February 1 and May 31 for the protection of juvenile steelhead.
4. All existing and new water control structures on outboard levees directly on steelhead migration routes, which are estuarine waters of Stevens Creek, Guadalupe River, and Coyote Creek that may be used as intake-only to divert water, will be closed during peak migration periods (December - May) (See Table 6). If these water control structures remain open from December through May, then they will be fitted with fish screens that meet NMFS criteria before steelhead migration begins (December 1). Fish screen designs will be provided to NMFS for review and approval.
5. The use of temporary cofferdams that would require dewatering will not be installed on creeks and sloughs that are known steelhead runs (*e.g*., Coyote Creek/Slough, Guadalupe River/Alviso Slough, and Stevens Creek/Whisman Slough) between February 1 and May 31.
6. Cofferdams will be closed when little or no water is present (*i.e*. during low tide), if practicable, to avoid or minimize the entrapment of fish in the construction area. This will be done by installing all but one sheet of the cofferdam, leaving an opening at the lowest point in the enclosure, and installing the remaining sheet at low tide when little or no water is present.
7. If cofferdams are anticipated to be closed when water deeper than one inch is present, a NMFS-approved biologist will be present to conduct fish rescue and relocation activities to safely remove any fish that may become stranded between the cofferdams. A record of relocated fish will be provided to NMFS within 7 days of each relocation event.
8. Armoring and bridging of levee breaches and water control structures will be done in dry conditions using temporary cofferdams installed with vibratory hammer methods as the primary method, and the use of an impact hammer only if necessary.
9. Pile driving will occur within a dewatered cofferdam or dewatered pond if tidal waters occur at the site during driving.
10. Tidally restored ponds will contain channels that are adequate for the ingress and egress of fish with tidal circulation.
11. In some specifically authorized instances in managed ponds, modified trash racks will be installed on water control structures in managed ponds to deter steelhead, green sturgeon, federally-managed species, and other fish species from entering the ponds.

12. The sequence of earthwork activities will be such that operations which are more efficient and feasible to perform during the dry season, such as working on levee tops, would be completed first. Levee lowering and breaching along the outer bounds of the ponds that are designed to establish hydraulic connection with adjacent sloughs will be performed after all the internal pond activities are completed (*i.e*., construction of habitat islands and habitat transition zones will be performed prior to breaching perimeter levees). Breaching will not occur until all necessary flood control components and in-water habitat enhancement features are completed.
13. All disturbed areas will be stabilized within 12 hours of any break in work unless construction will resume work within 7 days. Earthwork will be completed as quickly as possible, and site restoration will occur immediately following use.
14. Living shorelines methods will be generally intended to avoid the implementation of traditional shoreline stabilization structures like riprap and seawalls by using habitat features that reduce levee erosion and synergistically provide some habitat structure and function (*e.g*., oyster reefs, eelgrass beds, large woody debris). Refuge personnel can include NMFS for technical assistance in design and planning for O&M elements that would include placement of natural features used to protect shorelines and levees.
15. A Stormwater Pollution Prevention Plan (SWPPP) will be developed to ensure that during rain events, construction activities do not increase the levels of erosion and sedimentation. This plan will include the use of erosion control materials (*i.e*., baffles, fiber rolls, hay bales, or temporary containment berms) and erosion control measures such as straw application or hydroseeding with native grasses on disturbed slopes; and floating sediment booms and/or curtains to minimize any impacts that may occur due to increased mobilization of sediments.
16. Any large wood, native vegetation, and weed-free topsoil displaced by construction will be stockpiled for use during site restoration.
17. Treated wood will not be used in structures that come in contact with water.
18. All clean fill material proposed for upland and wetland placement will meet the qualifications set forth in the Regional Water Quality Control Board's (RWQCB) waste discharge requirements, approved with respect to chemical and biological suitability for uplands and wetlands by the Dredged Material Management Office, or through the development and agency approval of a Quality Assurance Project Plan (QAPP). If the above-mentioned thresholds are not attained and the material is approved for use by the RWQCB, information will be provided to NMFS with an analysis of the potential effects of the contaminated material to listed species.
19. A hazardous spill plan will be developed prior to construction of each action. The plan will describe what actions will be taken in the event of a spill. If a spill occurs, work at the site will immediately cease until the contractor has contained, and mitigated the spill. The contractor will immediately prevent further contamination and notify appropriate authorities, and mitigate damage as appropriate. The plan will also incorporate preventative measures to be implemented, such as the placement of refueling facilities, storage and handling of hazardous materials.
20. Vehicle staging, cleaning, maintenance, refueling, and fuel storage will be located 150 feet or more from any stream, water body, or wetland. If an action cannot meet this 150-foot requirement, additional BMPs may be required and will be described for each action.
21. All vehicles operated within 150 feet of any water body will be inspected daily for leaks

and, if necessary, repaired before leaving the staging area. Inspections will be documented in a record that is available for review on request.

22. No equipment will enter live water except for aquatic or amphibious equipment designed specifically for aquatic or amphibious use.
23. Project sites will be maintained trash-free and food refuse will be contained in secure bins and removed daily.

The conservation measures described above are proposed by FWS and considered parts of the proposed action to reduce or avoid adverse effects to listed species, designated critical habitat, and/or EFH.

1.3.4 Monitoring, Applied Studies, and Adaptive Management

The Adaptive Management Plan (AMP) of the SBSP is designed to help guide the planning and implementation of each project phase. The AMP provides a directed approach to achieving project objectives through learning from restoration and management actions for which many scientific and social uncertainties exist. For each issue or project objective, the AMP provides a restoration target, monitoring plan, management triggers, applied studies, and potential management actions. If monitoring shows that a management trigger is occurring, then applied studies and management actions, as appropriate, will be implemented to address the trigger, and ultimately address the project objectives (for more details of the AMP, see Appendix B in the project's biological assessment (AECOM 2017). The following management triggers and objectives in the AMP are relevant to listed fish, critical habitat and EFH:

- Preserve existing estuarine habitat areas: no significant decrease in South Bay intertidal and subtidal habitats, including restored pond mudflat, intertidal mudflat, subtidal shallow, and subtidal channel areas.
- Water quality in ponds will meet RWQCB standards: water quality parameters (*e.g.*, temperature, salinity, dissolved oxygen) will not decline from baseline levels, and will meet RWQCB Basin Plan water quality objectives.
- Mercury levels in sentinel species do not show significant increases over baseline conditions and are not higher in target restoration habitats than in existing habitats.
- Estuarine fish numbers of native adult and juvenile fish in foraging and rearing habitats will be enhanced relative to baseline numbers.

As part of the adaptive management process, ongoing monitoring and studies will continue to track the progress of SBSP implementation toward restoration of tidal marsh and managed ponds. Fish monitoring will be implemented to monitor indicator species, fish assemblages, and habitat conditions in South San Francisco Bay. These efforts will focus on fish assemblages using restored areas, as they evolve toward mature tidal marshes with defined channel systems. Monitoring will also focus on areas outside of restored sites in South San Francisco Bay in order to monitor changes in the abundance and diversity of fish and invertebrates. FWS will include NMFS in development of the design of any proposed ongoing or future monitoring and applied studies that relate to NMFS listed and managed species. Monitoring and analysis will evaluate restored pond, managed pond, slough channel, and San Francisco Bay use by pelagic and demersal fish. Data analysis will include species diversity, presence/absence, and seasonal patterns. Methods will include seines, otter trawls, fyke nets, and water quality (temperature, dissolved oxygen, salinity) sampling for pelagic and demersal fish and macroinvertebrates in the managed ponds, breached ponds, and adjacent sloughs in the Mountain View and Ravenswood Ponds of SBSP Phase 2. Quarterly monitoring will occur for a minimum of 3 years, and implementing the adaptive management process (which will include NMFS) to determine if monitoring goals have been achieved. Fishing pressure on fish in the South San Francisco Bay and obtain further information on species composition may also be collected using fish creel census methods.

In addition to fish monitoring, the SBSP Restoration Project proposes to monitor water quality and habitat characteristics in selected managed ponds and receiving waters. Site-specific water quality monitoring will be evaluated in the same restored ponds, managed ponds, sloughs, and bay waters where fish monitoring will occur (described above), and will be conducted by FWS staff and/or others. Water quality characteristics to be monitored include temperature, salinity, pH, dissolved oxygen (DO), and turbidity or secchi depth using sondes or other hand held meters. In addition, benthic and/or planktonic prey organisms may be collected using grab samples for benthic prey or plankton tows or plankton pipe traps or other similar methods for planktonic prey organisms.

Fish mortality event monitoring will be performed when fish kills are observed. Sampling methods will consist of random subsampling of dead fish (when fish mortality events are noted by FWS staff or other project personnel) using seines or long handled scoop nets to gather, identify, count, and measure fish species. Random samples taken in a known area will provide information on the numbers of dead fish per unit area. Water quality measurements will be taken including DO, salinity, and temperature, and habitat type will be noted. Fish mortality event monitoring will document and approximate the total area where dead fish occur by estimating the area by eye and/or by mapping onto aerial photos. Sampling methods will be used to estimate total numbers of dead fish, if possible.

An annual report will be submitted to NMFS that includes the prior year's monitoring methods, O&M actions implemented, and the results and outcomes observed. Each year prior to implementation, an annual work plan will be submitted to NMFS that describes the upcoming year's expected O&M activities, the locations and timing of their implementation, note any potential effects on NMFS listed and managed species and their habitats, and list any changes to the general conservation measures and any proposed adjustments to the typical monitoring and reporting efforts which the Refuge has made in previous years.

1.3.4.1 Steelhead Entrainment Studies

FWS proposes to continue efforts initiated in Phase 1 to track the entry and exit of juvenile CCC steelhead into the A8 Pond Complex through the armored notch gate at Guadalupe River/Alviso Slough. This study will be intended to assess the risk of entrainment and fate of entrained juvenile/smolt steelhead at the muted tidal connection of Pond A5, A7, A8, and A8S with the Guadalupe River. The general design would be to catch by net or electrofish steelhead in the Guadalupe River Watershed, insert passive integrated transponder (PIT) tags or other trackers into the fish, and then deploy sensors through the watershed and at the entry/exit points of the managed ponds to track fish movement through the system. FWS proposes to work with NMFS to determine the appropriate timing and methods for this study. The study will be conducted up to five steelhead migration seasons over the next 12-year period.

Juvenile CCC steelhead will be captured in three- to four-day blocks over a maximum of 10 sample days by net or backpack electrofishing from October 1 to December 31. Fish will be sampled in five main reaches in the Guadalupe River Watershed: Guadalupe River from Montague Expressway to Blossom Hill Road, Guadalupe Creek from the confluence of Guadalupe River to the base of Guadalupe Dam, Los Gatos Creek from the confluence with the Guadalupe River to Camden Avenue, Alamitos Creek from the confluence of the Guadalupe River to the base of Almaden Dam, and Calero Creek from the confluence with Alamitos Creek to the base of Calero Dam. Each sampling site will be 50 to 100 feet in length, and sampling will occur at multiple sites within each reach: 10 sites each on both Guadalupe River and Guadalupe Creek, and five sites each on Los Gatos, Alamitos, and Calero Creeks. A maximum of 720 juvenile *O. mykiss* will be handled annually. A subset of a maximum of 360 juvenile *O. mykiss* will be anesthetized and PIT-tagged annually, in order to ensure sufficient detection rates by downstream antenna arrays for more robust statistical analyses. Sampling efforts will be coordinated with the Santa Clara Valley Water District (SCVWD) biologists to eliminate the chance of duplicate sampling reaches. NMFS will be notified about sampling intentions at least two weeks prior to initial sampling activities each year.

PIT-tagged juvenile steelhead will be monitored for movement and survival patterns by stationary half-duplex PIT tag antenna arrays located several miles downstream of the sampling sites. The passive monitoring PIT antenna arrays will be operated and maintained during the period between October 1 and May 31. Half-duplex PIT tag antennas will be installed at a minimum of four monitoring locations in the watershed: Pond A8 Notch, Pond A5 tidal gate, Pond A7 tidal gate, and the Highway 101 bridge crossing.

Regarding electrofishing of juvenile steelhead, FWS and contractors will adhere to NMFS electrofishing guidelines (NMFS 2000). Regarding handling of fish, the smallest practical-sized knotless nylon mesh dip-nets (0.25-inch) will be used, and held in flow-through in-stream live cars. Fish will be separated by size class to avoid predation and will be held outside of the electrical field. Prior to anesthesia, fish will be scanned for PIT tags in order to avoid duplicate handling. Any previously PIT-tagged fish and/or fish too small to be tagged will be immediately returned to the environment. Untagged and adequately-sized fish will be closely observed in an anesthetic bath of Alka–Seltzer Gold (aspirin free) brand sodium bicarbonate until loss of equilibrium is achieved but operculum movement is still present. The lowest concentration of sodium bicarbonate that will permit safe handling will be used and will range from one to two tablets per gallon of fresh river water depending on fish size and water temperature. The bicarbonate material will be allowed to completely dissolve before fish are added to the anesthetic bath. Small juveniles will be anesthetized in groups of 10 fish (at most) and larger parr and smolts (if encountered) will be anesthetized in groups of two fish. Stress Coat will be added to the anesthetic solution as needed to combat stress from loss of the protective slime layer during handling.

Salmonids will be handled after one to two minutes in the anesthetic bath and will be processed immediately following loss of equilibrium. While anesthetized, juveniles will be individually placed onto a wetted measuring board and measured to the nearest millimeter (mm) fork length. Only fish in good condition and with fork lengths greater than 60 mm and 100 mm will be tagged with 12-mm and 23-mm half-duplex PIT tags, respectively (Sloat *et al.* 2011). Properly trained and qualified individuals will conduct PIT tagging using the incision method. The PIT tag will be inserted posterior to the tips of the pectoral fins (when the fins are laid along the side of the fish) on the abdomen to the right or left of the mid-ventral line at the tips of the pleural ribs. All tags will be scanned prior to insertion to verify proper function. After measurements are recorded and tagging is completed, all *O. mykiss* will be treated with Stress Coat and allowed to fully recover before being released back into the environment.

In general, *O. mykiss* will be handled with extreme care including, but not limited to, adequate circulation, water replenishment, and oxygenation in debris-free temporary holding units. Fish will be detained for the minimum time required to collect data and perform tagging. Temperatures in holding units will be documented and no sampling activities will occur if stream water temperatures are greater than 68°F (20°C). Overcrowding of fish in holding units will be prevented. Fish will be allowed to recover in five-gallon buckets of aerated fresh river water until normal behavior is observed. Water temperature in the recovery bucket will be monitored and maintained to be within two degrees of the ambient river temperature.

“Interrelated actions” are those that are part of a larger action and depend on the larger action for their justification. “Interdependent actions” are those that have no independent utility apart from the action under consideration (50 CFR 402.02). NMFS does not anticipate any interrelated or interdependent actions associated with the proposed action.

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 provides an opinion stating how the agency’s actions would affect listed species and their critical habitats. If incidental take is reasonably certain to occur, section 7(b)(4) requires NMFS to provide an Incidental Take Statement 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 biological opinion includes both a jeopardy analysis and/or an adverse modification analysis. The jeopardy analysis relies upon the regulatory definition of “to jeopardize the continued existence of” a listed species, which is “to engage in an action that would be expected, directly or indirectly, to reduce appreciably the likelihood of both the survival and recovery of a listed species in the wild by reducing the reproduction, numbers, or distribution of that species" (50 CFR 402.02). Therefore, the jeopardy analysis considers both survival and recovery of the species.

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

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

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

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

2.1.1 Use of Best Available Scientific and Commercial Information

To conduct the assessment presented in this opinion, NMFS examined an extensive amount of information from a variety of sources. Detailed background information on the biology and status of the listed species and critical habitat has been published in a number of documents including peer reviewed scientific journals, primary reference materials, and governmental and non-governmental reports. Additional information regarding the potential effects of the proposed activities for the SBSP Project Phase 2 on the listed species in question, their anticipated response to these actions, and the environmental consequences of the actions as a whole was formulated from the aforementioned resources, and the following:

- February 2017 Biological Assessment prepared for FWS and SCC by AECOM (AECOM 2017).
- September 2017 Supplemental to the Biological Assessment prepared for FWS and SCC by AECOM (AECOM and ESA 2017).

Information was also provided in email messages and telephone conversations between February 2017 and May of 2018. For information that has been taken directly from published, citable documents, those citations have been reference in the text and listed at the end of this document. A complete administrative record of this consultation is on file at the NMFS North-Central Coast Office in Santa Rosa, California (Administrative Record Number 151422WCR2017SR00137).

2.2 Rangewide Status of the Species and Critical Habitat

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

This biological opinion analyzes the effects of the proposed SBSP Restoration Project Phase 2 on the following Federally-listed species (DPS or ESU) and designated critical habitats:

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

North American Green Sturgeon (*Acipenser medirostris*) southern DPS
threatened (71 FR 17757; April 7, 2006)
critical habitat (74 FR 52300; September 8, 2008)

2.2.1 Species Description, Life History, and Status

In this opinion, NMFS assesses four population viability parameters to help us understand the status of CCC steelhead and southern DPS green sturgeon, and their populations' ability to survive and recover. These population viability parameters are: abundance, population growth rate, spatial structure, and diversity (McElhany *et al.* 2000a). NMFS has used existing information to determine the general condition of each population and factors responsible for the current status of each DPS or ESU.

We use these population viability parameters as surrogates for numbers, reproduction, and distribution, the criteria found within the regulatory definition of jeopardy (50 CFR 402.02). For example, the first three parameters are used as surrogates for numbers, reproduction, and distribution. We relate the fourth parameter, diversity, to all three regulatory criteria. Numbers, reproduction, and distribution are all affected when genetic or life history variability is lost or constrained. This results in reduced population resilience to environmental variation at local or landscape-level scales.

2.2.1.1 CCC Steelhead General Life History

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

Recent information indicates that steelhead originating from central California use a cool, stable, thermal habitat window (ranging between 8-14 degrees Celsius [°C]) in the marine environment characteristic of conditions in northern waters above the 40th parallel to the southern boundary of the Bering Sea (Hayes *et al.* 2011). Rearing steelhead juveniles prefer water temperatures of 7.2 to 14.4 Celsius (°C) and have an upper lethal limit of 23.9°C (Barnhart 1986; Bjornn and Reiser 1991). They can survive in water up to 27°C with saturated dissolved oxygen conditions and a plentiful food supply. Fluctuating diurnal water temperatures (Busby *et al*. 1996) and cold groundwater inflows also aid in survivability of steelhead juveniles in Mediterranean-type locales.

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

2.2.1.2 Status of CCC Steelhead DPS

Historically, approximately 70 populations of steelhead existed in the CCC steelhead DPS

(Spence *et al.* 2008; Spence *et al.* 2012). Many of these populations (about 37) were independent, or potentially independent, meaning they had a high likelihood of surviving for 100 years absent anthropogenic impacts (Bjorkstedt *et al.* 2005). The remaining populations were dependent upon immigration from nearby CCC steelhead DPS populations to ensure their viability (McElhany *et al.* 2000b; Bjorkstedt *et al.* 2005).

While historical and present data on abundance are limited, CCC steelhead numbers are substantially reduced from historical levels. A total of 94,000 adult steelhead were estimated to spawn in the rivers of this DPS in the mid-1960s, including 50,000 fish in the Russian River - the largest population within the DPS (Busby *et al.* 1996). Near the end of the 20th century the population of wild CCC steelhead was estimated to be between 1,700-7,000 fish (McEwan 2001). Recent estimates for the Russian River population are unavailable since monitoring data is limited. Abundance estimates for smaller coastal streams in the DPS indicate low population levels that are slowly declining, with recent estimates (2011/2012) for several streams (Redwood [Marin County], Waddell, San Vicente, Soquel, and Aptos creeks) of individual run sizes of 50 fish or less (The Nature Conservancy 2013). Some loss of genetic diversity has been documented and attributed to previous among-basin transfers of stock and local hatchery production in interior populations in the Russian River (Bjorkstedt *et al*. 2005). Similar losses in genetic diversity in the Napa River may have resulted from out-of-basin and out-of-DPS releases of steelhead in the Napa River basin in the 1970s and 80s. These transfers included fish from the South Fork Eel River, San Lorenzo River, Mad River, Russian River, and the Sacramento River. In San Francisco Bay streams, reduced population sizes and fragmentation of habitat has likely also led to loss of genetic diversity in these populations. For more detailed information on trends in CCC steelhead abundance, see (Busby *et al.* 1996; NMFS 1997; Good *et al.* 2005; Spence *et al.* 2008).

