UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL MARINE FISHERIES SERVICE
Southwest Region
501 West Ocean Boulevard, Suite 4200
Long Beach, California 90802- 4213

In Reply Refer To:
151422SWR2003SA9009;9010:JSS

JUL 19 2005

Michael Finan
Chief, Delta Office
U.S. Army Corps of Engineers
1325 J Street
Sacramento, California 95814-2922

Dear Mr. Finan:

This document transmits NOAA's National Marine Fisheries Service's (NMFS) biological and conference opinion (Enclosure 1) based on our review of the proposed Port of Stockton (Port) West Complex Dredging project and associated effects of the redevelopment of the former Rough and Ready Island naval base (West Complex) in San Joaquin County, California, and its effects on federally-listed endangered Sacramento River winter-run Chinook salmon (*Oncorhynchus tshawytscha*), threatened Central Valley spring-run Chinook salmon (*O. tshawytscha*), threatened Central Valley steelhead (*O. mykiss*), designated critical habitat for Sacramento River winter-run Chinook salmon, and proposed critical habitat for Central Valley spring-run Chinook salmon and Central Valley steelhead in accordance with section 7 of the Endangered Species Act (ESA) of 1973, as amended (16 U.S.C. 1531 et seq.). Your September 19, 2003, requests for section 7 consultation on dredging for the sections of the West Complex waterfront between docks 14 and 20 and dock 20 to the Burns Cutoff were received on September 20, 2003. A response was sent to the U.S. Army Corps of Engineers (Corps) on October 10, 2003, indicating that we did not concur with your determination that the proposed project was not likely to adversely affect the above listed species or designated or proposed critical habitats, and that formal consultation would be required for this project. NMFS further requested additional information from the Corps to describe the interrelated effects of the West Complex Redevelopment project with the proposed dredging projects. Additional information was received from the Port on August 5, 2004. On October 8, 2004, NMFS sent a letter to the Corps indicating that sufficient information had been received to initiate the consultation. On November 18, 2004, the Port provided the final set of data requested by NMFS for the consultation. On December 20, 2004, NMFS requested an extension of 45 days to review the additional information and incorporate it into the biological opinion.

This biological and conference opinion is based on information provided in the September 19, 2003, section 7 consultation initiation package; the draft and final Environmental Impact Report for the West Complex Redevelopment project; information supplied by the Port in their August 5, 2004 and November 18, 2004, letters to NMFS; meetings held November 6, 2003, and September 28, 2004, involving staff from NMFS, the Corps, the Port, and the consulting firm of Jones and Stokes, regarding the project and agency concerns; and numerous scientific articles and reports from both the peer reviewed literature and agency "gray literature." A complete administrative record of this consultation is on file at the Sacramento Area Office of NMFS.

Based on the best available scientific and commercial information, the biological and conference opinion concludes that the Port West Complex Dredging project and associated interrelated impacts of the West Complex Redevelopment project, proposed by the applicant and permitted by the Corps, is not likely to jeopardize the continued existence of the listed species or adversely modify designated or proposed critical habitat. NMFS also has included an incidental take statement with reasonable and prudent measures and non-discretionary terms and conditions that are necessary and appropriate to avoid, minimize, or monitor incidental take associated with the project. The conference opinion concerning proposed critical habitat does not take the place of consultation under section 7(a) 2 of the ESA. The conference opinion may be adopted as a biological opinion when the proposed critical habitat designations for Central Valley spring-run Chinook salmon and Central Valley steelhead become final if no significant new information is developed, and no significant changes to the project are made that would alter the contents of this opinion.

This document also transmits NMFS' Essential Fish Habitat (EFH) Conservation Recommendations for Pacific salmon (*O. tshawytscha*), starry flounder (*Platichthys stellatus*) and English sole (*Parophrys vetulus*) as required by the Magnuson-Stevens Fishery Conservation and Management Act (MSA) as amended (16 U.S.C. 1801 *et seq.*; Enclosure 2). This document concludes that the Port West Complex Dredging project and associated interrelated impacts of the West Complex Redevelopment project will adversely affect the EFH of Pacific Salmon in the action area and adopts certain terms and conditions of the incidental take statement and the ESA conservation recommendations of the biological and conference opinion as the EFH conservation recommendations.

The Corps has a statutory requirement under section 305(b)(4)(B) of the MSA to submit a detailed response in writing to NMFS within 30 days of receipt of these Conservation Recommendations that includes a description of the measures proposed for avoiding, mitigating, or offsetting the impact of the activity on EFH (50 CFR 600.920 [j]). If unable to complete a final response within 30 days, the Corps should provide an interim written response within 30 days before submitting its final response.

Please contact Mr. Jeffrey Stuart in our Sacramento Area Office at (916) 930-3607 or via e-mail at J.Stuart@noaa.gov if you have any questions regarding this response or require additional information.

Sincerely,

Rodney R McInnis

Rodney R. McInnis
Regional Administrator

Enclosures (2)
1. Biological Opinion
2. Essential Fish Habitat Conservation Recommendations

cc: James Starr, California Department of Fish and Game, 4001 North Wilson Way, Stockton,
CA 94205

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Sue McConnell, Central Valley Regional Water Quality Board, Sacramento Main Office,
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BIOLOGICAL AND CONFERENCE OPINION

AGENCY:	U.S. Army Corps of Engineers, Sacramento District
ACTIVITY:	Port of Stockton, West Complex Dredging Project
CONSULTATION CONDUCTED BY:	Southwest Region, National Marine Fisheries Service
FILE NUMBER:	151422SWR2003SA9009;9010
DATE ISSUED:	JUL 19 2005

I. CONSULTATION HISTORY

On September 19, 2003, the U.S. Army Corps of Engineers (Corps) requested consultation with separate letters on two related projects with NOAA's National Marine Fisheries Service (NMFS) pursuant to section 7 of the Endangered Species Act (ESA). The Corps sought concurrence that the Port of Stockton (Port), West Complex Dredging Activities for Docks 14-20 (ID No. 200300038) and Dock 20 to Burns Cutoff (ID No. 200300314) were not likely to adversely affect endangered Sacramento River winter-run Chinook salmon (*Oncorhynchus tshawytscha*), threatened Central Valley spring-run Chinook salmon (*O. tshawytscha*), and threatened Central Valley steelhead (*O. mykiss*). A biological assessment (BA) for each Corps application was included in the initiation package. On September 29, 2003, NMFS received public notice of the two projects from the Corps.

On October 10, 2003, NMFS responded to the two consultation requests with two letters requesting additional information for each of the projects. Chief among these requests was a thorough analysis of the interrelated and interdependent actions that would occur as a result of the dredging activities, particularly the redevelopment of the former Rough and Ready Island naval base (West Complex) and the anticipated increase in Port activities. On October 22, 2003, the Corps responded that the Port (*i.e.*, the applicant) would be available to provide the requested information.

On November 6, 2003, staff from NMFS, the Corps, and Jones and Stokes (*i.e.*, consultant to the Port) met to discuss prioritizing and streamlining the consultation for multiple dredging projects at the Port. The participants agreed to consider multiple West Complex activities as one project.

On December 2, 2003, NMFS received an electronic copy of the Draft Environmental Impact Report (EIR) for the West Complex Redevelopment project from the Port.

On August 5, 2004, NMFS received a response from Jones and Stokes concerning the October 10, 2003, additional information request made by NMFS for the two dredging projects. The response included electronic copies of the draft and final West Complex Redevelopment project

EIRs. During August and September 2004, numerous emails were sent between Jeffrey Stuart of NMFS and April Zohn of Jones and Stokes regarding the adequacy of the information in the August 5, 2004, information package. NMFS believed that the responses received to its October 2003 letter requesting additional information lacked the level of detail needed to fully analyze the effects of the project. Also during August and September 2004, NMFS provided comments to the Central Valley Regional Water Quality Control Board (Regional Board) regarding the dredging actions to take place at docks 14-20 of the West Complex.

On September 28, 2004, a meeting which included staff representing the Port, Jones and Stokes, the Corps, the Regional Board, the U.S. Fish and Wildlife Service (FWS), and NMFS took place to discuss outstanding issues concerning the West Complex Dredging project. Jones and Stokes agreed to provide the additional information requested by NMFS.

On October 8, 2004, NMFS sent a letter to the Corps for the West Complex Dredging project, indicating that the consultation commenced on August 5, 2004.

On November 18, 2004, NMFS received additional information on the West Complex Dredging project from Jones and Stokes.

On December 10, 2004, staff from NMFS and the Corps discussed an extension of the project timeline for an additional 45 days to allow NMFS to complete additional analysis and incorporate the new material into the biological opinion. On December 20, 2004, NMFS sent a letter to the Corps formally requesting this extension.

II. DESCRIPTION OF THE PROPOSED ACTION

The Corps proposes to authorize two permits under section 10 of the Rivers and Harbors Act and section 404 of the Clean Water Act to dredge approximately 576,000 cubic yards (cy) of material from the waters of the San Joaquin River, adjacent to the Port's wharves at the West Complex. The Port intends to remove accumulated sediment and debris from in front of Docks 14 through 20 and from the remaining waterfront area of the West Complex westward towards Burns Cutoff. The existing depth of the channel in front of these docks is approximately -20 feet (*i.e.*, 20 feet below mean lower low water (MLLW)). Currently, the authorized maintenance dredging depth is to -30 feet MLLW for these berths, but the Port intends to dredge beyond this depth to -35 feet MLLW.

This dredging activity is a subset of a much larger action, called the West Complex Redevelopment project as described in the Port's draft EIR for the project (Environmental Science Associates 2003). The West Complex, as described in the Port's environmental documents, occupies the Naval facilities formerly known as Rough and Ready Island. It is located in San Joaquin County, adjacent to the City of Stockton, and is approximately 75 miles east of San Francisco and 40 miles southeast of Sacramento (see Appendix B: Figure 1). The 1,459-acre West Complex is bounded on all sides by water: the Stockton Deepwater Ship Channel (DWSC) on the north, the Burns Cutoff on the south and west, and the San Joaquin River to the east (see Appendix B: Figures 2, 3, and 4). The facility is accessed via Washington

Street and Navy Drive, which connect with Fresno Avenue to the east. Fresno Avenue connects with Charter Way (SR 4) and the Crosstown Freeway. Regional access to the site is provided via I-5 and SR 4.

A. Project Activities

1. Dredging Activities

a. *Overview*

The Port is proposing to conduct dredging of sediments from docks 14 through 20 (formerly designated as docks A through K) along the waterfront of the West Complex. The purpose of this project is to provide opportunities for economic development at the Port through maritime activities. The primary objective of the dredging is to provide sufficient depth at the dock space to provide access to approximately 75 percent of the shipping fleet in operation at this time. Currently, the DWSC can service Panamax size ships (*i.e.*, ships that can safely transit the Panama Canal). The increased depth at the docks will provide larger vessels the opportunity to navigate and berth safely at the West Complex. The distance of dredging along the waterfront will be 6,230 linear feet from docks 14 through 20 with an additional 1,800 linear feet along the remaining portion of the waterfront between dock 20 and Burns Cutoff. Dredging will extend outwards from the edge of the docks approximately 125 linear feet until it intersects the dredged channel of the DWSC. The lengths of each of the docks along the West Complex are as follows: dock 14 is 1,104 feet; dock 15 is 755 feet; dock 16 is 745 feet; dock 17 is 842 feet; dock 18 is 841 feet; dock 19 is 988 feet; and dock 20 is 1,027 feet. The actual depth of the bottom material to be dredged will vary at each location, but the primary objective is to remove material from in front of each dock to result in a nominal operating depth of -35 feet MLLW at each berthing facility (Jones and Stokes 2003).

The total volume of dredged materials to be removed from the West Complex action area is estimated to be 576,000 cy. The applicant has analyzed the composition of the dredged slurry mixture and has assumed a solid to water content of 10 to 15 percent. Therefore, the project will generate approximately 2,800 acre feet (af) of dredged slurry material. This material will be delivered at an expected rate of 2.8 million gallons per day (mgd) to the dredge material disposal (DMD) site on nearby Roberts Island (see below).

b. *Dredging Operations*

The Port anticipates using a hydraulic dredge with a cutterhead to remove the bottom sediments from in front of the West Complex's waterfront. The dredge that is anticipated to be used in this project has a 2,000 horsepower (hp) engine to run the hydraulic pump. The dredge will have an 18-inch intake pipe suspended from an "A" frame on the deck of the dredge (Jones and Stokes 2003, 2004a). At the tip of the intake pipeline assembly (the ladder), a hydraulically run cutterhead unit will be mounted which consists of two or more sets of intermeshing metal teeth or blades. These teeth spin under hydraulic pressure and slice into the underlying sediment on the channel bottom, loosening and dislodging the bottom material. The suction applied to the intake pipe draws the sediment and water slurry into the pipe and propels it down the discharge pipeline to the DMD site. The cutterhead dredge is generally equipped with two stern spuds (pivot pipes) used to hold the dredge in its working position and to advance the dredge into the next cut or excavating area. During operation, the cutterhead swings from side to side alternately using the port and starboard spuds as a pivot. Cables attached to anchors on either side of the dredge control its lateral movement and help "walk" the dredge forward (Corps 1983). Dredging operations will continue for several days at a time on a 24-hour schedule. However, the actual dredging intake pipeline will only function for approximately 8 to 10 hours per day, with the remainder of the time filled with maintenance and logistical operations to keep the dredge in operating condition and to move the dredge barge from site to site along the West Complex's docks.