CCC steelhead have experienced serious declines in abundance and long-term population trends suggest a negative growth rate. This indicates the DPS may not be viable in the long term. DPS populations that historically provided enough steelhead immigrants to support dependent populations may no longer be able to do so, placing dependent populations at increased risk of extirpation. However, because CCC steelhead remain present in most streams throughout the DPS, roughly approximating the known historical range, CCC steelhead likely possess a resilience that is likely to slow their decline relative to other salmonid DPSs or evolutionarily significant units (ESU) in worse condition. In 2005, a status review concluded that steelhead in the CCC steelhead DPS remain "likely to become endangered in the foreseeable future" (Good *et al.* 2005). On January 5, 2006, NMFS issued a final determination that the CCC steelhead DPS is a threatened species, as previously listed (71 FR 834).

A 2008 viability assessment of CCC steelhead concluded that populations in watersheds that drain to San Francisco Bay are highly unlikely to be viable, and that the limited information available did not indicate that any other CCC steelhead populations could be demonstrated to be viable[4] (Spence *et al.* 2008). Although there were average returns (based on the last ten years) of adult CCC steelhead during 2007/08, research monitoring data from the 2008/09 and 2009/10 adult CCC steelhead returns show a decline in returning adults across their range compared to the previous ten years (Jeffrey Jahn, NMFS staff, personal communication, 2010). A 2011 status

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

update concludes that steelhead in the CCC steelhead DPS remains "likely to become endangered in the foreseeable future" (Williams *et al.* 2011), as new and additional information available since Good *et al.* (2005) does not appear to suggest a change in extinction risk. The most recent NMFS viability assessment of CCC steelhead describes the lack of recent data for CCC steelhead, and that generally populations are poorly monitored (Williams *et al.* 2016).

The viability of San Francisco Bay watershed populations remains highly uncertain. More data regarding adult abundance is needed for higher levels of accuracy in the seven independent populations inhabiting the watersheds of the coastal strata (Novato Creek, Corte Madera Creek, Guadalupe River, Saratoga Creek, Stevens Creek, San Francisquito Creek, and San Mateo Creek). In the Santa Cruz Mountains, the California Coastal Monitoring Program (CMP) has been recently initiated for CCC steelhead.[5] New information from three years of the CMP indicates that population sizes there are perhaps higher than previously thought. However, the long-term downward trend in the Scott Creek population, which has the most robust estimates of abundance, is a source of concern. Although steelhead occur in the Russian River, the ratio of hatchery fish to natural origin fish remains a concern. On May 26, 2016, NMFS chose to maintain the threatened status of the CCC steelhead (81 FR 33468).

2.2.1.3 Status of Critical Habitat for CCC steelhead

designating critical habitat, NMFS considers, among other things, the following requirements of the species: 1) space for individual and population growth, and for normal behavior; 2) food, water, air, light, minerals, or other nutritional or physiological requirements; 3) cover or shelter; 4) sites for breeding, reproduction, or rearing offspring; and, generally; 5) habitats that are protected from disturbance or are representative of the historic geographical and ecological distributions of this species (50 CFR 424.12(b)). In addition to these factors, NMFS also focuses on known PBFs within the designated area that are essential to the conservation of the species and that may require special management considerations or protection.

Critical habitat was designated for CCC steelhead on September 2, 2005 (70 FR 52488) and includes PBFs essential for the conservation of CCC steelhead. Critical habitat in estuaries is defined by the perimeter of the waterbody as displayed on standard 1:24,000 scale topographic maps or the elevation of extreme high water, whichever is greater. These PBFs include estuarine areas free of obstruction and excessive predation with the following essential features: (1) water quality, water quantity and salinity conditions supporting juvenile and adult physiological transitions between fresh- and saltwater; (2) natural cover such as submerged and overhanging large wood, aquatic vegetation, large rocks and boulders, and side channels; and (3) juvenile and adult forage, including aquatic invertebrates and fishes, supporting growth and maturation (70 FR 52488).

Freshwater PBFs include: (1) freshwater spawning sites with water quantity and quality conditions and substrate supporting spawning, incubation and larval development; (2) freshwater rearing sites with water quantity and floodplain connectivity to form and maintain physical habitat conditions and support juvenile growth and mobility; water quality and forage supporting juvenile development; and natural cover such as shade, submerged and overhanging large wood,

[5] For more information on the California Coastal Monitoring Program, visit: http://www.calfish.org/Home.aspx.

log jams and beaver dams, aquatic vegetation, large rocks and boulders, side channels, and undercut banks; (3) freshwater migration corridors free of obstruction with water quantity and quality conditions and natural cover such as submerged and overhanging large wood, aquatic vegetation, large rocks and boulders, side channels, and undercut banks supporting juvenile and adult mobility and survival.

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

A final recovery plan for CCC steelhead was prepared by NMFS in October 2016 (NMFS 2016). The plan describes key threats and identifies recovery strategies and actions to achieve goals and objectives. Several factors have contributed to the decline of CCC steelhead throughout their range. Development activities have changed the landscape through the construction of dams, water diversions, flood control projects, as well as, agricultural development and resources extraction. The recovery plan identifies actions needed to achieve recovery, and includes objective, measurable criteria by which NMFS will determine when recovery has been reached. Recovery plan actions ae primarily designed to restore ecological processes that support healthy steelhead populations, and address the various activities that harm these processes and threaten the species' survival. The recovery plan calls for a range of actions including the restoration of floodplains and channel structure, restoring riparian conditions, improving streamflows, restoring fish passage, protecting and restoring estuarine habitat, among other actions.

2.2.1.4 Green Sturgeon General Life History

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

Green sturgeon is the most marine-oriented species of sturgeon (Moyle 2002). Along the West Coast of North America, they range in nearshore waters from Mexico to the Bering Sea (Adams *et al.* 2002), with a general tendency to head north after their out-migration from freshwater (Lindley *et al.* 2011). While in the ocean, archival tagging indicates that green sturgeon occur in waters between 0 and 200 meters depth, but spend most of their time in waters between 20–80 meters and temperatures of 9.5–16.0°C (Nelson *et al.* 2010; Huff *et al.* 2011). In the estuarine environment, green sturgeon are exposed to varying water temperature, salinity, and DO. For example, Heublein *et al.* (2017) summarizes that green sturgeon in coastal estuaries have been detected in water temperatures ranging 11.9 to 21.9°C, salinities ranging from 8.8 to 32.1 ppt, and dissolved oxygen (DO) ranging from 6.54 to 8.98 milligrams of oxygen per liter (Kelly *et al.* 2007; Moser and Lindley 2007). Subadult and adult green sturgeon move between coastal waters and estuaries (Lindley *et al.* 2008; Lindley *et al.* 2011), but relatively little is known about how green sturgeon use these habitats. Lindley *et al.* (2011) reported multiple rivers and estuaries are visited by aggregations of green sturgeon in summer months, and larger estuaries (*e.g.*, San Francisco Bay) appear to be particularly important habitat. During the winter months, green sturgeon generally reside in the coastal ocean. Areas north of Vancouver Island are favored overwintering areas, with Queen Charlotte Sound and Hecate Strait likely destinations based on detections of acoustically-tagged green sturgeon (Lindley *et al.* 2008; Nelson *et al.* 2010).

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

Adult Southern DPS green sturgeon spawn in the Sacramento River Watershed during the spring and early summer months (Moyle *et al.* 1995). Eggs are laid in turbulent areas on the river bottom and settle into the interstitial spaces between cobble and gravel (Adams *et al.* 2007). Like salmonids, green sturgeon require cool water temperatures for egg and larval development, with optimal temperatures ranging from 11 to 17˚C (Van Eenennaam 2006). Eggs hatch after 6–8 days, and larval feeding begins 10–15 days post-hatch. Metamorphosis of larvae into juveniles typically occurs after a minimum of 45 days (post-hatch), when fish have reached 2 inches in total length (TL) after hatching larvae migrate downstream. Juveniles spend their first few years in the Delta and San Francisco Bay before entering the marine environment as subadults. Juvenile green sturgeon salvaged at the State and Federal water export facilities in the Southern Delta are generally between 8 and 16 inches TL (Adams *et al.* 2002), which suggests Southern DPS green sturgeon spend several months to a year rearing in freshwater before entering the Delta and San Francisco Bay. Laboratory studies conducted by (Allen and Cech 2007) indicated juveniles approximately 6 months old were tolerant of saltwater, but approximately 1.5-year old green sturgeon appeared more capable of successful osmoregulation in salt water.

Subadult green sturgeon spend several years at sea before reaching reproductive maturity and returning to freshwater to spawn for the first time (Nakamoto *et al.* 1995). Little data are available regarding the size and age-at-maturity for the Southern DPS green sturgeon, but it is likely similar to that of the Northern DPS. Male and female green sturgeon differ in age-at-maturity. Males can mature as young as 14 years and female green sturgeon mature as early as age 16 (Van Eenennaam *et al.* 2006). Adult green sturgeon are believed to spawn every 2 to 5 years. Recent telemetry studies by Heublein *et al.* (2009) indicate adults typically enter San Francisco Bay from the ocean and begin their upstream spawning migration between late February and early May. Adults swimming upstream to spawning areas in the upper Sacramento River typically migrate rapidly through the estuary toward their upstream spawning sites. Preliminary results from tagged adult sturgeon suggest travel time from the Golden Gate to Rio Vista in the Delta is generally 1-2 weeks. Post-spawning, Heublein *et al.* (2009) reported tagged Southern DPS green sturgeon displayed two outmigration strategies; outmigration from Sacramento River prior to September 1 and outmigration during the onset of fall/winter stream flow increases. The transit time for post-spawning adults through the San Francisco Estuary appears to be very similar to their upstream migration (*i.e*., 1-2 weeks).

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

Green sturgeon feed on benthic invertebrates and fish (Adams *et al.* 2002). Radtke (1966) analyzed stomach contents of juvenile green sturgeon captured in the Sacramento-San Joaquin Delta and found the majority of their diet was benthic invertebrates, such as mysid shrimp and amphipods (*Corophium spp*). Dumbauld *et al.* (2008) reported that immature green sturgeon found in Willapa Bay, Grays Harbor, and the Columbia River Estuary, fed on a diet consisting primarily of benthic prey and fish common to these estuaries (ghost shrimp, crab, and crangonid shrimp), with burrowing thalassinid shrimp representing a significant proportion of the sturgeon diet. Dumbauld *et al.* (2008) observed feeding pits (depressions in the substrate believed to be formed when green sturgeon feed) in soft-bottom intertidal areas where green sturgeon are believed to spend a substantial amount of time foraging.

2.2.1.5 Status of Southern DPS Green Sturgeon

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

CDFW's white sturgeon monitoring program incidentally captures Southern DPS green sturgeon. Trammel nets are used to capture white sturgeon and CDFW utilizes a multiple-census or Peterson mark-recapture method to estimate the size of subadult and adult sturgeon population (CDFW 2018b). By comparing ratios of white sturgeon to green sturgeon captures, estimates of Southern DPS green sturgeon abundance can be calculated. Estimated abundance of green sturgeon between 1954 and 2001 ranged from 175 fish to more than 8,000 per year and averaged 1,509 fish per year. Unfortunately, there are many biases and errors associated with these data, and CDFW does not consider these estimates reliable. For larval and juvenile green sturgeon in the upper Sacramento River, information is available from salmon monitoring efforts at the Red Bluff Diversion Dam (RBDD) and the Glenn-Colusa Irrigation District (GCID). Incidental capture of larval and juvenile green sturgeon at the RBDD and GCID have ranged between 0 and 2,068 green sturgeon per year (Adams *et al.* 2002). Genetic data collected from these larval green sturgeon suggest that the number of adult green sturgeon spawning in the upper Sacramento River remained roughly constant between 2002 and 2006 in river reaches above RBDD (Israel and May 2010). In 2011, rotary screw traps operating in the Upper Sacramento River at RBDD captured 3,700 larval green sturgeon which represents the highest catch on record in 16 years of sampling (Poytress *et al.* 2011).

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

During the spring and summer spawning period, researchers with University of California Davis have utilized dual-frequency identification sonar (*i.e.*, DIDSON) to enumerate adult green sturgeon in the upper Sacramento River. These surveys estimated 175 to 250 sturgeon (±50) in the mainstem Sacramento River during the 2010 and 2011 spawning seasons. However, it is important to note that this estimate may include some white sturgeon, and movements of individuals in and out of the survey area confound these estimates. Given these uncertainties, caution must be taken in using sonar-only estimates to infer the spawning run size for the Sacramento River, until further analyses are completed. Mora *et al.* (2018) estimated the spawning run size and population size in 2010–2015 by using DIDSON sampling, underwater video camera species identification, and acoustic tag detections. Spawning run size varied from

336 to 1,236 individuals. The total population size was estimated to be 17,548 individuals. The estimated number of adults was 2,106, the estimated number of juveniles was 4,387, and the estimated number of subadults was 11,055.

The NMFS status review update completed in 2006 concluded the Southern DPS of green sturgeon is likely to become endangered in the foreseeable future due to the substantial loss of spawning habitat, the concentration of a single spawning population in one section of the Sacramento River, and multiple other risks to the species such as stream flow management, degraded water quality, and introduced species (NMFS 2005). Based on this information, the Southern DPS green sturgeon was listed as threatened on April 7, 2006 (71 FR 17757). A 2015 five-year review found that there has not been a significant change in the status of Southern DPS green sturgeon and that the threatened status is still applicable (NMFS 2015).

2.2.1.6 Status of Critical Habitat for Southern DPS Green Sturgeon

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

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

A draft recovery plan for Southern DPS green sturgeon was released by NMFS in January 2018 (NMFS 2018). The draft plan describes key threats and identifies recovery strategies and actions to achieve goals and objectives. The construction of dams, water diversions, flood control projects, agricultural development and resources extraction have contributed to the decline of the Southern DPS of green sturgeon. The draft recovery plan presents 20 recovery actions that aim to restore passage and habitat, reduce mortality from fisheries, entrainment, and poaching, and address threats in the areas of contaminants, climate change, predation, sediment loading and oil and chemical spills. Most of the recovery efforts focus on the Sacramento River Basin and San Francisco Bay Delta Estuary environments, as threats in spawning and rearing habitats were considered the greatest impediments to recovery.

2.2.2 Factors Responsible for Steelhead and Green Sturgeon Stock Declines

NMFS cites many reasons (primarily anthropogenic) for the decline of steelhead (Busby *et al*. 1996) and southern DPS of green sturgeon (Adams *et al.* 2002; NMFS 2005). The foremost reason for the decline in these anadromous populations is the degradation and/or destruction of freshwater and estuarine habitat. Additional factors contributing to the decline of these populations include: commercial and recreational harvest, artificial propagation, natural stochastic events, marine mammal predation, avian predation, reduced marine-derived nutrient transport, ocean conditions, and global climate change.

2.2.2.1 Habitat Degradation and Destruction

The best scientific information presently available demonstrates a multitude of factors, past and present, have contributed to the decline of west coast salmonids and green sturgeon by reducing and degrading habitat by adversely affecting essential habitat features. Most of this habitat loss and degradation has resulted from anthropogenic watershed disturbances caused by urban development, agriculture, poor water quality, water resource development, dams, gravel mining, forestry (Adams *et al.* 2002; Busby *et al.* 1996; Good *et al*. 2005), and lagoon management (Smith 1990; Bond 2006).

2.2.2.2 Commercial and Recreational Harvest

In the past, commercial and recreational harvest of southern DPS green sturgeon was allowed under State and Federal law. The majority of these fisheries have been closed (NMFS 2015). Ocean salmon fisheries off California are managed to meet the conservation objectives for certain stocks of salmon listed in the Pacific Coast Salmon Fishery Management Plan, including any stock that is listed as threatened or endangered under the ESA. Early records did not contain quantitative data by species until the early 1950's. In addition, the confounding effects of habitat deterioration, drought, and poor ocean conditions on salmonids and green sturgeon make it difficult to assess the degree to which recreational and commercial harvest have contributed to the overall decline of salmonids and green sturgeon in West Coast rivers.

2.2.2.3 Artificial Propagation

Releasing large numbers of hatchery fish can pose a threat to wild salmon and steelhead stocks through genetic impacts, competition for food and other resources, predation of hatchery fish on wild fish, and increased fishing pressure on wild stocks as a result of hatchery production (Waples 1991).

2.2.2.4 Natural Stochastic Events

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

2.2.2.5 Marine Mammal Predation

Predation is not known to be a major factor contributing to the decline of West Coast salmon, steelhead, and green sturgeon populations relative to the effects of fishing, habitat degradation, and hatchery practices. Predation may have substantial impacts in localized areas. Harbor seal (*Phoca vitulina*) and California sea lion (*Zalophus californianus*) numbers have increased along the Pacific Coast (NMFS 1997).

In a peer reviewed study of harbor seal predation in the Alsea River Estuary of Oregon, the combined results of multiple methodologies led researchers to infer that seals consumed 21 percent (range equals 3 - 63 percent) of the estimated pre-spawning population of coho salmon. The majority of the predation occurred upriver, at night, and was done by a relatively small proportion of the local seal population (Wright *et al.* 2007). However, at the mouth of the Russian River, Hanson (1993) reported that the foraging behavior of California sea lions and harbor seals with respect to anadromous salmonids was minimal, and predation on salmonids appeared to be coincidental with the salmonid migrations rather than dependent upon them.

The Army Corps of Engineers has observed Steller sea lion (*Eumetopias jubatus*) preying on white sturgeon at the Bonneville Dam tailrace (Tackley *et al.* 2008). This suggests that predation of green sturgeon by sea lions may also occur in confined areas like dam tailraces when both species are present.

2.2.2.6 Avian Predation

Avian predation on juvenile salmonids is an important source of mortality in freshwater and estuarine habitats when birds and salmonids overlap spatially and temporally. Frechette *et al.* (2013) estimate that the population of kingfishers foraging in the Scott Creek estuary have the potential to remove 3–17 percent of annual production, whereas mergansers had the potential to remove 5–54 percent of annual steelhead production in this Central California coast watershed. Observed predation rates by cormorants and terns on Columbia River subyearling Chinook ranges between 2-22 percent, in which more than 8 million lower Columbia River (tule) fall-run Chinook Salmon subyearlings released from hatcheries are estimated to be consumed by double-crested cormorants and terns annually (Sebring *et al.* 2013).

2.2.2.7 Reduced Marine-Derived Nutrient Transport

Marine-derived nutrients from adult salmon carcasses have been shown to be vital for the growth of juvenile salmonids and the surrounding terrestrial and riverine ecosystems (Bilby *et al.* 1996; Bilby *et al.* 1998; Gresh *et al.* 2000). Declining salmon and steelhead populations have resulted in decreased marine-derived nutrient transport to many watersheds. Nutrient loss may be contributing to the further decline of ESA-listed salmonid populations (Gresh et al. 2000).

2.2.2.8 Ocean Conditions

Evidence suggests poor ocean conditions played a significant role in the low number of returning adult fall run Chinook salmon to the Sacramento River in 2007 and 2008 (Lindley *et al.* 2009). Changes in ocean conditions likely affect ocean survival of all west coast salmonid populations (Good et al. 2005; Spence et al. 2008).

2.2.2.9 Global Climate Change

Climate change is another factor affecting the rangewide status of threatened CCC steelhead, southern DPS of North American green sturgeon, and aquatic habitat in general. Impacts from global climate change are already occurring in California. For example, average annual air temperatures, heat extremes, and sea level have all increased in California over the last century (Kadir *et al.* 2013). Snow melt from the Sierra Nevada has declined (Kadir *et al*. 2013). However, total annual precipitation amounts have shown no discernable change (Kadir *et al.* 2013).

Modeling of climate change impacts in California suggests average summer air temperatures are expected to increase (Lindley *et al.* 2007). Heat waves are expected to occur more often, and heat wave temperatures are likely to be higher (Hayhoe *et al.* 2004). Total precipitation in California may decline; critically dry years may increase (Lindley *et al.* 2007; Schneider 2007). The Sierra Nevada snow pack is likely to decrease by as much as 70 to 90 percent by the end of this century under the highest emission scenarios modeled (Luers *et al.* 2006). Wildfires are expected to increase in frequency and magnitude, by as much as 55 percent under the medium emissions scenarios modeled (Luers *et al*. 2006). Vegetative cover may also change, with decreases in evergreen conifer forest and increases in grasslands and mixed evergreen forests. The likely change in amount of rainfall in Northern and Central Coastal California streams under various warming scenarios is less certain, although as noted above, total rainfall across the state is expected to decline.