The dredge slurry will be pumped approximately 10,000 to 12,000 feet from the dredge sites along the north shore of the West Complex to the DMD site on Roberts Island. The pipeline will be slightly buoyant and be constructed of durable plastic material. It will be designed to float approximately two inches above the water's surface when empty and will sink to the bottom when filled with the dredge slurry mixture. The anticipated route of the pipeline is along the southern shore of the San Joaquin River, outside of the DWSC boundaries, to avoid impinging on shipping traffic. Notes to mariners and navigational warning markers will be used as needed to prevent navigational hazards for recreational boaters (Jones and Stokes 2003).

The applicant has stated that the aforementioned dredging activities would also be applied to maintenance dredging efforts, which are anticipated to occur on a two year cycle for a minimum of five years after completing the initial dredging cycle. The applicant has also expressed the intention to continue to discharge dredge spoils to the Roberts Island DMD site. They have calculated a dredge spoils volume of 150,000 cy of dewatered material on a biennial basis (250,000 cy over the five-year period). The Port believes that the DMD site on Roberts Island will have sufficient capacity to hold this additional volume of dewatered dredge spoils (Jones and Stokes 2003).

c. *Dredge Materials Disposal Site – Roberts Island*

The DMD site on Roberts Island was constructed by pushing up earthen berms to contain the dredge slurry within a system of dikes. The description from the Regional Board's tentative Waste Discharge Requirements (WDR) indicates that the DMD site consists of two tracts of land; a 40-acre tract that acts primarily as a sedimentation basin and an additional 80-acre tract that serves to contain decant overflow from the sedimentation basin (Regional Board 2004). The Regional Board's data indicate that under its current configuration, the DMD site on Roberts Island cannot contain the projected volume of dredged slurry mixture. The use of this DMD site for other dredging operations within the region has reduced its capacity to below that necessary for this project without modifications to the height of the containment dikes. The applicant has indicated that they are considering raising the height of the berm to contain the additional volume of dredge slurry, while maintaining the required two feet of freeboard. The applicant anticipates holding dredge materials on the DMD site for 14 to 28 days before discharging decant water back into the channel of the San Joaquin River (Jones and Stokes 2003). The decant water would be discharged at an approximate rate of 2 mgd. The discharge flow likely would be continuous and reach a flow rate of 3 cubic feet per second (cfs).

2. Interrelated and Interdependent Activities

a. *Upland Development*

The Draft and Final EIRs submitted by the Port in compliance with the California Environmental Quality Act (CEQA) indicate the extent and scope of the redevelopment plan for the West Complex (Environmental Sciences Associates 2003, 2004). The Port has categorized future development into two categories associated with the proposed marine terminal and the proposed commercial and industrial park, each with three phases (Appendix A: Tables 1 and 2). The actual phasing will be driven by market demand, and therefore the schedule for implementation is uncertain.

(1) ***Marine Terminal Development.*** Full development of the marine terminal will require demolishing most of the existing buildings and relocating/upgrading or replacing roadway, railroad, and utility systems. The redevelopment of the marine terminal will occur in three phases described below.

Phase I consists of initial water-related development (*e.g.*, handling of dry, bulk materials), with a majority of the site developed in such a way that it is easily converted to container handling activities. The initial site is shown as 50 acres of off-channel facilities and 900 linear feet of wharf upgrade. The office or support functions required as part of the facility are planned to take place in an existing warehouse or transit shed and all utilities will be roughed in for future container activities.

Phase II is considered the midpoint in the conversion to maritime activities. Activities proposed under this phase replace the Phase I break-bulk facility with a 50-acre container terminal, provide the intermodal rail yard capabilities, and develop a new 50-acre break-bulk terminal and a new 170-acre auto processing facility.

Phase III will include the completion of the direct water-related facilities. This phase incorporates development on an additional 55 acres for container handling and intermodal rail yard activities. Development under this phase also completes the area slated as general marine development. Additionally, this area includes an adjacent 245 acres slated for water-related support and offers an expansion area for the future. A portion of the expansion will include the development of corridors to the intermodal rail yards, and for related expansion of the two container terminals. It is assumed that both container terminals and their related intermodal rail yards will be operated by or for the same entity. It should be noted that both container terminals require conversion of the wharves to accommodate 100-foot gage crane rails. Other uses in the expansion area may include continued low price leasing of the existing buildings, development of a precast concrete factory with its own batch plant, and other port related uses.

(2) ***Commercial and Industrial Park.*** Some 500 acres are available south of the central east - west McCloy Avenue/rail corridor for a three-phase development of a commercial and industrial park. Development under this phasing plan would occur from west to east and is considered independent of the marine terminal phased development.

Phase A likely would occur over a 140-acre site on the West Complex. Beyond interim upgrading of the existing five warehouse buildings, new structures and denser tenant populations will require the expansion of potable water service to development planned under the three phases. Required infrastructure under this phase likely will include the installation of a minimum 12-inch diameter water line, and the potential installation of several pump stations. Water used to suppress fires likely would be pumped from the river. Sanitary sewer, storm drainage, telecommunications, power, and gas facilities would be dependent on the nature and density of development and specific tenant requirements. Infrastructure improvements associated with this and other phases are discussed below.

This phase is expected to include the construction of several tilt-up structures that are likely to include office uses in the front, with larger high-bay light industrial functions located towards the rear of the buildings. Loading bays also would likely be provided in the rear of the buildings. This type of development lends itself to a rectilinear grid of streets that define “superblocks,” with truck alleys separating the rears of the buildings. Tenants are expected to take advantage of closely situated maritime, road, and rail services.

Phase B would likely occur over a 243-acre portion of the West Complex and would likely be comprised of several office buildings, typically three to five stories in height. As much as 2 million square feet of building space and a daytime population of 20,000 workers could be supported by this development. A structured parking area would also be constructed to support this dense development. If a single-use tenant is not found, conventional staged development can occur, making use of curvilinear streets, berming, and heavy planting to enhance the site.

Phase C would not be necessarily time-constrained by development planned under Phases A and B, and could be an expansion of a Phase B-type development, or a single-use tenant campus development. Existing buildings on the site include the damaged Officer’s Club, the NCO Club, the bowling alley, and a pool. These building are damaged beyond repair and will be demolished. Utilities would be brought to the site as discussed below. Buildings likely could be built up to 75 feet high.

(3) ***Infrastructure Improvements.*** A variety of infrastructure improvements are planned to support phased development of the marine terminal and commercial/industrial park developments. Infrastructure improvements are categorized into the following areas: access, internal road system, internal rail system and rail bridge, wharf, utilities, and existing structures (Appendix A: Table 3).

b. *Shipping Traffic*

The Port has estimated that dredging of the berthing facilities along the West Complex’s waterfront and the subsequent renovation of port facilities will increase shipping traffic by approximately 130 to 150 vessels per a year over the current level of 150 to 250 vessels per year (Jones and Stokes 2004b). This represents an increase in of ship traffic within the DWSC of 1.5 to 2 times the current volume of shipping traffic (average of 0.4 to 0.7 commercial vessels per day currently to 0.9 to 1.2 per day in the future). The Port facilities available to commercial shipping will accommodate Panamax size ships. These are ships with the following general dimensions:

Length overall:	965 feet (294 meters)
Beam (width)	106 feet (32.3 meters)
Draft	39.5 feet (12 meters)
Weight	40,000 to 60,000 Dead Weight Tons (DWT)

Currently, the DWSC does not have width restrictions for ships, and can accommodate 45,000 to 55,000 ton class ships fully loaded. Ships up to the 80,000 ton class can navigate the channel with partial loads. The maximum recommended length for ships transiting the DWSC to Stockton is 900 feet (275 meters) (Port 2004).

B. Proposed Conservation Measures

Design features integrated into the project description by the Corps and applicant to avoid, minimize, or compensate for potential impacts to listed species include the following (Jones and Stokes 2003; Environmental Sciences Associates 2003, 2004):

1. Construction activities will be scheduled so that they do not interfere with the presence of special status fish species. Dredging activities will take place from June 1 to December 31. This time frame is intended to avoid the majority of the adult and juvenile migration of listed anadromous species.

2. The Port will operate an aeration device that will deliver approximately 500 pounds of oxygen per day at the location of the dredging activities. The mobile device will be moved with the dredger at all times of the operation.

3. The Port will locally operate aeration equipment continuously during the dredging project and until such time following cessation of dredging that potential dissolved oxygen (DO) impacts have been eliminated. The aeration equipment used will have sufficient capacity to supply pure oxygen into the DWSC at a rate equal to or exceeding the predicted maximum rate of oxygen consumption derived from the expanded dredge volume.

4. The Port will hold decant water from the dredging operations on the Roberts Island DMD site until the decant water meets the criteria set forth in the Regional Board’s WDR. No decant water will be discharged back into the river until the decant water effluent meets those criteria.

5. The Port has indicated that it will employ Best Management Practices (BMPs) during its upland construction phase to minimize erosion and prevent siltation of adjacent waters of the United States (see below).

6. The Port has indicated in its EIR that it will develop a stormwater management plan for the West Complex that is in compliance with local, regional, and State guidelines (see below).

1. Construction BMPs

The proposed redevelopment plan has integrated several BMPs and a Storm Water Pollution Prevention Plan for the construction phase of the project. All construction plans and activities will implement multiple BMPs to provide effective erosion and sediment control. These BMPs are to be selected to achieve maximum sediment removal and to represent the best available technology that is economically achievable. BMPs to be implemented as part of the proposed mitigation measures will include the following general measures:

- Employ temporary erosion control measures (such as silt fences, staked straw bales/wattles, silt/sediment basins and traps, check dams, geofabric, sandbag dikes, and temporary revegetation or other ground cover) for disturbed areas;

- Protect the storm drain inlets on the site and in downstream off-site areas from sediment with the use of BMPs acceptable to the Port and City of Stockton;

- Sweep dirt and debris from paved streets in the construction zone on a regular basis, particularly before predicted rainfall events; and

- Establish grass or other vegetative cover on the construction site as soon as possible after disturbance. At minimum, vegetative application shall be done by September 15th to allow for plant establishment. No disturbed surfaces will be left without erosion control measures in place during the period of October 15th to April 15th.

2. Long-term Stormwater Prevention Plan

The long-term stormwater prevention plan proposed by the Port will include both BMPs that will address the project site as a whole, as well as guidance for BMPs to be implemented for specific projects on a project-by-project basis. These BMPs shall be selected to achieve maximum contaminant removal and represent the best available technology that is economically achievable. The BMPs will include a combination of source control, structural improvements, and treatment systems and will be implemented so as to ensure, at a minimum, no net increase in contaminant releases in comparison with pre-project conditions. BMPs may include but not be limited to the following:

- A wet retention basin(s), which holds a volume of stormwater until it is displaced by the next storm event, designed to provide effective water quality control. Wet retention basins have been shown to be more effective at contaminant removal than dry detention basins. Basin features shall include the following:

    1. Maximize retention time for settling of fine particles.
    2. Establish maintenance schedules for periodic removal of sedimentation, excessive vegetation, and debris that may clog basin inlets and outlets.
    3. Maximize the retention basin elevation to allow the highest amount of infiltration and settling prior to discharge. Wet retention basins are expected to remove, at a

minimum, 50 percent of suspended solids and metals, 30 percent of nitrogen and phosphorus, and up to 30 percent of pathogens;

- Grass strips, high infiltration substrates, and grassy swales shall be used where feasible throughout the project site to reduce runoff and provide initial storm water treatment. This type of treatment would apply particularly to parking lots;

- Small settling, treatment, and/or infiltration devices may be installed beneath large parking areas to provide initial filtration prior to discharge into flood control basins;

- Roof drains shall drain to natural surfaces or swales where possible to avoid excessive concentration and channelization of storm water. Roof drains may be directly connected to the storm drain system, if treatment control measures are provided downstream;

- All drain inlets shall be permanently stamped with the message “NO DUMPING FLOWS TO DELTA”, and,

- Permanent energy dissipaters will be included for drainage outlets.