For the California North Coast, some models show large increases (75 to 200 percent) in rainfall while other models show decreases of 15 to 30 percent (Hayhoe *et al*. 2004). Snowmelt contribution to runoff in the San Francisco Bay and San Joaquin Delta may decrease by about 20 percent per decade over the next century (Cloern *et al.* 2011). Many of these changes are likely to further degrade salmonid habitat by, for example, reducing stream flows during the summer and raising summer water temperatures. Estuaries may also experience changes detrimental to salmonids and green sturgeon. Estuarine productivity is likely to change based on changes in freshwater flows, nutrient cycling, and sediment amounts (Scavia *et al.* 2002). In marine environments, ecosystems and habitats important to sub-adult and adult green sturgeon and salmonids are likely to experience changes in temperatures, circulation and chemistry, and food supplies (Feely 2004; Brewer and Barry 2008; Osgood 2008; Turley 2008).

In the San Francisco Bay region, extreme warm temperatures generally occur in July and August, but as climate change takes hold, the occurrences of these events will likely begin in June and could continue to occur in September (Cayan *et al.* 2012). Interior portions of San Francisco Bay are forecasted to experience a threefold increase in the frequency of hot daytime and nighttime temperatures (heat waves) from the historical period (Cayan *et al*. 2012). Climate simulation models also predict that the San Francisco region will maintain its Mediterranean climate regime, but experience a higher degree of variability of annual precipitation during the next 50 years, and years that are drier than the historical annual average during the middle and end of the twenty-first century. The greatest reduction in precipitation is forecasted to occur in March and April, with the core winter months remaining relatively unchanged (Cayan *et al*. 2012). The projections described above are for the mid to late 21st Century. In shorter time frames, climate conditions not caused by the human addition of carbon dioxide to the atmosphere are more likely to predominate (Cox and Stephenson 2007; Santer *et al.* 2011).

2.3 Action Area

"Action area" means all areas to be affected directly or indirectly by the Federal action and not merely the immediate area involved in the action (50 CFR 402.02). The action area for the project encompasses 9,600 acres of former salt ponds located in the Don Edwards National Wildlife Refuge, owned and managed by FWS. The Refuge's ponds are located around the edge of South San Francisco Bay within San Mateo, Santa Clara, and Alameda counties. The estuarine portion of the action area includes two former salt-production pond complexes: Alviso and Ravenswood (Figure 2). The Alviso pond complex (8,000 acres) extends along the South San Francisco Bay from Mountain View to Fremont, and consists of 25 former salt ponds in Santa Clara and Alameda Counties. The Ravenswood pond complex (1,600 acres) is located at the western end of the Dumbarton Bridge in South San Francisco Bay, and consists of seven ponds along both sides of Highway 84 west of the Dumbarton Bridge, and on the bayside of the City of Menlo Park in San Mateo County, California.

Within each pond complex, the action area includes both open waters and subtidal habitats to the upper reaches of tidal action, tidal and non-tidal wetlands, and former salt ponds adjacent to the South San Francisco Bay. The action area also includes upland areas immediately adjacent to these features. The action area is bordered by the Bay on one side and is surrounded by urban development on all other sides.

Due to the project's proposed research on CCC steelhead movements in the lower Guadalupe River Watershed and A8 Pond Complex, the action area also includes the freshwater collection sites of juvenile steelhead. The project's monitoring program proposes the collection of juvenile steelhead from the Guadalupe River and its tributaries for application of PIT tags. The Guadalupe River Watershed in Santa Clara County, California flows to Alviso Slough within the Alviso Pond Complex and subsequently to South San Francisco Bay. Fish will be sampled in five freshwater reaches in the watershed: Guadalupe River from Montague Expressway to Blossom Hill Road, Guadalupe Creek from the confluence of Guadalupe River to the base of Guadalupe Reservoir, Los Gatos Creek from the confluence with the Guadalupe River to Camden Avenue, Alamitos Creek from the confluence of the Guadalupe River to the base of Almaden Reservoir, and Calero Creek from the confluence with Alamitos Creek to the base of Calero Reservoir. Each sampling site will be 50 to 100 feet in length, and sampling will occur at multiple sites within each of the five reaches described above.

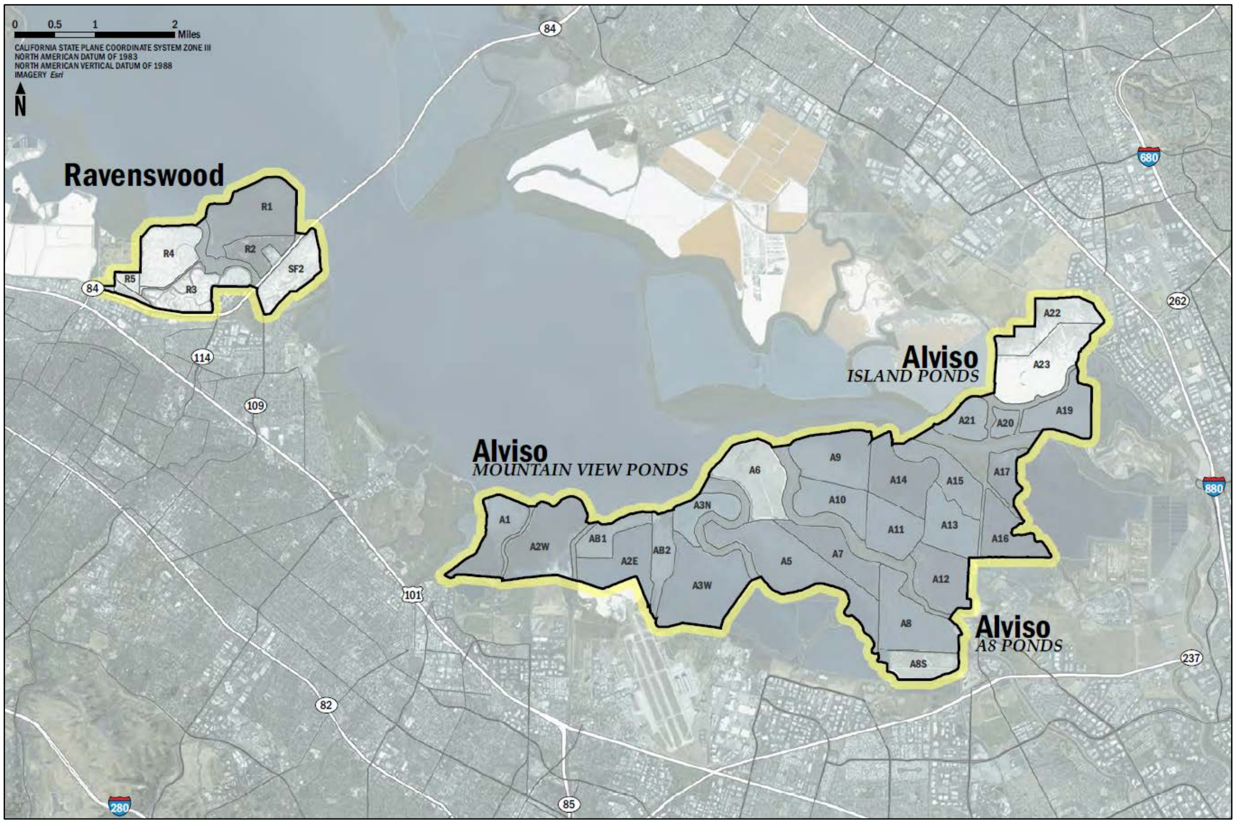

Figure 2. Action area including Phase 2 construction actions, and new and ongoing operations and management of pond and slough components of action area (AECOM and ESA 2017). Guadalupe River Watershed component of action area not shown.

2.4 Environmental Baseline

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

2.4.1 Action Area Overview

The San Francisco Bay Estuary is the largest estuary on the west coast of North America, and it is an extremely productive, diverse ecosystem (Trulio *et al.* 2004). During the past two centuries, the estuary lost more than 90 percent of historic tidal wetlands to diking, draining, and filling (Harvey 1988; Goals Project 1999). The South San Francisco Bay (South Bay) is a vital component of the larger Estuary and supports some of the most important habitat remaining in the entire Bay Area.

The term “South Bay” refers to the portion of San Francisco Bay south of Coyote Point on the western shore and San Leandro Marina on the eastern shore (Goals Project 1999). This region differs in several physical and ecological aspects from the Central Bay, North Bay, San Pablo

Bay, Suisun Bay, and the Delta portions of San Francisco Bay Estuary. The habitats included in the South Bay are open waters and subtidal habitats, tidal and non-tidal wetlands, former salt evaporation ponds adjacent to the Bay, and the upland areas immediately adjacent to these features. Many of these habitats have been dramatically modified by anthropogenic activities including dredging, agriculture, wastewater effluent, stormwater runoff, salt production, and flood protection.

Open water and subtidal habitats in the South Bay include tidal sloughs and channels, and areas of standing or flowing waters within the salt ponds and tidal marshes. The tidal sloughs and channels carry water through the marshes and between salt ponds and marsh remnants. Though the former salt ponds vary in their own depth and hydrology, they all have bay mud as the dominant substrate type, and in the areas surrounding them. The thickness of the bay mud depends on the location, with bay muds generally 10 to 20 feet thick in the Alviso Complex and 20 to 60 feet deep in the Ravenswood Complex (AECOM 2017). Underneath the bay mud are clays and alluvial deposits that may vary from sand to cobble. The maximum tidal range in the action area is approximately 9 feet in the most southern part of the action area where the majority of the Alviso Pond Complex is located. The Coyote Creek tide gauge (NOAA gauge 9414575), varies between -1.64 feet (-0.5 meters) MLLW and 7.9 feet (2.4 meters) NAVD88 at MHHW. The Alviso Slough tide station at Gold Street Bridge (9414551) has a tidal range of approximately 9.2 ft between MHHW and MLLW. The Palo Alto Yacht Harbor tide station (9414525) has a tidal range of approximately 7.6 ft between MHHW and MLLW, and it is expected that the Ravenswood Pond Complex has an approximate tidal range of 7 ft.

The action area includes expanses of intertidal mudflats which are minimally vegetated to unvegetated mud lying between MLLW and mean tide line (MTL) in the lower marsh zone. Mudflat habitat typically supports less than 10 percent cover of vascular emergent vegetation. Most of this habitat occurs just beyond the edge of fully vegetated wetlands, but also occurs between the low flow channel and edge of wetlands within the tidal reaches of slough and creek channels draining into the Bay. These flats are generally covered by shallow water during high tide, but are uncovered at low tide (Schoellhamer *et al.* 2005). Narrow mudflats occur along the edges of the tidal sloughs and channels, and on the outboard side of some salt pond levees, while much more extensive flats are present at the mouths of the major sloughs and along the edge of the Bay. Mudflats are dynamic depositional features, changing in extent and location depending on the nature of erosion and deposition of sediments. The mudflat substrate is composed primarily of fine-grained silts and clays that support an extensive community of diatoms, worms, and shellfish, as well as algal flora. Inundated mudflats provide foraging habitat for many species of fishes, as well as for wading birds. The high abundance of benthic invertebrates on mudflats is due to food sources in the form of detritus from tidal marshes, phytoplankton in the water column, and algae and diatoms growing on the intertidal mudflats (Warwick and Price 1975; Life Science Inc. 2003). During the daily high tides, fish move over the mudflats to feed on these invertebrates. As the tide recedes and the flats emerge, the fish retreat to subtidal areas while considerable numbers of birds, primarily shorebirds, leave their high-tide roosts and feed on the flats.

The action area includes areas of tidal salt marsh, brackish marsh and freshwater marsh. Salt-marsh habitat in the South Bay occurs primarily along the outboard (tidal) side of existing levees separating the salt ponds from the Bay and in former salt ponds transitioning to salt marsh due to large-scale restoration efforts of the SFSP Restoration Project and Refuge. Salt marsh vegetation consists of a limited number of halophytic (salt tolerant) species adapted to regular immersion by the tides. Areas of tidal salt marsh in the South Bay are characterized by interstitial soil salinities greater than 27 parts per thousand (ppt), on average (H. T. Harvey & Associates 2002). South Bay salt marshes typically consist of three zones: low marsh dominated by cordgrass (*Spartina foliosa*), middle marsh dominated by pickleweed (*Sarcocornia pacifica*), and high marsh with a mixture of pickleweed and other moderately halophytic (salt tolerant) species that can tolerate occasional high tides. These zones are not necessarily linear, but rather are intermingled throughout marshes, especially in wider, older marshes. Current tidal marshes in the South Bay occupy mere remnants of their former extent but they still support high densities, and fairly high diversity of wildlife species, including several San Francisco Bay endemics. The state and federally endangered salt marsh harvest mouse (*Reithrodontomys raviventris*) and the salt marsh wandering shrew (*Sorex vagrans halicoetes*) occur particularly where pickleweed is present. The California vole (*Microtus californicus eximius*) occurs here as well, and is often the most common small mammal in tidal marshes. Ridgway's rails (*Rallus obsoletus obsoletus*) nest in gumplant on the higher-elevation channel edges and in high pickleweed clumps, and more rarely in thicker stands of cordgrass, in both salt and brackish tidal marshes.

Brackish marsh habitat typically occurs in the low-to-mid intertidal reaches of sloughs and creeks draining into the Bay, where the vegetation is subject to tidal inundation diluted by freshwater flows from upstream, and groundwater emergence along the terrestrial edge of salt marshes. As such, the average interstitial soil salinity of vegetation associated with tidal brackish marsh in the South Bay is lower than in salt marshes, ranging from 15 ppt to 20 ppt (H. T. Harvey & Associates 2002). Marsh plant species richness and diversity increase in brackish marshes compared with salt marsh. The vegetation in brackish marsh habitat is dominated by emergent, vascular plant species adapted to intermediate (brackish) interstitial soil salinities, including short bulrushes such as alkali bulrush (*Scirpus robustus*) and saltmarsh bulrush (*Scirpus maritimus*). Brackish marshes support many of the wildlife species that use salt marsh and freshwater marsh habitats. Anadromous fish (migrating from saline to freshwater to spawn) and catadromous fish (migrating from fresh to saline water to spawn) and invertebrates such as shrimp use brackish marshes while physiologically acclimating to changing salinity on their migrations between saline and freshwater habitats. Brackish marshes support most of the bird species occurring in both salt and freshwater marshes.

Tidal ponds, sloughs, and channel areas are detritus rich and serve as important nurseries and feeding areas for estuarine fish. Fish populations in the action area represent several different trophic levels, including Pacific herring (*Clupea pallasi*), northern anchovy (*Engraulis mordax*), Pacific sardine (*Sardinops sagax*), staghorn sculpin (*Leptocottus armatus*), several species of perch, English sole (*Parophrys vetulus*), and California halibut (*Paralichthys californicus*) (AECOM 2017). Many of these fish species in turn support harbor seals and piscivorous birds such as the Forster's tern (*Sterna forsteri*), California least tern (*Sterna antillarum browni*), American white pelican (*Pelecanus erythrorynchos*), brown pelican (*Pelecanus occidentalis*), and double-crested cormorant (*Phalacrocorax auritus*). Waterfowl such as greater scaup (*Aythya marila*), lesser scaup (*Aythya affinis*), canvasbacks (*Aythya valisineria*), and surf scoters (*Melanitta perspicillata*) dive for bivalves, crustaceans, and other invertebrates in shallower subtidal areas. Although these areas support a high diversity of benthic and pelagic macroinvertebrates, most of the dominant invertebrates are nonnative species, although native oyster (*Ostrea lurida*) populations are present in small numbers. Additionally, California bay shrimp (*Crangon franciscorum*) spawn in the open ocean but spend much of their lives feeding in the brackish waters of South Bay sloughs (Baxter *et al.* 1999).

Freshwater marsh occurs in relatively limited areas of the project's action area in the upper reaches of sloughs and creeks draining into the Bay or from groundwater emergence. These areas are subject to some tidal influence, but they are also flushed with fresh water on a daily basis and, therefore, support mostly freshwater emergent vegetation. The water surface elevation within reaches of freshwater marsh may vary by as much as 10 feet depending on daily tidal activity and seasonal, fresh water flows from upstream. Broad-leaf cattail (*Typha latifolia*), and the taller bulrushes, including California bulrush and hard-stem bulrush, typically dominate the freshwater marsh habitat in the upper reaches of sloughs and creeks draining into the Bay. In areas of freshwater marsh, the Pacific treefrog (*Hyla regilla*), bullfrog (*Rana catesbeiana*), and western toad (*Bufo boreas*) are present.

The Guadalupe River Watershed is located in a Mediterranean climatic region, with over 90 percent of annual precipitation occurring between November and April. Cool, moist coastal fog generally alternates with clear, warm weather during the months of May through September, and significant rainfall during that time is rare. Land use in the watershed varies. Residential and commercial development of moderate to high density predominate the banks in watershed reaches available to CCC steelhead.

Flood control actions and water development have significantly altered stream conditions for fish within the freshwater reaches of the Guadalupe River watershed accessible to CCC steelhead. The SCVWD operates several reservoirs and water diversions. Guadalupe Dam, Almaden Dam and Calero Dam are complete barriers to fish passage and block access to historical upstream habitat for CCC steelhead. The SCVWD's operation of these reservoirs, in combination with Lexington Reservoir on Los Gatos Creek, dictate streamflow and water temperature downstream of their respective dams in the Guadalupe River watershed. In general, winter runoff is stored for release during the dry season to facilitate groundwater recharge. Stream reaches immediately below these dams are typically perennial due to water releases from the reservoirs. Flood control has resulted in engineered channel reaches with hardscape banks and beds.

2.4.2 Status of Species and Critical Habitat in Action Area

The Alviso and Ravenswood portions of the action area do not provide habitat suitable for spawning by either steelhead or green sturgeon, but rearing by juvenile life stages of both species does occur. Freshwater reaches in the Guadalupe River Watershed portion of the action area do provide habitat suitable, although degraded, for steelhead spawning and rearing. The Southern DPS of green sturgeon travel to the upper reaches of the Sacramento River to spawn, which is outside the action area of this project.

2.4.2.1 CCC Steelhead in the Action Area

NMFS is not aware of any systematic fish surveys that have been completed for CCC steelhead in the action area, but fisheries surveys have been conducted in the past and some sampling is ongoing. Three CCC steelhead spawning and rearing streams enter the South Bay in the vicinity of the SBSP's Alviso Pond Complex: Coyote Creek, Guadalupe River, and Stevens Creek. The lowermost reaches of Coyote Creek and Stevens Creek are tidally-influenced and are within the action area of the project. For the Guadalupe River Watershed, the lowermost reach drains to South San Francisco Bay via Alviso Slough and is within the Alviso Pond Complex portion of the action area. In addition, the portion of the upper Guadalupe Watershed accessible to anadromous salmonids (*i.e.,* downstream of impassable barriers) is also within the project's action area due to proposed steelhead PIT tag studies. The project proposes to capture and apply PIT tags to juvenile steelhead collected from the mainstem of the Guadalupe River as well as the following Guadalupe River tributaries: Guadalupe Creek, Los Gatos Creek, Alamitos Creek and Calero Creek.

For the Ravenswood Pond Complex, San Francisquito Creek enters South San Francisco Bay approximately 1.5 miles to the south and this stream supports a population of CCC steelhead. San Francisquito Creek is not within the action area of the project, but its close proximately to the Ravenswood Pond Complex suggests some outmigrating steelhead smolts could utilize the Ravenswood portion of the action area seasonally during their downstream migration to the Bay and ocean.

Estuaries are important nursery habitat for juvenile salmonids (Healey 1991; Thorpe 1994); however, specific information regarding steelhead utilization of estuaries is limited. For the estuarine portion of this project's action area, there is a paucity of information regarding steelhead. Based on the work of other researchers in Central California (Cannata 1998, Bond *et al*. 2008, Hayes *et al.* 2008), steelhead juveniles likely use brackish areas of the South Bay action area during the smoltification process as they move from a freshwater environment to the ocean. Brackish water portions of the action area likely provide fertile habitat that can produce an abundance of prey organisms for steelhead smolts. Research has shown that abundant food supplies in estuarine habitat can result in very high growth rates and the resulting larger smolts have a higher probability of ocean survival and a higher probability of returning to spawn as an adult (Bond *et al*. 2008, Hayes *et al.* 2008)

Juvenile CCC steelhead likely forage in both brackish and tidal marshes, but virtually no information is available to determine the extent of their utilization of these habitats in the action area. Fish surveys conducted in the Alviso Pond Complex have not detected steelhead in their surveys (Mejia *et al.* 2008; Hobbs *et al.* 2013; Lewis *et al.* 2016; Hobbs 2017). Studies conducted for Phase 1 of the SBSP Restoration Project and the San Jose-Santa Clara Wastewater Treatment Plant (WWTP) did not catch any steelhead in trawls, nets, or traps deployed from 2010 to 2017 (Dr. James Hobbs, UC Davis professor, personal communication, March 12, 2018). It is generally believed that steelhead migrate rapidly as smolts through estuaries to complete their growth to adulthood in the ocean (Quinn 2005; McMichael *et al.* 2006). Keegan (2007) reports Central Valley steelhead smolts equipped with ultrasonic tags appear to be focused on emigrating through San Francisco Bay as rapidly as possible. It is unknown if this behavior reported by Keegan (2007) is also representative of CCC steelhead originating from South Bay tributary streams, and it is also unknown if this behavior is a recent adaptation to the urbanization of San Francisco Bay. Returning adult steelhead likely navigate their way through the action area rapidly as they seek the freshwater upstream spawning grounds of their natal streams.

Within the Guadalupe River Watershed, CCC steelhead spawn and rear in the mainstem and several tributaries. Annual sampling conducted since 2004 by electrofishing index reaches in the mainstem Guadalupe River and Guadalupe Creek shows low densities of juvenile steelhead (SCVWD, unpublished data). The results of three years of electrofishing surveys by CDFW in the Guadalupe River Watershed (2015-2017) also indicate juvenile steelhead densities are low; however, there was an increase in the number of young-of-year in 2017 that was likely associated with the improved 2017 water year (Cochran 2018). Alamitos Creek and Los Gatos Creek are known to support steelhead spawning and juvenile rearing. Calero Creek is a tributary to Alamitos Creek and warm water conditions during the summer months limit the stream's ability to support juvenile steelhead rearing.

2.4.1.2 CCC Steelhead Critical Habitat in the Action Area

The tidally-influenced portion of the action area in the Alviso Pond Complex and the Ravenswood Pond Complex is designated critical habitat for CCC steelhead. The Guadalupe River from South San Francisco Bay upstream for a distance of approximately 10 miles (Lat. 37.3499, Long –121.9094) is also designated as critical habitat for CCC steelhead.

Estuarine PBFs of designated critical habitat for CCC steelhead in the action area include (70 FR 52488): (1) water quality, water quantity, and salinity conditions supporting juvenile and adult physiological transitions between fresh- and saltwater; (2) natural cover such as submerged and overhanging large wood, aquatic vegetation, large rocks and boulders, and side channels; and (3) juvenile and adult forage, including aquatic invertebrates and fishes, supporting growth and maturation.

Freshwater PBFs include (70 FR 52488): (1) freshwater rearing sites with water quantity and floodplain connectivity to form and maintain physical habitat conditions and support juvenile growth and mobility; water quality and forage supporting juvenile development; and natural cover such as shade, submerged and overhanging large wood, log jams and beaver dams, aquatic vegetation, large rocks and boulders, side channels, and undercut banks; and (2) freshwater migration corridors free of obstruction with water quantity and quality conditions and natural cover such as submerged and overhanging large wood, aquatic vegetation, large rocks and boulders, side channels, and undercut banks supporting juvenile and adult mobility and survival.

These estuarine and freshwater PBFs of designated critical habitat within the action area are partially degraded and limited due to altered and diminished freshwater inflow, shoreline development, shoreline stabilization, non-native invasive species, discharge and accumulation of contaminants, loss of tidal wetlands, and periodic sediment removal for flood control.

2.4.2.2 Green Sturgeon in the Action Area

Green sturgeon are likely to be present year-round within the tidally influenced portions of the action area (Alviso and Ravenswood Pond Complexes), but fisheries surveys in this area to date have been few and the only green sturgeon collections to date have been anecdotal reports by fishermen. As presented below, it is reasonable to assume the presence of green sturgeon based on their life history and known habitat conditions in the action area.

In the Alviso and Ravenswood portions of the action area mudflats and tidal sloughs along the shoreline may be used as foraging habitat by green sturgeon, likely preying on small demersal fish such as sand lance, and benthic invertebrates such as ghost shrimp, crab, crangonid shrimp, and thalassinid shrimp, which are similar green sturgeon prey in Washington and Oregon estuaries (Dumbauld *et al.* 2008). White sturgeon (*Acipenser transmontanus*), a relative of the green sturgeon, feed on similar prey as the green sturgeon and are caught in the South Bay. Hobbs *et al.* (2013) has collected white sturgeon during fish surveys in the action area, and his results indicate white sturgeon are most abundant in the Alviso Pond Complex of all South Bay sites. Green sturgeon are known to be generalist feeders and may feed opportunistically on a variety of benthic species encountered. For example, the invasive overbite clam (*Corbula amurensis*) has become a common food of white sturgeon and green sturgeon in San Francisco Bay (CDFG 2002).

Little is known about green sturgeon distribution and abundance in the Bay, and what influences their movements (Kelly *et al.* 2007). Although there are no reports of adult or juvenile green sturgeon observations within the action area, fisheries monitoring in this region to date has been very limited. Green sturgeon have been captured by CDFW sampling with mid-water and otter trawls in the South Bay near the San Leandro Channel (Jahn 2006), although no reports of any age class have occurred at South Bay sampling stations since (CDFW 2018a). From January 14, 2011, through December 31, 2011, acoustic tag receivers were operated at three locations within South San Francisco Bay: Dumbarton Railroad Bridge; lower Coyote Creek; and lower Guadalupe River (*i.e.*, Alviso Slough). Acoustic tagged green sturgeon were detected at the Dumbarton Bridge, but no detections were recorded at the receivers located in Coyote Creek or the Guadalupe River (unpublished data, T. Keegan, 2011). Although the acoustic receiver arrays were only operated for one year, this information suggests green sturgeon occur infrequently and in low numbers in the action area.

2.4.2.3 Green Sturgeon Critical Habitat in the Action Area

The tidally-influenced portions of the action area are designated as critical habitat for the Southern DPS of green sturgeon. PBFs of green sturgeon designated critical habitat in the action area include food resources, water flow, water quality, mitigation corridor, water depth, and sediment quality. The current condition of critical habitat in the action area is degraded over its historical conditions. Habitat degradation in the action area is primarily due to altered and diminished freshwater inflow, shoreline development, shoreline stabilization, non-native invasive species, discharge and accumulation of contaminants, loss of tidal wetlands, and periodic dredging for navigation.

2.4.3 Factors Affecting the Species Environment in the Action Area

The San Francisco Bay and Delta is one of the most human-altered estuaries in the world (Knowles and Cayan 2004). Major drivers of change in the action area that are common to many estuaries are water consumption and diversion, human modification of sediment supply, introduction of nonnative species, sewage and other pollutant inputs, and climate shifts. Terrestrial portions of the action area include large amounts of bay fill and receive water from direct precipitation, which will flow into storm drains and into a stormwater management system. Water and sediment quality within the action area is affected by stormwater runoff, industrial activities, and other urban influences. Responses to these drivers in San Francisco Bay include shifts in the timing and extent of freshwater inflow and salinity intrusion, decreasing turbidity, restructuring of plankton communities, nutrient enrichment and metal contamination of biota, and large-scale food web changes (Cloern and Jassby 2012).

2.4.3.1 Water and Urban Development

Urbanization, water development, and flood control in the Guadalupe River Watershed has significantly influenced streamflow and habitat conditions in the watershed for CCC steelhead. Five large reservoirs owned and operated by the SCVWD (Lexington Reservoir, Vasona Reservoir, Guadalupe Reservoir, Almaden Reservoir, and Calero Reservoir) dictate streamflow and water temperature conditions in the mainstem Guadalupe River and all the tributary streams currently accessible to steelhead. Reservoir operations by the SCVWD store winter runoff behind the dams for release during the dry season to facilitate groundwater recharge. Historically, low and dry flow conditions characterized the lower reaches of these streams during the summer months. Under present conditions, perennial flows are maintained by reservoir releases. Headwater stream reaches which naturally maintain perennial and cool streamflow conditions are now no longer accessible to steelhead due to the presence of impassable barriers at the dams. The reservoirs also intercept the downstream movement of bedload in the channel by capturing gravel and cobbles behind the dams. Thus, coarse sediments are currently lacking in many areas and degraded habitat conditions for steelhead for spawning, juvenile cover, and aquatic benthic invertebrate productivity. Actions for flood control have resulted in the straightening of channels and hardening of stream banks. General land use surrounding the Guadalupe River portion of the action area is dominated by urban and residential development.

2.4.3.2 San Jose-Santa Clara Regional Wastewater Treatment Plant

Within the Alviso Pond Complex portion of the action area, the San Jose-Santa Clara Regional WWTP is located between Coyote Creek and Artesian Slough, owned by the City of San Jose and City of Santa Clara. The WWTP pumps approximately 200 cubic feet per second (cfs) of tertiary treated water constantly year-round. The 2014 National Pollutant Discharge Elimination System Permit established effluent limitations for biochemical oxygen demand (BOD), total suspended solids (TSS), BOD & TSS Percent Removal, oil & grease, pH, total chlorine residual, turbidity, total ammonia, and *Enterococcus* bacteria. Dissolved oxygen (DO) in the receiving water cannot fall below 5.0 mg/L due to effluent discharges. Loads for BOD, ammonia, and TSS are calculated by multiplying each daily concentration by corresponding daily average flow. Effluent temperatures for 2017 ranged from 16.3 to 26.4°C, averaging 21.1°C. The DO average for effluent in 2017 was 7.3 mg/L (SJSCRWF 2018). The Alviso Pond Complex is a very productive marsh due to the high input of nutrients from the San Jose/Santa Clara Wastewater Treatment Plant (WWTP), the largest wastewater facility in the Bay (Senn and Novick 2014).

2.4.3.3. Salt Production

Solar salt production in the action area began in the mid-1850s and resulted in the conversion of large wetland areas in the South Bay to salt evaporation ponds (Siegel S.W. and Bachand P.M. 2002). Levees constructed around broad expanses of tidal mudflats and marsh isolated these areas from San Francisco Bay and allowed for conversion to salt evaporation ponds. Early salt production efforts were small operations scattered throughout the Bay, but by 1936, the Leslie Salt Company consolidated several smaller companies into one large operation (EDAW 2005). Cargill acquired the Leslie Salt Company in 1978 and continued producing approximately one million tons of salt annually from ponds around San Francisco Bay.

Solar salt production takes several years to complete the process, with the time period depending on seasonal variations in temperature, rainfall and evaporation rates (Siegel and Bachand 2002). The process begins with the intake of Bay water into an “intake” pond, either through pumps or through a gate that opens at high tide. Once in the system, the Bay water is referred to as brine. The brine flows slowly through a series of ponds called “evaporator” or “concentrator” ponds, with salinity increasing from one pond to the next through evaporation. When the brine becomes fully saturated with salt, the brine is pumped into “pickle” ponds for storage and then into crystallizer ponds for eventual harvesting (Life Science 2004). Within a crystallizer pond, evaporation continues and a layer of salt accumulates on the bed. This raw salt is mechanically harvested and sent to Cargill’s processing plant in Newark for further processing before it is ready for consumers. The remaining solution, an extremely saline liquid by-product known as bittern, is pumped into bittern ponds near the processing plants for long-term storage. Because of its high salinity, bittern is toxic to aquatic plants and wildlife and cannot be discharged back to the Bay.

In October 2000, Cargill proposed to consolidate salt pond operations and sell the land and salt production rights on 61 percent of its South Bay operation area. The State of California approved the purchase of the salt ponds from Cargill in 2003. FWS is now the landowners and land managers of the SBSP action area. The Ravenswood Pond Complex and Alviso Pond Complex are now part of the Don Edwards San Francisco Bay National Wildlife Refuge which is managed by the FWS. This refuge was the first urban National Wildlife Refuge established in the United States dedicated to preserving and enhancing wildlife habitat, protecting migratory birds, protecting threatened and endangered species, and providing opportunities for wildlife-oriented recreation and nature study for the surrounding communities (EDAW *et al.* 2007).

2.4.3.4 Restoration Actions in the Alviso and Ravenswood Pond Complexes

Beginning in 2006, former salt ponds in the action area were breached to restore tidal wetlands, while other ponds were equipped with new water control structures to enhance water circulation for the creation of managed ponds. Within the action area, SBSP Phase 1 restoration actions resulted in the creation of 940 acres of breached pond tidal habitats in the action area: Pond A6

(330 acres), Pond A17 (130 acres), Pond A19 (265 acres), Pond A20 (65 acres), and Pond A21 (150 acres). These tidal areas are showing signs of estuarine sedimentation and natural vegetation colonization. In addition to the above, since the Initial Stewardship Plan began in 2004, the SBSP has begun operation of 6,603 acres of managed ponds in the action area that are designed for use by primarily bird habitat, and approximately 7 miles of new trails have been constructed for public access.

As part of the SBSP Phase 1 actions, Ponds A8 and A8S were partially breached to create muted tidal ponds. Through the installation of a variable-size and reversible "notched" gate that opened in July 2010, tidal waters from Alviso Slough now enter Ponds A8 and A8S. Ponds A5 and A7 were also connected to Pond A8 and Pond A8S as part of Phase 1 actions. The muted tidal connection to Pond A8 Complex provided by the notched gated structure is operated to maximize the potential volume of water exchange between Alviso Slough and the pond while controlling water levels within the pond and ensuring mercury concentrations stay within acceptable levels. The notch consists of eight 5-foot bays that can be opened and closed independently, allowing tidal exchange between Pond A8 and Alviso Slough to be adjusted based on monitoring data.

Aquatic habitat conditions and the fish community within and outside tidally restored ponds, managed ponds and adjacent tidal sloughs in the Alviso Complex have been analyzed by Hobbs (2017). Hobbs (2017) found lower DO conditions in tidal wetlands and very low DO levels in managed ponds relative to adjacent tidal sloughs, particularly during the summer months. Managed ponds appear to be very susceptible to fish kills in summer, especially during warmer periods with a lack of wind that results in stronger eutrophication process and lower DO. Extreme variability of DO conditions that occur in managed ponds can be stressful to aquatic organisms, from both periods of anoxia/hyperoxia and hyperoxia (Ross *et al.* 2001; Lushchak and Bagnyukova 2006; Pollock *et al.* 2007). Tidal sloughs and breached ponds in the Alviso Complex did not experience the daily swings of hypoxia that were observed in managed ponds, but instead experience DO swings with tidal water movement. Water quality sonde data recorded lower summertime DO levels during low tide and levels typically increase as the incoming tide brings water in from South San Francisco Bay. The first significant winter storms of the year rapidly flush water and debris from South Bay creeks to sloughs and breached ponds, where water in the creeks has often become stagnant and hypoxic or anoxic.

Hobbs (2017) found that water temperatures were consistently higher in tidal sloughs and breached ponds of the Alviso Marsh Complex compared with Central South Bay and Bair Island Marsh Complex waters during the warmer summer-fall months. Seasonal variation is significant, with water temperatures in the action area reaching approximately 6 degrees Celsius (°C) in winter months and 25°C in summer months (Hobbs 2017). Shallower waters of managed ponds exhibit consistently higher temperatures than sloughs and breached ponds, especially during daytime hours in summer and fall months.

Although several of the studies conducted during Phase 1 (Hobbs *et al.* 2013; Lewis *et al.* 2016; Hobbs 2017) were performed during the most recent drought, waters in the action area are generally more saline in summer and fall, and less saline in winter and spring months due to rainfall patterns. Salinity reached lower than 10 parts per thousand (ppt) for brief periods during rain events in the winter, and slowly climbed to approximately 30 ppt during fall months. There is a lack of consistent and significant freshwater inflow in the Ravenswood Pond Complex that creates a more stable and consistent salinity regime. In the Alviso Marsh Complex, there are salinity swings of approximately 10 ppt every tide cycle (MacVean and Stacey 2011), largely due to amplified tide range in the South Bay and perennial freshwater inflow from the San Jose/Santa Clara WWTP (approximately 200 cfs of constant flow of tertiary treated wastewater). This salinity swing likely precludes fish, invertebrate, and plant species that cannot tolerate a wide range of salinity (stenohaline species).

The magnitude and extent of water connectivity and exchange between ponds and adjacent tidal sloughs throughout the tide cycle is an important factor that determines the composition of the fish and invertebrate community. Cook (2016) found that there were a lower number of benthic species observed in breached ponds compared to sloughs as a result of being drained at low tide. In addition, less mobile species were observed in lower frequencies in tidally-influenced breached ponds compared to sloughs and managed ponds. Hobbs *et al.* (2013) identified a high prey abundance in the breached ponds of the Alviso Pond Complex, including large amounts of mysid shrimp and amphipods (salmonid prey). Throughout the Alviso Pond Complex there is also an abundance of overbite clam and crangonid shrimp (sturgeon prey), although not necessarily limited to breached ponds. In addition, the Alviso breached ponds and sloughs may serve as nursery habitat for some species, such as English sole and Pacific herring, where a relative high abundance of juveniles were collected in sloughs near breach openings, although further research is needed for conclusive results (Hobbs *et al.* 2013). Throughout this project's action area, (Lewis *et al.* 2016) found that species tolerant of a wide range of dissolved oxygen and temperature were dominant, such as northern anchovy and Pacific staghorn sculpin.

Hobbs (2017) found that the overall abundance of fish and invertebrates was similar between managed and breached ponds, although non-native fish dominated in managed ponds, which were primarily comprised of small, short-lived pelagic forage species (*e.g.*, Mississippi silversides, rainwater killifish) and invertebrates. Managed ponds had the highest species richness (*i.e.*, number of species), because the addition of non-natives increased the total number of species observed in managed ponds. In several restored ponds and immediately adjacent sloughs, Hobbs *et al.* (2013) found higher densities of juvenile fishes in them than the surrounding area and concluded juvenile fish from several important species are using these habitats. The most abundant species of pelagic fish observed by Hobbs *et al.* (2013) in the Alviso Complex were American shad (*Alosa sapidissima*), longfin smelt (*Spirinchus thaleichthys*), Mississippi silverside (*Menidia beryllina*), yearling Pacific herring (*Clupea pallasii*), and threadfin shad (*Dorosoma petenense*).

<u>2.4.4 Previous Section 7 Consultations and Section 10 Permits in the Action Area</u>

Pursuant to section 7 of the ESA, NMFS has conducted numerous interagency consultations within the action area of the project, as it encompasses 9,600 acres of Refuge lands in three counties and a large portion of the Guadalupe River Watershed. The majority of these consultations have been completed with the Corps for bridge repairs/replacement, bank stabilization, shoreline stabilization, sediment removal, and tidal marsh restoration. The following recent and major formal and informal consultations have been completed for activities within the action area of this project.

NMFS and FWS conducted informal consultation for the Don Edwards National Wildlife Refuge Comprehensive Conservation Plan in Alameda, Santa Clara, and San Mateo Counties, California. FWS management activities included habitat enhancement and restoration activities, vegetation management activities including application of herbicides, mosquito abatement activities, and facility construction. Consultation concluded on June 29, 2017 with NMFS' letter of concurrence concluding that the project was not likely to adversely affect listed fish species or designated critical habitat under NMFS' jurisdiction (SWR-2012-2631).

NMFS, the U.S. Environmental Protection Agency (EPA), and the Corps completed reinitiation of a programmatic consultation in 2015 to address maintenance dredging throughout the greater San Francisco Bay, including portions of the action area of this project, for the Long Term Management Strategy for Disposal of Dredged Materials in the San Francisco Bay Region (LTMS). The LTMS programmatic consultation resulted in the issuance of an opinion on July 9, 2015, to the Corps and EPA (WCR-2014-1599). The July 9, 2015 opinion concluded the LTMS program was not likely to jeopardize the continued existence of listed fish species under the jurisdiction of NMFS, or adversely modify or destroy designated critical habitat.