C. Action Area

The action area includes 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 Port is situated on the San Joaquin River between river miles (RM) 37.5 and 41. The DWSC extends downstream for 37 miles to the City of Antioch, where the dredged ship channel leaves the main channel of the San Joaquin River at RM 4 and follows New York Slough to its mouth on the Sacramento River near the City of Pittsburg. For the purposes of this consultation, the action area includes all water bodies adjacent to the Port East Complex, which comprises Docks 2 through 13 and the ship turning basin, and lies east of the confluence of the San Joaquin River with the DWSC at Channel Point; all water bodies adjacent to the Port West Complex, which comprises Docks 14 through 20, and is bounded entirely by the DWSC, Burns Cutoff, and the San Joaquin River as discussed earlier; the terrestrial portion of the West Complex, which encompasses nearly 1,500 acres of land; and the entire length of the San Joaquin River and DWSC between the Port and the mouth of New York Slough. This area was selected because it represents the anticipated upstream extent of tidal mixing that carries water from the West Complex upstream into the turning basin and into the San Joaquin River south of Channel Point, and the measurable downstream extent of impacts such as increased vessel traffic. The length of affected waterway is approximately 41 miles. Although some effects resulting from vessel traffic, contaminants, and degradation of water quality may occur in off-channel sloughs and cuts, their effects will be difficult to measure demonstrably. Project effects occurring downstream of New York Slough will likewise be difficult to quantify due to the commingling of other commercial vessel traffic in the area.

III. STATUS OF THE SPECIES AND CRITICAL HABITAT

The following Federally listed species, designated critical habitat, and proposed critical habitat occur in the action area and may be affected by the proposed project:

Sacramento River winter-run Chinook salmon – endangered
Sacramento River winter-run Chinook salmon designated critical habitat
Central Valley spring-run Chinook salmon – threatened
Central Valley spring-run Chinook salmon proposed critical habitat
Central Valley steelhead – threatened
Central Valley steelhead proposed critical habitat

A. Species and Critical Habitat Listing Status

Sacramento River winter-run Chinook salmon were originally listed as threatened in August 1989, under emergency provisions of the ESA, and formally listed as threatened in November 1990 (55 FR 46515). The Evolutionarily Significant Unit (ESU) consists of only one population that is confined to the upper Sacramento River in California's Central Valley. NMFS designated critical habitat for winter-run Chinook salmon on June 16, 1993 (58 FR 33212). The ESU was reclassified as endangered on January 4, 1994 (59 FR 440), due to increased variability of run sizes, expected weak returns as a result of two small year classes in 1991 and 1993, and a 99 percent decline between 1966 and 1991. Critical habitat was delineated as the Sacramento River from Keswick Dam, (RM 302) to Chipps Island (RM 0) at the westward margin of the Delta, including Kimball Island, Winter Island, and Brown's Island; all waters from Chipps Island westward to the Carquinez Bridge, including Honker Bay, Grizzly Bay, Suisun Bay, and the Carquinez Strait; all waters of San Pablo Bay westward of the Carquinez Bridge, and all waters of San Francisco Bay north of the San Francisco-Oakland Bay Bridge. The critical habitat designation identifies those physical and biological features of the habitat that are essential to the conservation of the species and that may require special management consideration and protection. Within the Sacramento River this includes the river water, river bottom (including those areas and associated gravel used by winter-run Chinook salmon as spawning substrate), and adjacent riparian zone used by fry and juveniles for rearing. In the areas west of Chipps Island, including San Francisco Bay to the Golden Gate Bridge, this designation includes the estuarine water column and essential foraging habitat and food resources utilized by winter-run Chinook salmon as part of their juvenile outmigration or adult spawning migrations.

Central Valley spring-run Chinook salmon were listed as threatened on September 16, 1999 (50 FR 50394). This ESU consists of spring-run Chinook salmon occurring in the Sacramento River Basin. Critical habitat has not been designated for spring-run Chinook salmon in the Central Valley as of the writing of this opinion, but is expected to be implemented within the next year. Waters of the Delta are expected to be included as part of the critical habitat for Central Valley spring-run Chinook salmon in the new listing.

Central Valley steelhead were listed as threatened under the ESA on March 19, 1998 (63 FR 13347). This ESU consists of steelhead populations in the Sacramento and San Joaquin River (inclusive of and downstream of the Merced River) basins in California's Central Valley.

Critical habitat has not been designated for steelhead in the Central Valley as of the writing of this opinion, but is expected to be implemented within the next year. Waters of the Delta are expected to be included as part of the critical habitat for Central Valley steelhead in the new listing.

1. Proposed and Final Listing Status Changes

On June 14, 2004, NMFS proposed to upgrade Sacramento River winter-run Chinook salmon from endangered to threatened status (69 FR 33102). However, on June 28, 2005, after reviewing the best available scientific and commercial information, NMFS issued its final decision to retain the status of Sacramento River winter-run Chinook salmon as endangered (70 FR 37160). This decision was based on the continued threats to Sacramento River winter-run Chinook salmon and the continued likelihood of this ESU becoming extinct throughout all or a significant portion of its range.

In addition, on June 14, 2004, NMFS proposed several changes involving West Coast salmon hatchery populations(69 FR 33102). The following final decisions regarding Central Valley ESUs were issued on June 28, 2005 (70 FR 37160): (1) the LSNFH population has been included in the listed Sacramento River winter-run Chinook salmon population, and (2) the Feather River Hatchery (FRH) spring-run Chinook salmon population has been included as part of the Central Valley spring-run Chinook salmon ESU.

Finally, on June 14, 2004, NMFS proposed the following changes involving Central Valley steelhead populations (69 FR 33102): (1) the Coleman National Fish Hatchery (CNFH) and FRH steelhead populations were proposed for inclusion in the listed population of steelhead (these populations were previously included in the ESU but were not deemed essential for conservation and thus not part of the listed steelhead population), and (2) all resident *O. mykiss*, present below natural or long-standing artificial barriers, were proposed to be included as part of the listed steelhead ESUs. The final decisions on these steelhead proposals have been deferred for six months for further scientific review(70 FR 37160).