In 2015, the Corps initiated consultation with NMFS to address their funding and construction of the South Bay Shoreline Phase 1 Study near the City of Alviso. NMFS' May 19, 2015 concurrence letter for the project concluded the proposed action was not likely to adversely affect listed fish species or designated critical habitat under the jurisdiction of NMFS (WCR-2014-1850).

NMFS and the Federal Transit Administration (FTA) conducted formal consultation for the replacement of a railroad bridge over Los Gatos Creek. FTA provided funding to the Peninsula Corridor Joint Powers Board to construct this Caltrain bridge project. A biological opinion was issued to the FTA on April 29, 2015 that concluded the project was not likely to jeopardize the continued existence of listed fish species under the jurisdiction of NMFS, or adversely modify or destroy designated critical habitat (WCR-2015-1934).

To address routine stream maintenance activities conducted by the SCVWD throughout Santa Clara County, the Corps consulted with NMFS on their issuance of a regional general permit that authorizes sediment removal for flood control, streambank stabilization, and other minor maintenance activities. The most recent consultation with NMFS on the SCVWD's regional general permit for stream maintenance was completed in 2014. The biological opinion issued by NMFS on April 8, 2014, concluded the Corps' authorization of the program was not likely to jeopardize the continued existence of CCC steelhead and Southern DPS green sturgeon or adversely modify or destroy designated critical habitat (SWR-2011-3722).

NMFS and the Corps conducted formal consultation for the City of San Jose's construction of a pedestrian bridge across Los Gatos Creek. Consultation concluded on March 19, 2014 with NMFS' issuance of a biological opinion to the Corps that concluded the project was not likely to jeopardize the continued existence of listed fish species under the jurisdiction of NMFS, or adversely modify or destroy designated critical habitat (WCR-2013-151).

NMFS and the Corps completed consultation in 2009 for Phase 1 of the SBSP Restoration

Project. This consultation include FWS Phase 1 actions, O&M of various Refuge facilities, and also included CDFW actions within the Eden Landing portion of the SBSP. A biological opinion was issued to the Corps on January 14, 2009 that concluded FWS and CDFW's Phase 1 activities and ongoing maintenance actions were not likely to jeopardize the continued existence of listed fish species under the jurisdiction of NMFS, or adversely modify or destroy designated critical habitat (SWR-2007-8128).

NMFS completed consultation in 2004 pursuant to section 7 of the ESA with the Corps, USGS, and FWS on the Initial Stewardship Plan (ISP) of the SBSP Restoration Project. The ISP was an interim plan to maintain and enhance the biological and physical conditions within the salt ponds acquired from Cargill during the period between the cessation of salt production and the implementation of the long-term SBSP. Section 7 consultation on the ISP was concluded informally by letter from NMFS dated May 10, 2004, with a determination that the proposed interim management actions in the SBSP action area were not likely to adversely affect listed fish species (SWR-2004-798). ISP actions that will be ongoing under the long-term SBSP were re-evaluated in this consultation and are addressed in this biological opinion.

NMFS and the Corps completed consultation in 2000 for the Guadalupe River Flood Control Project in downtown San Jose. A biological opinion was issued on August 11, 2000 that concluded the project was not likely to jeopardize the continued existence of listed fish species under the jurisdiction of NMFS, or adversely modify or destroy designated critical habitat (SWR-2001-2211). The Corps reinitiated consultation in 2002 to address changes to the project's monitoring program and NMFS issued a supplemental biological opinion on October 28, 2003 SWR-2002-1732).

Consultation between NMFS and the Corps for the Lower Guadalupe River Flood Control Project was completed in 2003 with the NMFS issuance of a biological opinion on April 17, 2003. The biological opinion concluded the SCVWD's construction of the lower river flood project was not likely to jeopardize the continued existence of listed fish species under the jurisdiction of NMFS, or adversely modify or destroy designated critical habitat (SWR-2001-2156).

For the Upper Guadalupe River Flood Control Project, NMFS and the Corps completed the original consultation in 2000 and a biological opinion was issued on April 18, 2000 (SWR-2000-1826). To address proposed revisions to the project, the Corps reinitiated consultation in 2004 and a supplemental biological opinion was issued by NMFS to the Corps on February 11, 2005 (SWR-2005-156). Both biological opinions concluded the project was not likely to jeopardize the continued existence of listed fish species under the jurisdiction of NMFS, or adversely modify or destroy designated critical habitat.

Research and enhancement projects resulting from NMFS' Section 10(a)(1)(A) research and enhancement permits and section 4(d) limits or exceptions could potentially occur in the action area. Salmonid and sturgeon monitoring approved under these programs may include juvenile and adult net surveys and tagging studies. In general, these activities are closely monitored and require measures to minimize take during the research activities. As of May 2018, two activities requiring a Section 10(a)(1)(A) research and enhancement permit is occurring in the action area.

Permit #16417 has been issued to the SCVWD for the collection of juvenile CCC steelhead via downstream migrant traps in the Guadalupe River. Although this permit expires on June 30, 2018, SCVWD has submitted a request for renewal and expansion of the activities conducted under this permit. The second activity is the University of California Davis (UC Davis) Longfin Smelt Monitoring Program. This study is funded by CDFW for UC Davis to conduct otter and mid-water trawling year-round in the greater San Francisco Bay region, including the action area of this project. Permit #19820 for longfin smelt monitoring was issued to Dr. James Hobbs on September 28, 2017 and it expires on December 31, 2021. As of May 2018, one entity has authorization under the State ESA 4(d) exception program to conducted research in the action area and this project is the CDFW Inland Bay Fisheries Watershed Restoration and Resource Assessment Program.

2.4.5 Climate Change Impacts in the Action Area

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

2.5 Effects of the Action

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

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

In general, implementation of Phase 2 actions are expected to provide benefits to threatened CCC steelhead and threatened green sturgeon by increasing the amount of tidal and subtidal estuarine habitat in the action area. Some operation and maintenance activities during the 12-year work period may have adverse effects on individual fish. Both steelhead and green sturgeon use the tidal and brackish channels in the action area for foraging and some fish may be entrained into new and ongoing managed ponds. Adverse effects may also occur during implementation of the fish monitoring program, and listed fish may be subjected to degraded water quality and other temporary effects during construction activities. Sloughs and channels in the action area connect San Francisco Bay with several South Bay steelhead spawning streams. As a result, adult and juvenile steelhead seasonally migrate through the action area to access Coyote Creek, Guadalupe River, and Stevens Creek. Juvenile steelhead may also utilize portions of the action area to ease the transition from fresh- to saltwater during the process of smoltification (*i.e*., physiological adaptation to the saltwater environment). Juvenile and adult green sturgeon may utilize the tidal channels and sloughs for foraging throughout the year.

2.5.1 Effects to Listed Fish

2.5.1.1 Tidal Marsh Restoration

The Project's Phase 2 pond breaching of 1,005 acres at Ponds A1 (275 acres) and A2W (435 acres) in the Alviso Pond Complex, and Pond A4 (295 acres) in the Ravenswood Pond Complex is expected to benefit steelhead and green sturgeon by restoring full access to these former salt ponds and allowing the full tidal range to bring Bay waters into these areas from adjacent sloughs and channels, thereby increasing productivity and beginning transitional processes toward tidal marsh habitat. At the Island Ponds (Ponds A19, A20, and A21), additional breaches, expanded breaches, and levee lowering are also anticipated to benefit steelhead and green sturgeon by increasing tidal flow connectivity throughout the existing 480-acre site.

Tidal marshes are important components of the San Francisco Bay aquatic ecosystem for fish and invertebrates. Phase 2 restoration of new areas of tidal marsh habitat will increase the quantity of tidal marsh and tidal channel habitat in the action area for both steelhead and green sturgeon. Detrital input from restored marshes is expected to increase productivity in the benthic invertebrate food chain and potentially increasing the density of the invertebrate prey base available to various fish species in the action area. Detritus originating from the breakdown of plant material and phytoplankton in tidal marshes forms much of the foundation for the food web that ultimately provides sustenance for the estuary's aquatic flora and fauna (EDAW *et al.* 2007). Flood tides receding from tidal marshes bordering the South Bay convey nutrients and carbon from the marshes to fish and invertebrates in subtidal channels and to the bay itself. As a result of the twice-daily tidal cycles, the tidal sloughs and channels of the action area are important rearing and nursery areas for fish. In addition, tidal channel networks will further develop within restored marshes and increase the amount of foraging opportunities during high tide. The channel network created within Phase 2 tidal restoration sites is also expected to provide fish the opportunity to adequately exit the marsh during low tide.

NMFS expects marsh restoration will benefit productivity on adjacent South Bay mudflat habitat. Crustaceans, polychaete worms, gastropod and bivalve mollusks, and other invertebrates live on or just below the surface of the mud (Harvey *et al.* 1977). Detrital input from restored marshes is expected to increase invertebrate productivity on adjacent mudflats. Fish that move over the mudflats to feed on these invertebrates will benefit from the increased productivity. As the tide recedes and the mudflats emerge, the fish will retreat to subtidal areas in adjacent channels.

Juvenile CCC steelhead originating from Stevens Creek, the Guadalupe River, and Coyote Creek Watersheds utilize the tidal and brackish marshes and sloughs in the action area for foraging and transition to seawater. Although more research is needed on steelhead estuarine residence time, estuaries are typically important habitat for young salmonids as they migrate to the ocean (Quinn 2005), providing productive growing conditions for foraging juvenile salmonids and growth rates typically exceeding rates observed in freshwater (Shapovalov and Taft 1954; Kjelson *et al.* 1981; Bond 2006). Young salmonids have the ability to feed off a variety of different organisms (Macdonald *et al.* 1987) like copepods, larval fish, and other zooplankton, and the rich productivity of tidal sloughs and channels in the South Bay offer many foraging opportunities. Salmonid smolts which are larger at the time of ocean entry have shown higher survival rates to adulthood. Additional growth which occurs in the estuary by a juvenile salmonid prior to ocean entry may be small, but could make a significant difference in overall survival at sea (Quinn 2005). In addition to feeding and growth opportunities, estuaries provide a gradual transition from fresh- to saltwater. By easing this stressful period for salmonids, estuaries can assist in the smoltification process of juvenile steelhead. Phase 2 actions are expected to increase the productivity of these areas through the restoration of tidal marsh areas and expanding this habitat type and availability for CCC steelhead juveniles and smolts.

For the Southern DPS green sturgeon, juveniles are thought to move downstream from the upper Sacramento River to the Delta and San Francisco Bay early in their first year, where they remain for approximately three years. Once in San Francisco Bay, green sturgeon are believed to be primarily opportunistic benthic foragers due to the sub-terminal placement of their mouth and the diets of other species in the genus *Acipenser* (Kelly *et al.* 2007). Stomach content analyses by Radtke (1966) and Ganssle (1966) suggest they feed in San Francisco Bay on benthic crustaceans, particularly amphipods, shrimps, clams, annelid worms, crabs, and small fishes. The project's restoration of tidal conditions at Ponds A1, A2W, R4, and further opening of A19, 20, and 21 are expected to increase aquatic productivity in adjacent tidal sloughs and channels and enhance foraging opportunities for green sturgeon.

It is important to note that although native flora and fauna are adapted to tidal sloughs and marsh habitat, the action area's sloughs and breached pond marsh habitat also include areas of degraded water quality conditions for native fish. Fish and invertebrates that may benefit from the abundant prey and productivity described above (Environmental Baseline), are also exposed to degraded water quality conditions in sloughs and breached ponds. Dissolved oxygen (DO) concentrations are consistently hypoxic in summer and fall months, especially at low tide. The first winter storms flush water that may be hypoxic/anoxic with toxins and harmful debris. In addition, summer and fall month daytime temperatures consistently reached 25 degrees Celsius

(Hobbs 2017), which are not optimal temperatures for steelhead and green sturgeon. During daytime hours in summer and fall months and brief periods after the first winter storms in the action area's sloughs and breached ponds, fish are exposed to a tradeoff between abundant prey (described above) and poor water quality conditions. Given this tradeoff, NMFS expects these fish move with tidal water movement and avoid poor water quality conditions generally observed during low tide periods. This project's pond breaching activities are expected to benefit steelhead and green sturgeon due to the increased prey abundance and foraging area.

2.5.1.2 Entrainment Risk at Managed Ponds

FWS proposes to install new water control structures at Ravenswood Ponds R3, and R5/S5 (Table 4, Table 5), and continue to operate several water control structures at existing managed ponds. As a result of Phase 2 actions, Pond R5/S5 (67 acres) and Pond R3 (270 acres) will be converted to 337 acres of managed ponds to benefit water fowl and shorebirds, respectively. Conditions within most managed ponds will not be suitable for the long-term survival of steelhead or green sturgeon, and in some cases, conditions may not be suitable for the short-term survival of these species. Most managed ponds will be operated to maintain shallow water conditions for foraging by shorebirds and waterfowl. Proposed water depths in managed ponds typically range from 1-6 feet.

The new Pond R3 water control structures will be operated as outlet-only during wet season months, and during summer and fall the gates will be operated for small amounts of two-way flow to refresh the water in the borrow ditches and slough traces to get small amounts of water exchange for invertebrate bird prey production in the remnant channels and borrow ditches, which are expected to be a few feet deep. The bottom of pipe elevations for the R3/Ravenswood slough are at the same level as the majority of the pond bottom elevation (2 ft NAVD88) and the culvert bottom pipe elevation between R3 and R5/S5 is a few feet higher (4.5 ft NAVD88), and it is expected that most of the flow exchange will occur with Ravenswood Slough. Due to the small amounts of water exchange, it is not expected that large amounts of fish will be forced into Pond R3 via water flow. Steelhead and green sturgeon with the vicinity of the Ravenswood Complex are typically of a large enough size that their swimming ability will allow them to avoid being overtaken by inflow water velocities and entrained into managed ponds. However, fish that do swim through the culvert into the pond will be exposed to degraded water quality, and increased bird predation. Based on expected conditions, particularly during the summer months, the water conditions in R3 are likely to be excessively shallow, warm, and hypoxic for steelhead and green sturgeon. Long durations of exposure to these conditions would likely result in injury or mortality of steelhead and green sturgeon.

New water control structures at Pond R5/S5 will be operated for two-way flow year-round, with some periods when one tide gate will operate as an outlet only to maintain water levels for bird habitat. The bottom of pipe elevation of the culvert between the breached Pond R4 and R5/S5 (3.5 NAVD88) is approximately at the mean tide line and bay water is expected to flow in and out during most tidal cycles. The culvert between R5/S5 and Flood Slough will allow two-way flow with a bottom of pipe elevation (2 ft NAVD88) below the mean tide line. With average and max summer inflows expected to be 63 cfs and 353 cfs, respectively (average and max winter inflows will be 23 cfs and 118 cfs due to presence of rainwater in pond), large volumes of water will be moving from Flood Slough into the managed Pond R5/S5 during flood tides and then drain out again during ebb tide. Few juvenile steelhead are expected to be in the vicinity of Flood Slough particularly during the summer months, because the nearest creek with a small but consistent steelhead run is over 1.5 miles to the south, and the water control structure is at the most inland end of the slough. Juvenile steelhead, if near the culvert opening, could be entrained into Pond R5/S5 during flood tide conditions. Exiting the pond would be available to juvenile steelhead on slack and ebb tides, provided they were not consumed by piscivorous birds (*e.g.* herons, egrets) or fish (*e.g.* striped bass).

Throughout the action area, the future operation of new Phase 2 water control structures and the ongoing operation of existing water control structures at managed ponds poses an entrainment risk to juvenile steelhead and green sturgeon foraging in the adjacent sloughs, marsh, and South Bay habitat. As water flows into a managed pond through the culverts during flood tide conditions, small fish may be overtaken by the inflow, entrained through the culvert, and forced to enter managed ponds. If the water control structure is operated for two-way flow, then it is likely fish would have the ability to exit the pond at slack tide or on an outgoing tide. If the structure is operated as intake-only, fish entrained into a managed pond will likely become trapped. Outlets at some managed ponds are located hundreds or thousands of feet distance from the intake structure and, therefore, the chance of an individual fish successfully finding its way out of the managed pond is remote. If such fish are able to tolerate the conditions within the ponds and eventually return to tidal sloughs via pond outlets, the impact on an individual would likely not be substantial. However, managed ponds are typically shallow water with sub-optimal temperature and DO conditions with increased predation risk (due to high bird populations) than tidal habitats. Striped bass (*Morone saxatilis*) also pose a significant predation risk at water control structures and in managed ponds (Hobbs 2016). As a result, entrainment in managed ponds at water control structures which are operated as intake-only, including ponds where the outlet is far from the intake, is expected to result in the mortality of steelhead and green sturgeon.

To minimize the risk of entrainment and entrapment at managed ponds, FWS will continue to implement the operational measures developed for Phase 1 at the intakes which pose the greatest risk to steelhead and green sturgeon (Table 6). The measures include: (1) continued operation of fish screens at the A16 intake to prevent entrainment; (2) seasonal closure of the intakes during the steelhead migration season; and (3) seasonal operation of the structures for "two-way flow" which allows for water to both enter and exit the culvert with the tidal cycle during the steelhead migration season. Seasonal closures and fish screens will be employed at intake-only water control structures to managed ponds located directly on steelhead streams while two-way flow operations will be employed at intakes located directly on the shoreline of San Francisco Bay.

Juvenile steelhead typically range in size from 150 to 300 mm during their outmigration, and they may be susceptible to entrainment due to their small size. Intake velocities have the potential to overwhelm a small fish and draw them into a managed pond with the waters of the flood tide. To minimize this risk, the water control structures identified in Table 6 will be used as outlet-only or completely closed from February 1 to May 31, the majority of the outmigration season of juvenile steelhead South Bay streams. Protection of this critical time period will allow for their safe passage from freshwater rearing streams to the South Bay and the ocean. A small number of steelhead smolts may outmigrate in early June, but this is expected to be less than one percent of the total migrants. Downstream migrant trapping performed by the SCVWD in Stevens Creek, Coyote Creek, and the Guadalupe River during 1997, 1998, and 1999 captured 256 steelhead smolts, and only one of these captures occurred after June 1st (SCVWD, unpublished data).

For water control structures located directly on the shoreline of the San Francisco Bay, FWS will operate them as two-way flow or outlet-only during the period between February 1 and May 31. This operation mode will allow for steelhead and green sturgeon to easily enter and exit managed ponds through the same water control structure during the same tidal cycle. In the summer and fall months, fish are expected to encounter less than suitable conditions within the managed pond complex due to warm temperatures, low DO concentrations, higher salinities, and fish and avian predation. If fish do not exit with the receding tide, they will be exposed to conditions in managed ponds that may result in physical injury or mortality. Although more research and surveys are needed throughout the SBSP to quantify the number of fish entrained into managed ponds, NMFS anticipates the number of entrained and trapped listed fish is small due to multiple deterrents that include dark lighting near the culvert gates, presence of tide gates and trash racks, and poor water quality. The ability of adult steelhead and green sturgeon with stronger swimming ability to avoid entrainment, and the potential to swim out of the managed pond on an outgoing tide will also limit entrapment. Fish that successfully escape the managed ponds will return to the tidal sloughs and channels of the South Bay, and it is expected that their foraging, rearing, and/or migration will continue unimpaired.

Seasonal operational restrictions at all water control structures will not apply during the period between June 1 and January 31 (Table 6). At locations where pond intakes receive water directly from tidal sloughs and channels, juvenile steelhead and green sturgeon may be entrained. Entrainment may result in temporary entrapment in a managed pond, or it could result in the mortality of the individual. Fish that enter managed ponds during high tides could potentially be subject to increased predation or they could perish due to poor water quality or lack of food before another high tide enables them to return to tidal channels outside the managed ponds. However, NMFS believes the risk of entrainment at these locations during the period of June 1 through January 31 is generally low and few fish are likely to be lost in these managed ponds. For steelhead, this period of operation is outside the smolt outmigration season and few juvenile steelhead are expected to be in South San Francisco Bay during this time period. Green sturgeon and adult steelhead are relatively large fish during their migration and residence in San Francisco Bay and, due to their strong swimming ability, are unlikely to be entrained by a water control structure. Green sturgeon sampled by CDFW in the South Bay between 1980 and 2004 were all in excess of 600 mm in length. Data from trawls by CDFW in San Pablo Bay show green sturgeon juveniles ranged from 328 to 733 mm in length. The excellent swimming ability of larger fish will allow them to avoid entrainment through an unscreened intake culvert where water movement is based on gravity flow (*i.e.*, not pumps).

At the armored notch at Pond A8, (Hobbs 2014 and Hobbs 2016) the SBSP conducted two years of research collecting data on PIT-tagged juvenile steelhead from the Guadalupe River Watershed, in an attempt to understand outmigration patterns and entrainment risk at the gated intake structure. The armored notch at Pond A8 is not a typical intake structure for a SBSP managed pond. Most managed ponds have a tide gate and culvert system that operates as the water control structure. At Pond A8, FWS constructed eight 5-foot wide weirs (or gates) that can be opened independently of each other; thus, the risk of entrainment at Pond A8 is higher than that of water control structures at other managed ponds.

To evaluate entrainment risk at Pond A8, the SBSP study applied 70 PIT tags to juvenile steelhead in freshwater reaches of the Guadalupe River and its tributaries in early 2014. In the fall and early winter of 2014, the study tagged an additional 28 juvenile steelhead before the 2014-15 smolt outmigration season. Due to drought conditions in 2014-15 and 2015-16, it has been speculated that there was high mortality of the tagged fish prior to migration and, in combination with technical difficulties at monitoring arrays, only one PIT-tagged fish was observed at the Pond A8 notch (Hobbs 2016). This tagged steelhead was only detected once and flow conditions at the notch suggest it was exiting Pond A8. There was no detection associated with this fish's entry into the A8 Pond Complex (Hobbs 2014). It was assumed that the tagged fish successfully entered and exited the notch structure. Since this study resulted in only one observation of a PIT-tagged fish at the Pond A8 notch, the steelhead results are considered inconclusive, and more research is planned.

The armored notch at Pond A8 on Alviso Slough is a much larger intake than other SBSP water control structures, and as such, it poses a larger entrainment risk to listed fish. During Phase 2, FWS proposes to operate the notched intake structure at Pond A8 with all eight gates open for year-round operation, and maximum flow through the structure. The armored notch is too large to be effectively equipped with a fish screen. Based on the best available information to date, loss of steelhead and green sturgeon due to entrainment at the Pond A8 intake structure is expected to be low because the structure is operated for two-way flow and large volumes of water pass through the structure on each tidal cycle. As described above for "two-way" operated structures, this operational mode is anticipated to allow for most steelhead and green sturgeon to easily enter and exit managed ponds through the same water control structure during the same or subsequent tidal cycles.

Although fish may be capable of passing through the Pond A8 notch, they are expected to be subjected to an increase risk of predation by striped bass. Eighteen striped bass were tagged during the Hobbs (2016) study with results showing that adult striped bass likely utilize the pond and notch structure year-round. It was observed that the striped bass swim in and out of the notch frequently, and position behind the columns of the notch structure that serve as flow refuges during tidal water movement (Dr. James Hobbs, UC Davis professor, personal communication, March 12, 2018). Fishermen in the area also report frequently capturing striped bass, up to 50 pounds, year-round on both the Alviso Slough side and interior Pond A8 side of the notch (Hobbs 2016). These results strongly suggest striped bass reside in and around the Pond A8 notch year-round. Operation of the structure which concentrates tidal flow and fish moving through a relatively narrow opening presumably creates an effective foraging environment for striped bass. As a result, operation of the Pond A8 notch structure is expected to increase predation rates on juvenile steelhead in Alviso Slough as smolts seasonally outmigrate from the Guadalupe River Watershed.

It is also likely that an increased risk of predation occurs at water control structures and breaches at other locations in the SBSP action area, but at a lower level than the Pond A8 notch. Fish that enter or that are entrained into managed ponds will be exposed to a higher risk of predation by birds and fish. Managed ponds are shallow (1-6 feet average depths) and provide no cover from predators for juvenile steelhead or green sturgeon. In addition, water quality conditions may be poor at the time of pond entry (*e.g*., summer-fall low DO concentrations, high temperatures), potentially reducing their swimming performance and the fleeing ability of fish. There is no known data quantifying predation magnitude or frequency on juvenile steelhead or green sturgeon. Several piscivorous species of fish (*e.g*., striped bass) and birds (*e.g.*, egrets, herons, terns) are common in the action area (FWS 2017).

Based on the limited chances of entrainment, the limited number of listed fish likely present when entrainment could occur, and the available data on fish use of the South Bay and the action area, NMFS concludes that a very small number of juvenile steelhead and green sturgeon are likely to become entrained in the ponds and be injured or killed. Native fish in the action area are adapted to habitat conditions of tidal sloughs and tidal marsh areas where water is moving in and out of channels and marsh plains twice daily (Hobbs *et al.* 2013, Hobbs 2017). The managed ponds are an artificial environment where many native fish species are not expected to thrive due to poor water quality conditions and lack of tidal water level changes. The data show that non-native species dominate the managed ponds. Hydraulic conditions, dark lighting and the presence of trash racks are known to discourage fish movement (FWS 1995). These conditions will be present at most SBSP water intakes and are expected to impede and deter the passage of larger fish, including green sturgeon and adult steelhead, into managed ponds. Juvenile steelhead that remain in the South Bay for year-round rearing and foraging are expected to rapidly grow and their larger size and swimming ability also reduces the risk of entrainment at managed pond intake structures. Overall, the intakes which pose the greatest risk of entrainment to steelhead and green sturgeon will have fish screens or seasonal operational measures. A small number of steelhead and green sturgeon may be entrained into managed ponds and some of these fish would likely be lost to poor water quality or predation.

2.5.1.3 Monitoring Program

Over the next 12-year period of the SBSP, FWS has proposed an adaptive management plan that includes monitoring to track the progress and effectiveness of restoration actions. Monitoring activities include surveys of managed ponds, breached ponds (*i.e.*, restored marshes), and other locations within the action area. For fish, surveys are proposed to monitor indicator species, fish community assemblages, and assess habitat conditions. Sampling performed during these surveys may result in the collection of CCC steelhead and Southern DPS green sturgeon. Collection and PIT tagging of juvenile steelhead in the Guadalupe River Watershed is proposed to evaluate smolt outmigration patterns and entrainment rates at the Pond A8 notched intake structure.

Surveys for Birds and Seals

Surveys for shorebirds and harbors seals by boat and airplane may disturb fish including steelhead and green sturgeon. Noise from boats and planes may startle fish and result in temporary dispersion from the area of disturbance. If listed fish react behaviorally to the sound produced boats or planes, adequate water depths and carrying capacity in the open water areas of tidal sloughs, restored ponds, and South San Francisco Bay will provide sufficient area for fish to disperse and will not adversely affect listed fish. Monitoring of harvest mouse populations by trapping within restored marshes and vegetation mapping from aerial photos and ground-surveys is expected to have no effect on steelhead and green sturgeon. Water quality and sediment monitoring are also expected to have no effect of steelhead and green sturgeon. Only monitoring of fish through sampling with nets, traps and other gear has the potential to directly encounter steelhead or green sturgeon.

Fish Surveys in Alviso and Ravenswood Pond Complexes
Fish sampling may be performed with a variety of gear types including pursue seines, fyke nets, beach seines, and throw nets. Sampling performed within managed ponds is not expected to encounter listed steelhead or green sturgeon because listed fish are unlikely to be present in managed ponds. However, sampling performed in restored tidal marshes and slough channels adjacent to managed ponds may encounter steelhead and green sturgeon.

Capturing and handling fish causes them stress, though they typically recover fairly rapidly from the process and, therefore, the overall effects of the handling are generally short-lived. The primary contributing factors to stress and death from handling are excessive doses of anesthetic, differences in water temperatures (between the original habitat and the container in which the fish are held), dissolved oxygen conditions, the amount of time that fish are held out of the water, and physical trauma (Kelsch and Shields 1996). Stress on salmonids increases rapidly from handling if the water temperature exceeds 64 degrees Fahrenheit (°F) or dissolved oxygen is below saturation. Fish that are transferred to holding tanks can experience trauma if care is not taken in the transfer process. In addition, when fish are handled by samplers to obtain measurements and other data, it is not uncommon for fish to be dropped on the ground by the handlers because the fish are not sedated enough or properly restrained. This can result in internal injuries, especially in females with developing ovaries (Stickney 1983). An injured fish is more susceptible to developing diseases, which can lead to delayed mortality. Some of the injuries which can lead to disease are the loss of mucus, loss of scales, damage to integument and internal damage (Stickney 1983, Kelsch and Shields 1996). The potential risks associated with capture and handling are dependent of the specific method of capture gear type.

Seine nets may be used in the SBSP fish monitoring program. These nets trap fish by encircling them with a long wall of webbing. Typically, the top edge of a seine has floats and the bottom edge is weighted. As the net is closed, the fish become concentrated in the net. Seines are usually large enough that they are fished by two or more people, though can be small enough to be fished by one person. Generally, seines are set in an arc around the targeted fish and then dragged to shore. Seines are effective for sampling littoral areas of lentic habitats. In lotic habitats, seines are most easily used in areas of low velocity, but can be used in high velocity areas if ends of the net are held in place while someone approaches the net from upstream, herding fish into the net. To be most effective, a seine needs to be deployed quickly enough that the target species cannot escape the encircling net. Small fish can be gilled in the mesh of a seine. Scales and dermal mucus can be abraded by contacting the net. Fish can be suffocated if they are not quickly removed from the net after the net is removed from the water to process the fish. Also, the fish can be crushed by the handler when removing the net from the water.

Otter trawls and mid-water trawls have been used to sample fish in the South Bay. Trawls are cone-shaped, mesh nets that are towed, typically, along benthic habitat (Hayes 1983, Hayes et al. 1996). Rectangular doors, attached to the towing cables, keep the mouth of the trawl open. Most trawls are towed behind a boat, but small trawls can be operated by hand. As fish enter the trawl, they tire and fall to the cod-end of the trawl. Mortality and injury rates associated with trawls can be high, particularly for small or fragile fish. Fish can be crushed by debris or other fish caught in the net. Depending on mesh size, some small fish are able to escape the trawl through the netting. However, not all fish that escape the trawl are uninjured, as fish may be damaged while passing through the netting. Short duration trawl hauls (5 to 10 minutes maximum) may reduce injuries (Hayes 1983, Stickney 1983, Hayes *et al.* 1996).

Fish sampling methods for the SBSP Restoration Project will be designed to avoid and minimize lethal collections, but some adverse effects to listed fish are expected with the above gear types. However, the amount of unintentional injury and mortality attributable to fish capture is expected to vary widely depending on the method used, the ambient conditions, and the expertise and experience of the field crew. The extent and nature of effects on listed fish associated with the SBSP monitoring program will be highly dependent on sampling locations and gear types. Pursue seines, fyke nets, beach seines, and throw nets may capture both steelhead and green sturgeon, but most fish will likely be released and returned to the South Bay unharmed.

The results of fish sampling conducted to date in the South Bay suggest few listed fish are likely to be encountered during SBSP monitoring efforts in the Alviso and Ravenswood Pond Complexes over the next 12 years. Hobbs *et al.* (2013) sampled fish for the SBSP Program from 2010 through 2012 in the Alviso Pond Complex and Bair Island Marsh by otter trawl, baited minnow trap, seine, trammel net, and gill net. Slough habitats, intertidal creeks, breached ponds, and other habitats throughout the action area were sampled and resulted in the capture a wide range of species, but only one anadromous salmonid was collected (Hobbs *et al.* 2013)[6]. No steelhead or green sturgeon have been captured in the SBSP monitoring efforts to date, with the exception of the targeted steelhead tagging and monitoring effort in freshwater reaches of the Guadalupe River. Additionally, studies conducted for the San Jose-Santa Clara WWTP in sloughs, breached ponds, and managed ponds (Lewis *et al.* 2016, Hobbs 2017) have not captured any steelhead or green sturgeon in trawls, nets, or traps deployed in the Alviso Pond Complex (Dr. James Hobbs, UC Davis professor, personal communication, March 12, 2018).

Based on these previous sampling programs with gear types similar to that proposed for the next 12 years within the Alviso and Ravenswood complexes, it is anticipated that the project's fish sampling program will encounter no more than five juvenile Southern DPS green sturgeon and no more than ten juvenile CCC steelhead annually. These collections will be performed by qualified and experienced fisheries biologists with measures that will avoid and minimize potential injuries and mortalities. The researchers do not intend to kill any listed fish, but a small number may be injured or die as an inadvertent result of the activities. NMFS estimates that less than three percent of captured individuals will be injured or killed during sampling, resulting in the loss of four juvenile steelhead, two juvenile green sturgeon over the 12- year period.

[6] A single Chinook salmon (*Oncorhynchus tshawytscha*) was captured in Coyote Creek adjacent to Pond A19 on March 19, 2012.

Guadalupe River Steelhead Outmigration and Entrainment Studies

To assess steelhead outmigration patterns and entrainment risk at the Pond A8 notched intake structure, FWS proposes a program of PIT tagging and monitoring. This work will be a continuation of studies initiated during Phase 1 and will be conducted up to five steelhead migration seasons over the next 12-year period. The proposed studies will initially involve the collection of juvenile steelhead from freshwater reaches in the Guadalupe River Watershed below impassable dams and insertion of PIT tags into fish in good condition with fork lengths greater than 60 mm for 12-mm tags and 100 mm for 23-mm tags. PIT-tagged juvenile steelhead will then be monitored for movement and survival patterns by stationary half-duplex PIT tag antenna arrays (*i.e.* tag readers) located several miles downstream of the sampling sites during the period between October 1 and May 31. Half-duplex PIT tag readers will be installed at a minimum of four monitoring locations in the watershed: Pond A8 Notch, Pond A5 tidal gate, Pond A7 tidal gate, and the Highway 101 bridge crossing. This steelhead monitoring program will adversely affect juveniles during the collection and tagging phase of the study, but the passive monitoring of tagged fish by the antenna arrays is anticipated to have no effect.

The SBSP program proposes to collect juvenile steelhead via electrofishing in the Guadalupe River, Guadalupe Creek, Los Gatos Creek, Alamitos Creek, and Calero Creek. A maximum of 720 juvenile *O. mykiss* will be handled annually. From the total collected, a subset of a maximum of 360 juvenile *O. mykiss* will be anesthetized and PIT-tagged annually up to five times over the 12-year period.

Collection of juvenile steelhead by electrofishing and implanting of PIT tags are expected to result in stress, injury and mortality of fish. The primary contributing factors to stress and death from handling are excessive doses of anesthetic, differences in water temperatures (between the original habitat and the container in which the fish are held), dissolved oxygen conditions, the amount of time that fish are held out of the water, and physical trauma (Kelsch and Shields 1996). Stress on salmonids increases rapidly from handling if the water temperature exceeds 18 degrees Celsius or dissolved oxygen is below saturation. Fish that are transferred to holding tanks can experience trauma if care is not taken in the transfer process. In addition, when fish are handled by samplers to obtain measurements and other data, it is not uncommon for fish to be dropped on the ground by the handlers because the fish are not sedated enough or properly restrained. This can result in internal injuries, especially in females with developing ovaries (Stickney 1983). An injured fish is more susceptible to developing diseases, which can lead to delayed mortality. Some of the injuries which can lead to disease are the loss of mucus, loss of scales, damage to integument and internal damage (Stickney 1983, Kelsch and Shields 1996).

A PIT tag is a small electronic device that is inserted into the body cavity of the fish using a modified hypodermic needle. Typically, the PIT tag is inserted just in front of the pelvic girdle. When the fish passes by a PIT tag antenna reader, which can be a stationary device installed in the creek channel or a smaller handheld device, the reader identifies the unique number of the individual fish's PIT tag. The insertion of a PIT tag requires that the fish be captured and extensively handled, exposing the fish to the risk of stress and injury. However, PIT tags have been demonstrated to have very little effect on growth, survival, swimming speed, stamina, and behavior of fish (Jenkins and Smith 1990, Prentice *et al*. 1990). Mortalities associated with PIT tags have been found to be less than one percent (Dare 2003).

Because of their small size, there is low probability that PIT tags will cause a major interference with fish life processes (Nielsen 1992). Short term effects of PIT tagging have been observed while tagging broodstock of some species, but these are mainly the result of capture and handling. When implanted in small juvenile fish, there can be difficulty with buoyancy compensation, reduced access to food and slower growth over the first post-tagging days (Davenport *et al.* 1999). *O. mykiss* at 79 mm fork length are expected to weigh 3 to 5 grams and tag weight ratios would be on the order of 1-2 percent in air. Healing is usually achieved in less than 14 days in salmonids (Prentice *et al.* 1990, Davenport *et al*. 1999). No effect on swimming stamina or stride efficiency was found in PIT tagged juvenile Chinook salmon (Prentice *et al.* 1990, Davenport 1999).

Biomark, Inc, a tag supplier has evaluated PIT tag technology extensively in the Pacific Northwest and estimates that post-tagging mortality is less than 0.5 percent with proper tagging technique. Under the SBSP monitoring program, researchers will practice measures to reduce the probability of injury or mortality to juvenile ESA-listed salmonids during PIT tagging procedures. Only fish that are of adequate size and in good condition will be PIT tagged. All fish that are subjected to PIT tagging will be thoroughly anesthetized, which will expedite PIT tag insertion and reduce the probability of injury to the fish. Fish will be carefully observed and allowed to recover fully before being released.

As described above, studies to monitoring juvenile steelhead outmigration and entrainment at Pond A8 are not intended to result in the lethal take of CCC steelhead. However, stress, injury and mortality of a small percentage is anticipated. Based on the results of similar fish collection and tagging activities by other researchers in California streams, incidental lethal take is expected to be less than 3 percent for all captured and tagged juvenile steelhead, and less than 2 percent for all captured and untagged juveniles. No collection of adult steelhead is anticipated because sampling will be limited to the period between October 1 and December 31 prior to the peak upstream migration and spawning season of adults.

Based on the above, the total number of juvenile CCC steelhead that will be handled per migration season will be 720 juveniles. The maximum level of mortality from PIT tagging will be three percent of the annual maximum of 360 juveniles (*i.e.* 11 juvenile steelhead). The maximum level of mortality from capturing and releasing the remaining 360 juvenile steelhead allowed to be handled will be two percent (*i.e.* seven juvenile steelhead). The remainder of captured, tagged, and untagged fish are expected to be released unharmed to the same reach of stream as collection in the Guadalupe River Watershed.

2.5.1.4 Phase 2 Construction Activities and Maintenance Activities

The majority of Phase 2 construction activities in the Ravenswood Pond Complex will be limited to areas within perimeter levees before levee breaching will occur. Ravenswood Ponds R3, R4, R5, and S5 are currently isolated from the tidal waters and no listed fish will be present during construction activities within perimeter levees. These Phase 2 actions will not affect listed fish species or adjacent tidal channels, because work will be isolated from waters of adjacent sloughs and the Bay. When construction in the interior areas of the Ravenswood Ponds has been completed, the levee surrounding Pond R4 will be breached to restore the former salt pond to tidal wetlands, and at Ponds R3, R5, and S5 water control structures will be installed to create muted tidal managed ponds.

At Alviso Ponds A1 and A2W, sediment placement for habitat transition zones, habitat islands, removal of internal levees, and levee improvements will also be constructed prior to the breaching of perimeter levees. These construction activities will have no effect on listed steelhead or green sturgeon since work activities will be isolated from tidal waters of San Francisco Bay. On the outboard side of perimeter levees, levee breaching at Ponds A1 and A2W, as well as, levee breach widening and levee lowering at A19, A20, A21, and R4; construction of bridges and water control structures; and PG&E boardwalk construction will affect tidal waters where steelhead and green sturgeon may be present.

Levee Breaching, Levee Lowering, and Levee Maintenance
During Phase 2, FWS proposes to construct breaches on perimeter levees for tidal restoration at Ponds A1, A2W, and R4. Lowering of perimeter levees is proposed at Ponds A19, A20, A21, and R4. Construction activities at these perimeter levee sites are expected to be completed within a few days or few weeks at each site, due to their relatively small size. During levee breaching events, the discharge of salinity-laden waters from pond interior areas is expected. Water quality monitoring performed at similar levee breach sites during Phase 1 of the SBSP and at other wetland restoration sites around San Francisco Bay indicates discharges will likely contain high salinity levels, but these levels do not reach thresholds that would adversely affect listed fish species and salinities return to baseline levels within a few days. Green sturgeon are euryhaline, that is they are tolerant of variation in ambient salinity levels. Breaching, widening, and lowering events will be scheduled by FWS to occur between June 1 and January 31 which will avoid the outmigration season of CCC steelhead smolts through the action area, rendering potential effects to juvenile steelhead discountable. Adult steelhead could be present during the winter months, but they are also tolerant of the expected levels of variation in salinity levels associated with a levee breach event. NMFS anticipates that any short-term impact associated with increased salinity in the channels following levee breaching will be insignificant to steelhead and green sturgeon. Levee lowering is not expected to result in a single large discharge from interior ponds.