B. Species Life History and Population Dynamics

1. Chinook Salmon

a. *General Life History*

Chinook salmon exhibit two generalized freshwater life history types (Healey 1991). "Stream-type" Chinook salmon, enter freshwater months before spawning and reside in freshwater for a year or more following emergence, whereas "ocean-type" Chinook salmon spawn soon after entering freshwater and migrate to the ocean as fry or parr within their first year. Spring-run Chinook salmon exhibit a stream-type life history. Adults enter freshwater in the spring, hold over summer, spawn in fall, and the juveniles typically spend a year or more in freshwater before emigrating. Winter-run Chinook salmon are somewhat anomalous in that they have characteristics of both stream- and ocean-type races (Healey 1991). Adults enter freshwater in winter or early spring, and delay spawning until spring or early summer (stream-type).

However, juvenile winter-run Chinook salmon migrate to sea after only four to seven months of river life (ocean-type). Adequate instream flows and cool water temperatures are more critical for the survival of Chinook salmon exhibiting a stream-type life history due to over summering by adults and/or juveniles.

Chinook salmon mature between two and six plus years of age (Myers *et al.* 1998). Freshwater entry and spawning timing generally are thought to be related to local water temperature and flow regimes. Runs are designated on the basis of adult migration timing; however, distinct runs also differ in the degree of maturation at the time of river entry, thermal regime and flow characteristics of their spawning site, and the actual time of spawning (Myers *et al.* 1998). Both spring-run and winter-run Chinook salmon tend to enter freshwater as immature fish, migrate far upriver, and delay spawning for weeks or months. For comparison, fall-run Chinook salmon enter freshwater at an advanced stage of maturity, move rapidly to their spawning areas on the mainstem or lower tributaries of the rivers, and spawn within a few days or weeks of freshwater entry (Healey 1991).

During their upstream migration, adult Chinook salmon require streamflows sufficient to provide olfactory and other orientation cues used to locate their natal streams. Adequate streamflows are necessary to allow adult passage to upstream holding habitat. The preferred temperature range for upstream migration is 38 ºF to 56 ºF (Bell 1991; California Department of Fish and Game [CDFG] 1998). Adult winter-run Chinook salmon enter San Francisco Bay from November through June (Hallock and Fisher 1985) and migrate past Red Bluff Diversion Dam (RBDD) from mid-December through early August (NMFS 1997). The majority of the run passes RBDD from January through May, and peaks in mid-March (Hallock and Fisher 1985). The timing of migration may vary somewhat due to changes in river flows, dam operations, and water year type. Adult spring-run Chinook salmon enter the Delta from the Pacific Ocean beginning in January and enter natal streams from March to July (Myers *et al.* 1998). In Mill Creek, Van Woert (1964) noted that of 18,290 spring-run Chinook salmon observed from 1953 to 1963, 93.5 percent were counted between April 1 and July 14, and 89.3 percent were counted between April 29 and June 30. Typically, spring-run Chinook salmon utilize mid- to high elevation streams that provide appropriate temperatures and sufficient flow, cover, and pool depth to allow over-summering while conserving energy and allowing their gonadal tissue to mature.

Spawning Chinook salmon require clean, loose gravel in swift, relatively shallow riffles or along the margins of deeper runs, and suitable water temperatures, depths, and velocities for redd construction and adequate oxygenation of incubating eggs. Chinook salmon spawning typically occurs in gravel beds that are located at the tails of holding pools (USFWS 1995). The range of water depths and velocities in spawning beds that Chinook salmon find acceptable is very broad. Bell (1991) identifies the preferred water temperature for adult spring-run Chinook salmon migration as 38ºF to 56ºF. Boles (1988), recommends water temperatures below 65 ºF for adult Chinook salmon migration, and Lindley *et al.* (2004) report that adult migration is blocked when temperatures reach 70ºF, and that fish can become stressed as temperatures approach 70 ºF. Reclamation reports that spring-run Chinook salmon holding in upper watershed locations prefer water temperatures below 60ºF, although salmon can tolerate temperatures up to 65 ºF before they experience an increased susceptibility to disease. The upper preferred water temperature for spawning Chinook salmon is 55ºF to 57ºF (Chambers 1956; Bjornn and Reiser 1995). Winter-run Chinook salmon spawning occurs primarily from mid-April to mid-August, with the peak activity occurring in May and June in the Sacramento River reach between Keswick dam and RBDD (Vogel and Marine 1991). The majority of winter-run Chinook salmon spawners are three years old. Physical Habitat Simulation Model (PHABSIM) results (FWS 2003a) indicate winter-run Chinook salmon suitable spawning velocities in the upper Sacramento River are between 1.54 feet per second (ft/s) and 4.10 ft/s, and suitable spawning substrates are between 1 and 5 inches in diameter. Initial habitat suitability curves (HSCs) show spawning suitability rapidly decreases for water depths greater than 3.13 feet (FWS 2003a). Spring-run Chinook salmon spawning occurs between September and October depending on water temperatures. Between 56 and 87 percent of adult spring-run Chinook salmon that enter the Sacramento River basin to spawn are three years old (Calkins *et al.* 1940; Fisher 1994). PHABSIM results indicate spring-run Chinook salmon suitable spawning velocities in Butte Creek are between 0.8 ft/s and 3.22 ft/s, and suitable spawning substrates are between 1 and 5 inches in diameter (FWS 2004). The initial HSC showed suitability rapidly decreasing for depths greater than 1.0 feet, but this effect was most likely due to the low availability of deeper water in Butte Creek with suitable velocities and substrates rather than a selection by spring-run Chinook salmon of only shallow depths for spawning (FWS 2004).

The optimal water temperature for egg incubation is 44^{o}F to 54^{o}F (Rich 1997). Incubating eggs are vulnerable to adverse effects from floods, siltation, desiccation, disease, predation, poor gravel percolation and poor water quality. Studies of Chinook salmon egg survival to hatching conducted by Shelton (1955) indicated 87 percent of fry emerged successfully from large gravel with adequate subgravel flow. The length of time required for eggs to develop and hatch is dependent on water temperature and is quite variable. Alderdice and Velsen (1978) found that the upper and lower temperatures resulting in 50 percent pre-hatch mortality were 61 ^{o}F and 37 ^{o}F, respectively, when the incubation temperature was held constant.

Winter-run Chinook salmon fry begin to emerge from the gravel in late June to early July and continue through October (Fisher 1994), generally at night. Spring-run Chinook salmon fry emerge from the gravel from November to March and spend about 3 to 15 months in freshwater habitats prior to emigrating to the ocean (Kjelson *et al.* 1981). Post-emergent fry disperse to the margins of their natal stream, seeking out shallow waters with slower currents, finer sediments, and bank cover such as overhanging and submerged vegetation, root wads, and fallen woody debris, and begin feeding on small insects and crustaceans.

When juvenile Chinook salmon reach a length of 50 to 57 mm, they move into deeper water with higher current velocities, but still seek shelter and velocity refugia to minimize energy expenditures. In the mainstems of larger rivers, juveniles tend to migrate along the margins and avoid the elevated water velocities found in the thalweg of the channel. When the channel of the river is greater than 9 to 10 feet in depth, juvenile salmon tend to inhabit the surface waters (Healey 1982). Stream flow and/or turbidity increases in the upper Sacramento River Basin are thought to stimulate emigration. Emigration of juvenile winter-run Chinook salmon past RBDD may begin as early as mid-July, typically peaks in September, and can continue through March in dry years (Vogel and Marine 1991; NMFS 1997). From 1995 to 1999, all winter-run Chinook salmon outmigrating as fry passed RBDD by October, and all outmigrating pre-smolts and smolts passed RBDD by March (Martin *et al.* 2001). The emigration timing of Central Valley spring-run Chinook salmon is highly variable (CDFG 1998). Some fish may begin emigrating soon after emergence from the gravel, whereas others over summer and emigrate as yearlings with the onset of intense fall storms (CDFG 1998). The emigration period for spring-run Chinook salmon extends from November to early May, with up to 69 percent of the young-of-the-year fish outmigrating through the lower Sacramento River and Delta during this period (CDFG 1998).

Fry and parr may rear within riverine or estuarine habitats of the Sacramento River, Delta, and their tributaries. In addition, Central Valley spring-run Chinook salmon juveniles have been observed rearing in the lower reaches of non-natal tributaries and intermittent streams in the Sacramento valley during the winter months (Maslin *et al.* 1997, Snider 2001). Within the Delta, juvenile Chinook salmon forage in shallow areas with protective cover, such as intertidal and subtidal mudflats, marshes, channels and sloughs (McDonald 1960, Dunford 1975). Cladocerans, copepods, amphipods, and larvae of diptera, as well as small arachnids and ants are common prey items (Kjelson *et al.* 1982; Sommer *et al.* 2001; MacFarlane and Norton 2002). Shallow water habitats are more productive than the main river channels, supporting higher growth rates, partially due to higher prey consumption rates, as well as favorable environmental temperatures (Sommer *et al.* 2001). Optimal water temperatures for the growth of juvenile Chinook salmon in the Delta are range between 54 to 57 ºF (Brett 1952). In Suisun and San Pablo Bays water temperatures reach 54ºF by February in a typical year. Other portions of the Delta (*i.e.*, South Delta and Central Delta) can reach 70 ºF by February in a dry year. However, cooler temperatures are usually the norm until after the spring runoff has ended.

As Chinook salmon fry and fingerlings mature, they prefer to rear further downstream where ambient salinity is up to 1.5 to 2.5 parts per thousand (Healy 1980, 1982; Levings *et al.* 1986). Juvenile winter-run Chinook salmon occur in the Delta from October through early May based on data collected from trawls, beach seines, and salvage records at the Central Valley Project (CVP) and State Water Project (SWP) pumping facilities (CDFG 1998). The peak of listed juvenile salmon arrivals in the Delta generally occurs from January to April, but may extend into June. Upon arrival in the Delta, winter-run Chinook salmon spend the first two months rearing in the more upstream, freshwater portions of the Delta (Kjelson *et al.* 1981, 1982). Data from the CVP and SWP salvage records indicate that most spring-run Chinook salmon smolts are present in the Delta from mid-March through mid-May depending on flow conditions (CDFG 2000).

Within the estuarine habitat, juvenile Chinook salmon movements are dictated by the tidal cycles, following the rising tide into shallow water habitats from the deeper main channels, and returning to the main channels when the tide recedes (Levy and Northcote 1982; Levings 1982; Healey 1991). As juvenile Chinook salmon increase in length, they tend to school in the surface waters of the main and secondary channels and sloughs, following the tides into shallow water habitats to feed (Allen and Hassler 1986). In Suisun Marsh, Moyle *et al.* (1986) reported that Chinook salmon fry tend to remain close to the banks and vegetation, near protective cover, and in dead-end tidal channels. Kjelson *et al.* (1982) reported that juvenile Chinook salmon demonstrated a diel migration pattern, orienting themselves to nearshore cover and structure during the day, but moving into more open, offshore waters at night. The fish also distributed themselves vertically in relation to ambient light. During the night, juveniles were distributed randomly in the water column, but would school up during the day into the upper three meters of the water column. Available data indicates that juvenile Chinook salmon use Suisun Marsh extensively both as a migratory pathway and rearing area as they move downstream to the Pacific Ocean. Winter-run Chinook salmon fry remain in the estuary (Delta/Bay) until they reach a fork length of about 118 mm (*i.e.*, 5 to 10 months of age) and then begin emigrating to the ocean perhaps as early as November and continuing through May (Fisher 1994; Myers *et al.* 1998). Little is known about estuarine residence time of spring-run Chinook salmon. Juvenile Chinook salmon were found to spend about 40 days migrating through the Delta to the mouth of San Francisco Bay and grew little in length or weight until they reached the Gulf of the Farallones (MacFarlane and Norton 2002). Based on the mainly ocean-type life history observed (*i.e.*, fall-run Chinook salmon) MacFarlane and Norton (2002) concluded that unlike other salmonid populations in the Pacific Northwest, Central Valley Chinook salmon show little estuarine dependence and may benefit from expedited ocean entry. Spring-run yearlings are larger in size than fall-run yearlings and are ready to smolt upon entering the Delta; therefore, they are believed to spend little time rearing in the Delta.

b. *Population Trend – Sacramento River Winter-run Chinook Salmon*

The distribution of winter-run Chinook salmon spawning and rearing historically was limited to the upper Sacramento River and its tributaries, where spring-fed streams allowed for spawning, egg incubation, and rearing in cold water (Slater 1963; Yoshiyama *et al.* 1998). The headwaters of the McCloud, Pit, and Little Sacramento Rivers, and Hat and Battle Creeks, provided clean, loose gravel, cold, well-oxygenated water, and optimal stream flows in riffle habitats for spawning and incubation. These areas also provided the cold, productive waters necessary for egg and fry development and survival, and juvenile rearing over the summer. The construction of Shasta Dam in 1943 blocked access to all of these waters except Battle Creek, which has its own impediments to upstream migration: the fish weir at the Coleman National Fish Hatchery and other small hydroelectric facilities situated upstream of the weir (Moyle *et al.* 1989, NMFS 1997, 1998). Approximately, 299 miles of tributary spawning habitat in the upper Sacramento River is now inaccessible to winter-run Chinook salmon. Yoshiyama *et al.* (2001) estimated that in 1938, the Upper Sacramento had a “potential spawning capacity” of 14,303 redds. Most components of the winter-run Chinook salmon life history (*e.g.*, spawning, incubation, freshwater rearing) have been compromised by the habitat blockage in the upper Sacramento River.