For levee maintenance, repairs to extend the operational life of the levee typically involve the placement of material dredged from the inside of pond or imported material on levee tops or levee sides. Riprap may also be placed on levees to address localized erosion from high energy waves. A dragline, barge-mounted dredge, aquatic excavator, or amphibious construction equipment may be used for levee repair. Dredging on the outside of perimeter levees may be performed periodically to move equipment between ponds or maintenance of inlet/outlet channels for enhancing water flow. These periodic maintenance activities at levees are expected to result in localized and temporary degradation of water quality. Temporary increases in turbidity and suspended sediment in the adjacent water column will be limited to periods of construction activities. The area of affected water quality is expected to be small and quickly disperse with tidal circulation. Most maintenance activities will be completed within a few days. The riprap or sediment fill placed on the levee slope below the tide line will result in reductions in prey resource productivity (the importance of prey resources described above), however the small areas filled over the course of the project period, and associated small reduction in prey resources are expected to have an insignificant effect on foraging by steelhead and green sturgeon because of the large areas of existing and restored tidal marsh that will improve foraging availability (described above) elsewhere throughout the action area.

Water Quality Effects from Construction

Degraded water quality during Phase 2 construction activities on and outside perimeter levees is anticipated in tidal waters adjacent to work sites. Construction of bridges, water control structure work, PG&E's boardwalk construction and other maintenance activities on perimeter levees will disturb soft sediments along the shoreline and in subtidal areas. Excavation of the pilot channels for the Pond R4 levee breach and construction of habitat transition zones in Pond A8 will also disturb soft sediments during construction in tidal waters. Disturbance of the substrate is expected to result in elevated levels of suspended sediment and turbidity in the adjacent water column. If suspended sediment loads remain high for an extended period of time, the primary productivity of an aquatic area may be reduced (Cloern 1987), and fish may suffer reduced feeding ability and be prone to fish gill injury (Benfield and Minello 1996; Nightingale and Simenstad 2001).

Although disturbance of soft sediments and degraded water quality are anticipated, SBSP construction and maintenance activities on perimeter levees are likely to result in minor effects to water quality because work will be performed at low tide and appropriate avoidance measures (*e.g*., straw bales, silt fences) will be deployed to prevent and minimize the discharge of sediment and other materials into the adjacent water column. Areas of disturbance will be temporary and limited to small areas immediately on and adjacent to existing levees. Hazardous material BMPs (*e.g*., fueling BMPs, leak avoidance BMPS, hazardous spill plan) will be implemented at work sites to avoid contact with tidal waters. Thus, potential impacts to water quality are anticipated to be localized, short-term, and considerably less than the thresholds commonly cited as the cause of behavioral and physical impacts to fish. The waters of the action area have high ambient levels of turbidity year-round (AECOM 2017) that steelhead, green sturgeon, and their prey resources in San Francisco Bay commonly encounter due to storm flow runoff events and wind and wave action. In addition, small increases in localized turbidity are expected to quickly dissipate with incoming and outgoing tides. The effects of minor and localized turbidity associated with construction activities on the outboard side of perimeter levees are expected to be insignificant to steelhead and green sturgeon.

Elevated Underwater Sound

Pile driving with a vibratory and/or impact hammer is proposed for the installation of two bridges in Pond A2W, and four bridges over water control structures in Ponds R3 and R5/S5. The bridges will be supported by a total of 32 14-inch concrete piles for Pond A2W, and a total of 32 16-inch piles for Ponds R3 and R5/S5. Elevated underwater sound associated with bridge construction is anticipated during pile driving. The 14-inch and 16-inch piles will be installed with a vibratory hammer, however some may require the use of an impact hammer. To assess the potential effects of impact hammer pile driving, NMFS uses a dual metric criterion of 206 decibels (dB) re one micropascal peak sound pressure level for any single strike and an accumulated sound exposure level (cSEL) of 187 dB re one micropascal squared-second to correlate physical injury to fish from underwater sound produced during pile driving.[7] Vibratory

[7] June 12, 2008 memorandum from the Fisheries Hydroacoustic Working Group regarding the agreement in

hammers generate lower sound levels and different sound wave forms that are not known to cause physical injury or mortality to fish (Buehler *et al.* 2015). Thus, the use of a vibratory hammer by this project during construction or maintenance activities is expected to avoid underwater sound pressure levels that are harmful to fish.

To assess the potential level of elevated underwater sound during this project's use of an impact hammer, NMFS examined the results of underwater sound measurements from other pile driving projects in San Francisco Bay (Buehler *et al.* 2015). Hydroacoustic measurements from projects installing similar sized concrete pile indicate the sound pressure levels generated by this project's use of an impact hammer will not exceed the 206 dB peak pressure threshold or the cSEL of 187 dB. Elevated levels of underwater sound may startle fish in the vicinity and they may temporarily disperse from the area. Adequate water depths and area within the adjacent open waters of the Bay would be expected to provide displaced fish sufficient area and depth to disperse. For these reasons, it is anticipated that effects of elevated underwater sound levels associated with pile installation will be insignificant to threatened steelhead and green sturgeon.

Dewatering

Temporary cofferdams will be constructed with sheet piles or wood when dry substrate is needed for construction and maintenance activities (*e.g.*, bridge construction and water control structure installation/replacement). FWS has proposed conservation measures to minimize potential entrapment and stranding of fish inside of cofferdams. These measures include restricting construction of cofferdams on creeks and sloughs that are known to contain steelhead runs (*e.g.*, Coyote Creek/Slough, Guadalupe River/Alviso Slough, and Stevens Creek/Whisman Slough) to the period between June 1 and January 31 when juvenile steelhead are not migrating from their natal streams through the tidally-influenced portions of the action area. Cofferdams will also be installed at low tide with closure methods designed to avoid the capture and stranding of fish. If water remains in cofferdams after closing, then dewatering will occur. A biological monitor will be onsite to ensure proper closure methods.

Regarding the potential for entrapment and entrainment, the likelihood of steelhead and green sturgeon to be in the shallow water work areas during a cofferdam closure is exceedingly small. Migrating steelhead adults and smolts generally follow the safety of areas adjacent to deeper water. Also, the smolt outmigration period is generally from late winter through spring, and FWS will not install cofferdams on creeks and sloughs that are known steelhead runs (*e.g.*, Coyote Creek/Slough, Guadalupe River/Alviso Slough, and Stevens Creek/Whisman Slough) between February 1 and May 31. Green sturgeon may be found within South San Francisco Bay and within the tidal sloughs and channels of the Alviso and Ravenswood Pond Complexes year-round. However, green sturgeon in the action area are relatively large fish and are unlikely to remain in shallow water areas during the disturbances and sound vibrations of sheet pile driving to build cofferdams. Sturgeon would likely be startled and disburse to adjacent available salt marsh, mud flat, or shallow water habitats prior to cofferdam completion. Additionally, a biological monitor will be onsite during all cofferdam installations. For all these reasons, the

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principle for interim criteria for injury to fish from pile driving activities. Document available at: http://www.wsdot.wa.gov/NR/rdonlyres/40l0ED62-B403-489C-AF05-5F4 7 l 3D663C9/0/InterimCriteriaAgreement.pdf.

potential for entrapment and entrainment of green sturgeon and steelhead in cofferdams is considered unlikely.

2.5.2 Effects to Critical Habitat

2.5.2.1 Tidal marsh restoration

The anticipated effects of Phase 2 tidal marsh restoration actions on designated critical habitat for CCC steelhead and the Southern DPS of green sturgeon are primarily beneficial. Post-construction, breached levees adjacent to the South Bay will restore 1,005 acres of tidal salt marsh at Ponds A1, A2W, and R4. This significant expansion of tidal marsh and tidal channels within the South Bay will benefit steelhead and green sturgeon rearing and foraging. Flood tides receding from tidal marshes will convey important nutrients and food resources to fish and invertebrates in subtidal channels and the South Bay itself. As a result, restored tidal sloughs and channels in the action area are expected to increase the productivity of steelhead and green prey resources (*i.e*., invertebrates and fish) in the action area.

Phase 2 of the SBSP is expected to enhance and expand the area of several estuarine PBFs of CCC steelhead critical habitat including: (1) natural cover such as submerged and overhanging wood, aquatic vegetation, and side channels; and (2) juvenile and adult forage, including aquatic invertebrates and fishes, supporting growth and maturation. For the Southern DPS of green sturgeon, Phase 2 tidal restoration actions are expected to enhance and expand the area of the following estuarine PBFs of critical habitat: food resources, water flow, water quality, water depth, and sediment quality. Section 2.5.1.1 of this opinion also describes anticipated benefits associated with the expansion of tidal marsh habitat in the project's action area.

2.5.2.2 Temporary Construction Impacts

The effects of construction on steelhead and green sturgeon habitat, including designated critical habitat, are described above in Section 2.5.1.4 of this opinion. Levee breaching, pilot channel excavation, Refuge and PG&E facility construction and maintenance activities (*e.g*., bridges, water control structures, habitat transition zones, docks, fences, platforms and other facilities), on the outboard side of perimeter levees are expected to result in short-term disturbance to fringe marsh and the adjacent shoreline. Localized impacts to water quality may occur in the form of increased levels of turbidity and suspended sediment. However, these construction activities are generally small in area and construction activities are typically a few days in duration. Thus, adverse effects on critical habitat due to construction of Phase 2 facilities and ongoing O&M are expected to be minor, localized, and short-term.

2.5.2.3 Prey Resources

Phase 2 actions, such as excavation of pilot channels through outboard sloughs or mudflats, periodic dredging for water circulation at water control structures, and levee fortification will disturb the substrate and associated benthic community. Many of these benthic organisms are prey resources for fish. Addition of sediment and rock to maintain structures and features, including levees, habitat islands, construction of habitat transition zones in Pond A8, and maintenance of habitat transition zones, and construction of the PG&E boardwalk could result in loss of prey resources across tens of meters of intertidal and subtidal habitat.

Periodic small-scale dredging, excavation, burial, and other project activities results in the removal of the top layer soft bottom habitat and removal of invertebrate prey species in that layer. Research suggests that even in dynamic environments, anthropogenic disturbance to the biological community, combined with the physical alteration of habitat, results in a loss of ecological function over varying timescales (Reish 1961; Oliver *et al.* 1977; Thrush *et al.* 1995; Watling *et al.* 2001). Recovery of the disturbed habitat could take months to years (Gilkinson *et al.* 2005), or never return its pre-disturbed state (McConnaughey *et al.* 2000). Recovery time depends on the frequency of disturbance, sediment characteristics, and the level of environmental disturbance by water movement at the site. Based on available literature, it is assumed that these activities result in a temporary loss of prey resources within those areas in the first 3-5 years of project implementation until recolonization and recovery is achieved. After the first 3-5 years, prey resources are likely to increase as described above.

Levee improvements will occur along 11,000 linear feet of existing levee in Ponds A1 and A2W, which are currently being operated as muted-tidal managed ponds. The majority of the onsite sediment or clean fill, as described above, placed at Ponds A1 and A2W will occur in upland habitat before ponds are breached to begin transition to tidal marsh habitat. However, a small amount of fill will cover the pond bottom a few feet into the pond interior along the levee reach between Charleston Slough and Pond A2W. Since this area is currently managed as a muted tidal pond, listed fish are not expected to be present in this area and no impacts to foraging habitat are expected. Post-breaching, the lower portions of habitat transition zones along levees will become intertidal zones and are expected to be colonized by benthic organisms which contribute to prey resource productivity. The 31 acres of habitat transition zone fill in Ponds A1 and A2W, including the tidal marsh intertidal zone, will contribute to steelhead and green sturgeon prey resource productivity as the 710 acres in Ponds A1 and A2W transition to restored tidal marsh in the former muted-tidal managed ponds.

Habitat transition zones will also be constructed in Ravenswood Pond R4 before the pond is breached to become tidally influenced. Pond R4 will be restored to 295 acres of tidal marsh habitat, and is expected to produce steelhead and green sturgeon prey resources, as described above for Ponds A1 and A2W. Habitat transition zones will also be constructed in Pond A8 with total dimensions of 4,150 feet long and approximately 200 feet wide. As described above, Pond A8 is also currently operated as a muted-tidal managed pond. Thus, fill placed in Pond A8 is not expected to decrease prey resource productivity, because habitat conditions within this pond are degraded with dominance of non-native species and poor water quality. Thus, the fill placement in Pond A8 is not expected to decrease prey productivity because it is a muted-tidal managed pond with limited capacity to support rearing by listed fish. Within the Pond A8 Complex, the fill is relatively small (19 acres) compared to the size of Pond A8 (1,400 acres).

The proposed PG&E boardwalk will be located in an intertidal area of tidal marsh habitat in and around Alviso Ponds A1 and A2W. Overwater structures can cause adverse effects to submerged aquatic vegetation and impacting the prey resource productivity of the habitat by altering ambient light conditions and through activities associated with the use and operation of the facilities (Nightingale and Simenstad 2001b). However, permanent shading of the area underneath the boardwalk is not expected because the area directly underneath the proposed boardwalk is intertidal marsh habitat, which is at a higher elevation and only inundates at high tides, thus being exposed to ample amounts of light at all lower tide levels. The height (10 feet) of the boardwalk off the pond bottom and its width (5 feet) will be sufficient to allow light underneath boardwalk for marsh vegetation growth. Regarding potential trampling effects, PG&E crews are expected to utilize the boardwalk to avoid any trampling affects to marsh vegetation. Based on the above, no reduction in prey resource productivity or other impacts to listed fish habitat are expected from the proposed project's boardwalk construction.

2.5.2.4 Fish Passage and Pond Operation

The proposed operation of existing managed ponds in the Alviso and Ravenswood Pond Complexes and the two new managed ponds (Ponds R3 and R5/S5) are expected to generally avoid the entrainment of listed fish. Measures to seasonally modify operation of water control structures on key channels are designed to protect juvenile steelhead during the season of migration through the action area. Water quality, increased risk of predation, and habitat conditions within managed ponds are generally unsuitable for steelhead and green sturgeon, as presented in Section 2.5.1.2 of this opinion. Habitat conditions at the pipe culvert water control structures are poor with respect to hydraulic conditions, dark lighting, and the presence of trash racks, which are known to discourage fish movement (FWS 1995). These conditions at the project's water control structures are expected to impede and deter the passage of larger native fish, including green sturgeon, into managed ponds.

2.6 Cumulative Effects

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

To identify potential future non-federal projects in the action area, NMFS reviewed the cumulative effects information provided in the SBSP Restoration Project Phase 2 EIS/EIR, the project's biological assessment, and the Santa Clara Valley Water District's website (http://www.valleywater.org). NMFS did not identify any future non-Federal actions that are reasonably certain to occur within the action area.

2.7 Integration and Synthesis

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

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

Estuaries are important rearing and foraging habitat for steelhead and green sturgeon. Tidal marshes and channels in the South Bay provide important habitat for rearing of juvenile steelhead and juvenile sturgeon, acclimation of steelhead smolts to seawater, and serve as migration corridors to several South Bay steelhead streams. The proposed implementation of the project is anticipated to benefit threatened CCC steelhead, the southern DPS of green sturgeon, and their respective designated critical habitats. The restoration of 1,005 acres of tidal salt marsh at Ponds A1, A2W, and R4 will expand the quantity of estuarine habitat in the South Bay and enhance the quality of existing habitat. Detritus originating from the breakdown of plant material and phytoplankton in restored tidal marshes will become important nutrients and food resources to fish and invertebrates in subtidal channels and the South Bay estuary habitat. Tidal channel networks will develop within the restored marshes and provide new foraging opportunities during high tide. Increases in productivity will likely increase the prey base available to various fish species in the action area. Restored tidal marshes and channels are expected to support prey species such as crustaceans, clams, annelid worms, crabs, and small fishes for steelhead and green sturgeon. The expansion of tidal marsh habitat in the South Bay is expected to improve PBFs of designated critical habitat for steelhead and green sturgeon in the action area.

At four locations during Phase 2, FWS will be creating new managed ponds for various species of birds at Ravenswood Ponds R3, and R5/S5. Ongoing operations and maintenance will be performed at existing managed ponds in the action area. Water control structures on perimeter levees surrounding managed ponds draw water from tidal sloughs and the South Bay to circulate through the managed ponds. Water quality and habitat conditions within managed ponds are generally unsuitable for steelhead and green sturgeon while the risk of avian and fish predation is also increased. To avoid or minimize the risk of entraining listed steelhead and green sturgeon into managed ponds, FWS has proposed to continue the seasonal operational measures for water control structures located in critical migration areas for steelhead to prevent juvenile steelhead from being entrained and lost in managed ponds. Water control structures that draw water directly on the shoreline of the South Bay and on channels at the mouths of steelhead streams will be operated for outlet-only or two-way flow during the period between February 1 and May 31 (Table 6). This will allow fish entering a water control structure to freely exit the managed pond at the same location, and this could be accomplished during the same or subsequent tidal cycle. The period of February 1 through May 31 encompasses the majority of the steelhead outmigration season. It is not possible to accurately quantify the number of steelhead and green sturgeon expected to be entrained in managed ponds. However, based on the analysis above, NMFS expects the numbers of listed fish entrained will be very low. In addition, if entrained, most listed fish are expected to successfully exit the managed ponds at slack or outgoing tide, but some fish may become lost and perish due to poor water quality or predation. Due to the size and intake velocities at these water control structures, entrainment will likely to be limited to a very small number of juvenile steelhead and green sturgeon. The larger size and excellent swimming ability of adult fish will allow them to successfully avoid entrainment.

Phase 2 construction activities and O&M activities on the outboard side of perimeter levees (*e.g.*, levee breaching, pilot channel excavation, water control structure installation/repair) are expected to result in short-term disturbance to habitat and temporary degradation of water quality in adjacent tidal areas. The largest Phase 2 construction activities will occur within the interior berms of the ponds before breaching will occur (*e.g.*, levee improvements, habitat islands, boardwalk construction) or dewatered cofferdams and will not affect listed fish species or critical habitat because work will be isolated from tidal waters of adjacent sloughs and the Bay. Localized impacts to substrate and water quality may occur in the form of increased levels of turbidity and suspended sediment. However, these construction activities outside of perimeter levees are generally small in area and construction is typically a few days to few weeks in duration. For these reasons, impacts due to construction of Phase 2 facilities and ongoing O&M are expected to be minor, localized, and short-term.

Proposed research by the SBSP project is expected to collect, PIT tag, and release juvenile steelhead in the Guadalupe River Watershed. This research is designed to improve our understanding of outmigration patterns of steelhead in the Guadalupe River Watershed and estimate entrainment risk at the Pond A8 water control structures. Based on previous sampling, NMFS anticipates that the project will collect and tag a significantly smaller number that the proposed maximum of 360 fish per year for up to five seasons during the 12-year project period. Despite the efforts of researchers to reduce injury and mortality to CCC steelhead, lethal take of juveniles may occur as a result of this research activity. The limited amount of available information suggests that CCC steelhead abundance in the Guadalupe Watershed is very low, population growth rates are likely negative, and the distribution is constricted and fragmented. Despite the degraded condition of CCC steelhead population, the adverse effects of research activities proposed by the SBSP are likely minimal. Electrofishing and tagging will be performed by qualified and experienced fisheries biologists with measures that will avoid and minimize potential injuries and mortalities. The researchers do not intend to kill any listed fish, but a small number may be injured or die as an inadvertent result of the activities. NMFS estimates that incidental lethal take will be less than 3 percent for all captured and tagged juvenile steelhead, and less than 2 percent for all captured and untagged juveniles. No collection of adult steelhead is anticipated. If the maximum number of steelhead juveniles are collected, the number of steelhead subject to injury and mortality during collection and PIT tagging research activities would be 18 or less annually (up to five seasons).

Additional monitoring efforts by the SBSP project are proposed within tidal sloughs, breached ponds (*i.e.*, restored marsh), and managed ponds in the Alviso and Ravenswood Complexes to monitor indicator species, fish community assemblages, and assess habitat conditions. As described above, these studies are not intended to result in the lethal take of CCC steelhead; however, stress, injury, and mortality of a small percentage is anticipated. Based on the results of previous SBSP sampling efforts and the use of similar gear types by other California researchers, it is anticipated that the project's fish sampling program will encounter no more than five juvenile Southern DPS green sturgeon, and no more than ten juvenile CCC steelhead annually. NMFS estimates that less than three percent of captured individuals will be injured or killed during these surveys (total of four juvenile steelhead, and two juvenile green sturgeon for the project's 12-year period).

Steelhead are distributed throughout the South Bay tributaries of Stevens Creek, Guadalupe River, and Coyote Creek. Green sturgeon distribution and abundance are not well known in the South Bay. Due to the relatively large number of juvenile steelhead that are produced by each spawning pair, steelhead spawning in these watersheds in future years are likely to produce enough juveniles to replace the few that may be lost due to entrainment, increased levels of predation, and incidental mortality associated with fish surveys and PIT tagging. Loss of green sturgeon due to entrainment by water control structures at managed ponds and due to collection by SBSP monitoring activities is expected to be very low. Based on the above, a very small number of green sturgeon and steelhead are expected to be adversely affected and killed by the SBSP Phase 2 actions and ongoing O&M activities. However, it is unlikely that the small potential loss of individuals as a result of the Project will impact future adult returns due to the proportionally large number of green sturgeon and CCC steelhead unaffected by the Project compared to the small number of listed fish affected by the Project. Due to the life history strategy of green sturgeon that spawn every 3-5 years over an adult lifespan of as much as 40 years (Moyle 2002), the few individuals injured or killed during SBSP activities are likely to be replaced in subsequent generations of green sturgeon. For CCC steelhead, the relatively large number of juveniles produced by each spawning pair in the Guadalupe River, Coyote Creek, and Stevens Creek Watersheds in future years are likely to produce enough juveniles to replace the few that may be lost to SBSP project activities. Thus, it is unlikely that the small potential loss of juveniles during the 12-year duration of this project will impact future adult returns.

Regarding future climate change effects in the action area, California could be subject to higher average summer air temperatures and lower total precipitation levels. Reductions in the amount of snowfall and rainfall would reduce stream flow levels in Northern and Central Coastal rivers. Estuaries may also experience changes in productivity due to changes in freshwater flows, nutrient cycling, and sediment amounts. For this Project, SBSP activities will occur over a 12-year period beginning in 2019, and the above effects of climate change are not likely to be detected within that time frame. If the effects of climate change are detected, they will likely materialize as moderate changes to the current climate conditions within the action area. These changes may place further stress on CCC steelhead and Southern DPS green sturgeon populations. The effects of the proposed action combined with moderate climate change effects may result in conditions similar to those produced by natural ocean-atmospheric variations (as described in the Environmental Baseline) and annual variations. The species are expected to persist through these phenomena, as they have in the past, even when concurrently exposed to the effects of similar projects.

2.8 Conclusion

After reviewing and analyzing the current status of the listed species and critical habitat, the environmental baseline within the action area, the effects of the proposed action, any effects of interrelated and interdependent activities, and cumulative effects, it is NMFS' biological opinion that the proposed action is not likely to jeopardize the continued existence of threatened CCC steelhead, Southern DPS green sturgeon, or destroy or adversely modify designated critical habitat.

2.9 Incidental Take Statement

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

2.9.1 Amount or Extent of Take

The number of threatened CCC steelhead and Southern DPS green sturgeon that may be incidentally taken during implementation of Phase 2 of the SBSP over a 12-year period beginning in 2019 is expected to be small. Incidental take may occur as entrainment at water control structures at managed ponds, exposure to degraded water quality conditions, increased levels of predation at SBSP facilities, and during steelhead collection and tagging activities in the Guadalupe River Watershed. The precise number of fish taken by entrainment at managed pond intake structures and subjected to increased levels of predation and degraded water quality at SBSP facilities cannot be accurately quantified due to: (1) the precise number of fish that may be present is unknown; and (2) the precise number of fish that may be entrained or preyed upon is unknown. Based on the configuration of the water control structures and their associated seasonal operations, the number of fish entrained into managed ponds is expected to be limited to a small number of juvenile steelhead and juvenile green sturgeon during the next 12 years. Most of these entrained fish are expected to successfully escape the managed ponds and return to the tidal sloughs and channels of the South Bay.

For the SBSP fish monitoring activities, sampling in the Alviso and Ravenswood Pond Complexes may encounter CCC steelhead and Southern DPS green sturgeon. Based on these previous sampling programs with gear types similar to that proposed for the next 12 years, it is anticipated that the project's fish sampling program will encounter no more than five juvenile Southern DPS green sturgeon, and no more than ten juvenile CCC steelhead annually. NMFS estimates that less than three percent of captured individuals will be injured or killed during these surveys in tidal waters (total of four juvenile steelhead, and two juvenile green sturgeon for the project's 12-year period).

Within the Guadalupe River Watershed, steelhead collections and tagging may collect up to 720 juveniles annually and apply up to 360 PIT tags. NMFS estimates that incidental lethal take will be less than 3 percent for all captured and tagged juvenile steelhead, and less than 2 percent for all captured and untagged juveniles. No collection of adult steelhead is anticipated. If the maximum number of steelhead juveniles are collected, the number of steelhead subject to injury and mortality during collection and PIT tagging research activities would be 18 or less annually (up to five seasons).

2.9.2 Effect of the Take

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

2.9.3 Reasonable and Prudent Measures

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

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

1. Undertake measures to ensure that harm and mortality to CCC steelhead and Southern DPS green sturgeon during fish monitoring and research activities is low.

2. Ensure the project's water control and fish screen structures minimize or eliminate the risk of fish entrainment.

3. Undertake measures to avoid and minimize harm to CCC steelhead and Southern DPS green sturgeon resulting from construction activities.

4. Prepare and submit reports regarding the project's construction of Phase 2 facilities, ongoing operations at managed ponds, post-construction site performance, and results of the fish monitoring and research studies.

2.9.4 Terms and Conditions

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

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

   a. FWS shall retain qualified biologists with expertise in the areas of anadromous salmonid and green sturgeon biology, including handling, collecting, and relocating salmonids and sturgeon; species/habitat relationships; and biological monitoring of salmonids and green sturgeon. FWS shall ensure that all biologists working on the project are qualified to conduct fish collections in a manner which minimizes all potential risks to steelhead and green sturgeon.

   b. FWS shall prepare and submit to NMFS for review and approval all Phase 2 proposals that involve fisheries sampling. Proposals shall be submitted to NMFS for review and approval at least 90 days in advance of the initiation of the study. Non-lethal sampling techniques shall be used at all locations that are likely to encounter steelhead or green sturgeon.

   c. If electrofishing techniques will be employed to collect fish for research efforts described above, FWS and contractors shall adhere to the NMFS Guidelines for Electrofishing Waters Containing Salmonids Listed Under the Endangered Species Act, found at: http://www.westcoast.fisheries.noaa.gov/publications/reference_documents/esa_refs/section4d/electro2000.pdf

   d. Steelhead and green sturgeon shall be handled with extreme care and kept in water to the maximum extent possible during handling activities. All captured fish shall be kept in cool, shaded, aerated water protected from excessive noise, jostling, or overcrowding any time they are not in the stream, and fish shall not be removed from this water except when released. To avoid predation, the biologists shall have at least two containers and segregate young-of-year fish from larger age-classes and other potential aquatic predators. Captured salmonids and green sturgeon will be relocated, as soon as possible, to a suitable location in which suitable habitat conditions are present to allow for adequate survival of transported fish and fish already present.

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

   a. FWS shall submit draft design plans for all new and replacement water control structures on perimeter levees in the project area to NMFS for review and approval at least 120 days prior to construction.

   b. The permittee shall submit draft design plans for all fish screens to NMFS for review and approval at least 120 days prior to construction.

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

   a. FWS shall allow any NMFS employee(s) or any other person(s) designated by NMFS, to accompany field personnel to visit the project sites during activities described in this opinion.

   b. Once construction is completed, all project-introduced material (*e.g.*, pipe, cofferdam) must be removed. Excess materials will be disposed of at an appropriate disposal site.

   c. Construction equipment used on the outside of perimeter levees will be checked each day prior to work and, if necessary, action will be taken to prevent fluid leaks. If leaks occur during work FWS or their contractor will contain the spill and remove the affected soils.

   d. Any pumps used to divert live stream flow, outside the dewatered work area, will be screened and maintained throughout the construction period to comply with NMFS' Fish Screening Criteria for Anadromous Salmonids. See: http://www.westcoast.fisheries.noaa.gov/publications/hydropower/southwest_region_1997_fish_screen_design_criteria.pdf.

   e. The biologists shall monitor the construction sites during placement and removal of cofferdams, channel diversions, and access ramps to ensure that proper methods are employed to avoid any adverse effects to steelhead and green sturgeon.

   f. If any steelhead or green sturgeon are found dead or injured, the biologist shall contact NMFS biologist Brian Meux by phone immediately at (707) 575-1253 or the NMFS North Central Coast Office (Santa Rosa, California) at 707-575-6050. The purpose of the contact is to review the activities resulting in take and to determine if additional protective measures are required. All salmonid and green sturgeon mortalities shall be retained, placed in an appropriately-sized sealable plastic bag, labeled with the date and location of collection, fork length, and be frozen as soon as possible. Frozen samples shall be retained by the biologist until specific instructions are provided by NMFS. The biologist may not transfer biological samples to anyone other than the NMFS North Central Coast Office without obtaining prior written approval from the NMFS North Central Coast Office supervisor. Any such transfer will be subject to such conditions as NMFS deems appropriate.

4. The following term and condition implements reasonable and prudent measure 4:

   a. FWS shall provide written reports to NMFS by January 31 of each year regarding the project's construction of Phase 2 facilities at pond complexes during the prior calendar year. Reports shall include descriptions of: (1) levee work, including breaches; (2) construction of water control structures; (3) excavation of pilot channels and other areas outside or perimeter levees; (4) construction of recreational facilities outside of perimeter levees; and (5) other facilities and structures on or outside of perimeter levees. The reports shall include the dates construction began and was completed; a discussion of any unanticipated effects or unanticipated levels of effects on salmonids or sturgeon, a description of any and all measures taken to minimize those unanticipated effects and a statement as to whether or not the unanticipated effects had any effect on ESA-listed fish; the number of salmonids or sturgeon killed or injured during the project action; and photographs taken before, during, and after the activity from photo reference points.

b. FWS shall provide written reports to NMFS by January 31 of each year regarding the project's construction of water control facilities and fish screens on perimeter levees throughout the entire project area. The reports shall include the dates construction began and was completed; a discussion of any unanticipated effects or unanticipated levels of effects on salmonids or sturgeon, a description of any and all measures taken to minimize those unanticipated effects and a statement as to whether or not the unanticipated effects had any effect on ESA-listed fish; the number of salmonids or sturgeon killed or injured during the project action; and photographs taken before, during, and after the activity from photo reference points.

c. FWS shall provide written reports to NMFS by January 31 of each year regarding operation of all water control facilities on perimeter levees. The reports shall indicate the dates in which the structure began and ceased operation as one-way flow, two-way flow, inlet only, or outlet only.

d. FWS shall provide written reports to NMFS by January 31 of each year regarding the results of fish monitoring and research. If the full report for the prior year is not available by January 15, a summary of fish captures and results shall be provided and the full report provided by September 15 of the year.

e. The Corps and permittees shall provide written reports to NMFS by January 31 of each year regarding observations and data collected at fish kills within the project area. If a full report for the prior year is not available by January 15, a summary of fish kill observations shall be provided and the full report provided by September 15 of the year.

f. All the above reports shall be submitted to NMFS Santa Rosa Area Office, Attention: San Francisco Bay Branch Supervisor, 777 Sonoma Avenue, Room 325, Santa Rosa, California 95404-6528.

2.10 Conservation Recommendations

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

NMFS has the following conservation recommendation:

1. FWS should proceed as expeditiously as possible to meet the SBSP overall goal of achieving a 50:50 mix of tidal and managed pond habitats. The risks that the ongoing operation of managed ponds pose to listed fish include entrainment, entrapment, degraded water quality, and increased predation. NMFS recommends transitioning the remaining acreage of managed ponds throughout the SBSP to meet the goal of 7,500 acres of tidal restoration as rapidly as feasible.

2. NMFS recommends increasing the frequency and extent of fish community monitoring in the Alviso and Ravenswood Pond Complexes. Monitoring should include: 1) fish community surveys developed in association with NMFS to determine fish and invertebrate abundance and distribution; 2) fish tagging studies that would contribute to a more thorough understanding of the connectivity and passage conditions at water control structures for native and non-native fish.

2.11 Reinitiation of Consultation

This concludes formal consultation for Phase 2 of the South Bay Salt Ponds Restoration Project.

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

3. 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. The MSA (section 3) defines EFH as “those waters and substrate necessary to fish for spawning, breeding, feeding, or growth to maturity.” Adverse effect means any impact that reduces quality or quantity of EFH, and may include direct or indirect physical, chemical, or biological alteration of the waters or substrate and loss of (or injury to) benthic organisms, prey species and their habitat, and other ecosystem components, if such modifications reduce the quality or quantity of EFH. Adverse effects on EFH may result from actions occurring within EFH or outside of it and may include site-specific or EFH-wide impacts, including individual, cumulative, or synergistic consequences of actions (50 CFR

600.810). Section 305(b) also requires NMFS to recommend measures that can be taken by the action agency to conserve EFH.

This analysis is based, in part, on the EFH assessment provided by the Corps and descriptions of EFH for Pacific Coast groundfish (Pacific Fishery Management Council [PFMC] 2005), coastal pelagic species (PFMC 1998), and Pacific Coast salmon (PFMC 2014) contained in the fishery management plans developed by the PFMC and approved by the Secretary of Commerce.

3.1 Essential Fish Habitat Affected by the Project

Effects of the proposed project will impact EFH for various federally managed fish species within the Pacific Coast Groundfish, Pacific Coast Salmon, and Coastal Pelagic Species FMPs. Furthermore, the project area is located in estuary Habitat Area of Particular Concern for various federally managed fish species within the Pacific Coast Groundfish and Pacific Coast Salmon FMPs.

3.2 Adverse Effects on Essential Fish Habitat

Adverse effects to EFH will occur in the estuarine portion of the action area described above, through (1) entrainment into managed ponds (2) degraded water quality during construction, (3) disturbance of benthic habitat, and (4) Elevated underwater sound levels.

Entrainment Risk at Managed Ponds

The installation of new water control structures at Ravenswood Ponds R3, and R5/S5 (Table 4, Table 5), and continued operation of water control structures at existing managed ponds are expected to adversely affect EFH by creating habitat conditions that increase the risk of fish entrainment (see Section 2.5.1.2 in the above opinion). Conditions within most managed ponds will not be suitable for the long-term survival of most native fish species, and in some cases, conditions may not be suitable for the short-term survival of these species. Managed ponds are typically shallow water with sub-optimal temperature and low DO conditions with increased predation risk (due to high bird populations) than tidal habitats. Striped bass (*Morone saxatilis*) also pose a significant predation risk at water control structures and in managed ponds (Hobbs 2016). As a result, entrainment in managed ponds at water control structures is expected to result in loss of native fishes.

Phase 2 Construction Activities and Maintenance Activities

Phase 2 construction activities on perimeter levees and in tidal waters are expected to degrade water quality and disturb benthic habitat (see Section 2.5.1.4 of the above opinion). In-water work activities (*i.e.*, levee breaching, cofferdam and boardwalk construction, and levee repairs and maintenance, pile installation) are expected to result in elevated levels of turbidity and suspended sediment in the water column. However, conservation measures (*e.g.*, straw bales, silt fences) are proposed that will avoid and minimize the discharge of sediment and other materials into the adjacent water column. Construction and maintenance on the outboard side of perimeter levees will be performed at low tide under dewatered conditions, if dewatering is necessary, and may also disturb sediment in localized areas. Increases in turbidity are anticipated to be short-term, minor, and localized. In addition, twice daily tides are expected to dissipate localized increases in turbidity that may result from project activities. Due to the conservation measures and short duration and small work areas of most proposed construction actions, in-water work is expected to have localized, minor, and temporary periods of elevated turbidity that dissipate with tidal circulation.

Phase 2 actions, such as excavation of pilot channels through outboard sloughs or mudflats, periodic dredging for water circulation at water control structures, and levee fortification will disturb the substrate and associated benthic community. Many of these benthic organisms are prey resources for federally-managed fish. Addition of sediment and rock to maintain structures and features, including levees, habitat islands, construction of habitat transition zones in Pond A8, maintenance of habitat transition zones, and installation of the PG&E boardwalk could result in loss of prey resources. However, for the reasons as described above (entrapment, water quality, and predation risk), managed ponds are not considered supportive habitat for native species, including federally-managed species, therefore the addition of sediment fill in these areas as described above will not further degrade the habitat value of these areas for federally-managed species in the above listed FMPs. As presented above, detrimental shading effects are not expected from the installation of the PG&E boardwalk.

Levee breaching, pilot channel excavation, Refuge and PG&E facility construction and maintenance activities, small-scale dredging, and dewatering, (*e.g*., bridges, water control structures, docks, fences, platforms and other facilities), on the outboard side of perimeter levees are expected to result in temporary disturbance to fringe marsh and the adjacent South Bay shoreline. However, as described above, effects are expected to be short-term, minor, and localized.

Elevated Underwater Sound Levels

Pile driving of installation of piles at two bridges in Pond A2W will increase underwater sound pressures and will effect fishes in the vicinity (Section 2.5.1.4 of the above opinion). The 14-inch and 16-inch concrete piles will be installed with a vibratory hammer, however some may require the use of an impact hammer. Vibratory hammers generate lower sound levels and different sound wave forms that are not known to cause physical injury or mortality to fish (Buehler et al. 2015). However, the project's use of an impact hammer would generate higher levels of underwater sound. Hydroacoustic measurements from projects installing similar sized concrete pile with an impact hammer indicate the sound pressure levels generated by this project will not exceed the 206 dB peak pressure threshold or the cSEL of 187 dB, but elevated levels of underwater sound may startle fish in the vicinity and they may temporarily disperse from the area.

3.3 Essential Fish Habitat Conservation Recommendations

Project activities maintain and continue fish passage conditions near water intake structures (Table 6), and add two new managed ponds with pipe culvert water control structures (R3 and R5/S5). The proposed project's construction of managed ponds introduces habitat conditions with expected adverse effects of entrainment, degraded water quality, and increased risk of predation, as presented above. The new and continued operation of managed ponds is a concern for the overall quality of essential fish habitat available for federally-managed fish; therefore the following EFH Conservation Recommendations are provided below.

1. FWS should proceed as expeditiously as possible to meet the SBSP overall goal of achieving a 50:50 mix of tidal and managed pond habitats. The risks that the ongoing operation of managed ponds pose to listed fish include entrainment, entrapment, degraded water quality, and increased predation. NMFS recommends transitioning the remaining acreage of managed ponds throughout the SBSP to meet the goal of 7,500 acres of tidal restoration as rapidly as feasible.

2. NMFS recommends increasing the frequency and extent of fish community monitoring in the Alviso and Ravenswood Pond Complexes. Monitoring should include: 1) fish community surveys developed in association with NMFS to determine fish and invertebrate abundance and distribution; 2) fish tagging studies that would contribute to a more thorough understanding of the connectivity and passage conditions at water control structures for native and non-native fish.

3.4 Supplemental Consultation

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

4. DATA QUALITY ACT DOCUMENTATION AND PRE-DISSEMINATION REVIEW

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

4.1 Utility

Utility principally refers to ensuring that the information contained in this consultation is helpful, serviceable, and beneficial to the intended users. The intended users of this opinion are the U.S. Fish and Wildlife Service (FWS) and partners of the South Bay Salt Ponds Restoration Project, including the California Coastal Conservancy, National Oceanic and Atmospheric Administration, Santa Clara Valley Water District, U.S. Army Corps of Engineers, Wildlife Conservation Board, and Resources Legacy Fund. Individual copies of this opinion were provided to the FWS and SCC. This opinion will be posted on the Public Consultation Tracking System website (https://pcts.nmfs.noaa.gov/pcts-web/homepage.pcts). The format and naming adheres to conventional standards for style.

4.2 Integrity

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

4.3 Objectivity

Information Product Category: Natural Resource Plan

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

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

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

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

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