Following the construction of Shasta Dam, the number of winter-run Chinook salmon initially declined but recovered during the 1960s. The initial recovery was followed by a steady decline from 1969 through the late 1980s following the construction of the RBDD. Since 1967, the estimated adult winter-run Chinook salmon population ranged from 117,808 in 1969, to 186 in 1994 (FWS 2001; CDFG 2002b). The population declined from an average of 86,000 adults in 1967 to 1969 to only 1,900 in 1987 to 1989, and continued to remain low, with an average of 2,500 fish for the period from 1998 to 2000 (see Appendix B: Figure 5). Between the time Shasta Dam was built and the listing of winter-run Chinook salmon as endangered, major impacts to the population occurred from warm water releases from Shasta Dam, juvenile and adult passage constraints at RBDD, water exports in the southern Delta, acid mine drainage from

Iron Mountain Mine, and entrainment at a large number of unscreened or poorly-screened water diversions (NMFS 1997, 1998).

Population estimates in 2001 (8,224), 2002 (7,441), 2003 (8,218), and 2004 (7,701) show a recent increase in the escapement of winter-run Chinook salmon. The 2003 run was the highest since the listing. Winter-run Chinook salmon abundance estimates and cohort replacement rates since 1986 are shown in Table 1. The population estimates from the RBDD counts has increased since 1986 (CDFG 2004a), there is an increasing trend in the five year moving average (491 from 1990-1994 to 5,451 from 1999-2003); and the five year moving average of cohort replacement rates has increased and appears to have stabilized over the same period (Table 1).

Table 1. Winter-run Chinook salmon population estimates from RBDD counts, and corresponding cohort replacement rates for the years since 1986 (CDFG 2004a, Grand Tab February 2005).

Year	Population Estimate (RBDD)	5-Year Moving Average of Population Estimate	Cohort Replacement Rate	5-Year Moving Average of Cohort Replacement Rate	NMFS Calculated Juvenile Production Estimate (JPE)[a]
1986	2,596	-	-	-	
1987	2,186	-	-	-	
1988	2,885	-	-	-	
1989	696	-	0.27	-	
1990	433	1,759	0.20	-	
1991	211	1,282	0.07	-	40,100
1992	1,240	1,092	1.78	-	273,100
1993	387	593	0.90	0.64	90,500
1994	186	491	0.88	0.77	74,500
1995	1,297	664	1.05	0.94	338,107
1996	1,337	889	3.45	1.61	165,069
1997	880	817	4.73	2.20	138,316
1998	3,002	1,340	2.31	2.48	454,792
1999	3,288	1,961	2.46	2.80	289,724
2000	1,352	1,972	1.54	2.90	370,221
2001	8,224	3,349	2.74	2.76	1,864,802
2002	7,441	4,661	2.26	2.22	2,136,747
2003	8,218	5,705	6.08	3.02	1,896,649
2004	7,701	6,587	0.94	2.71	881,719
median	1,352	1,340	1.66	2.37	313,916

[a] JPE estimates were derived from NMFS calculations utilizing RBDD winter-run counts through 2001, and carcass counts thereafter for deriving adult escapement numbers.

c. *Status - Sacramento River Winter-run Chinook Salmon*

Numerous factors have contributed to the decline of winter-run Chinook salmon through degradation of spawning, rearing and migration habitats. The primary impacts include blockage of historical habitat by Shasta and Keswick Dams, warm water releases from Shasta Dam, juvenile and adult passage constraints at RBDD, water exports in the southern Delta, heavy metal contamination from Iron Mountain Mine, high ocean harvest rates, and entrainment in a large number of unscreened or poorly screened water diversions within the Central Valley. Secondary factors include smaller water manipulation facilities and dams, loss of rearing habitat in the lower Sacramento River and Delta from levee construction, marshland reclamation, and interactions with, and predation by, introduced non-native species (NMFS 1997, 1998).

Since the listing of winter-run Chinook salmon, several habitat problems that led to the decline of the species have been addressed and improved through restoration and conservation actions. The impetus for initiating restoration actions stem primarily from the following: (1) ESA section 7 consultation Reasonable and Prudent Alternatives (RPAs) on temperature, flow, and operations of the CVP and SWP; (2) Regional Board decisions requiring compliance with Sacramento River water temperatures objectives which resulted in the installation of the Shasta Temperature Control Device in 1998; (3) a 1992 amendment to the authority of the CVP through the Central Valley Improvement Act (CVPIA) to give fish and wildlife equal priority with other CVP objectives; (4) fiscal support of habitat improvement projects from the CALFED Bay-Delta Program (*e.g.*, installation of a fish screen on the Glenn-Colusa Irrigation District [GCID] diversion); (5) establishment of the CALFED Environmental Water Account (EWA); (6) Environmental Protection Agency (EPA) actions to control acid mine runoff from Iron Mountain Mine; and (7) ocean harvest restrictions implemented in 1995.

The susceptibility of winter-run Chinook salmon to extinction remains linked to the elimination of access to most of their historical spawning grounds and the reduction of their population structure to a small population size. Recent trends in winter-run Chinook salmon abundance and cohort replacement are positive and may indicate some recovery since the listing. Although NMFS recently proposed that this ESU be upgraded from endangered to threatened status, it made the decision in its Final Listing Determination (June 28, 2005, 70 FR 37160) to continue to list the Sacramento River winter-run Chinook salmon ESU as endangered. This population remains below the recovery goals established for the run (NMFS 1997, 1998) and the naturally spawned component of the ESU is dependent on one extant population in the Sacramento River. In general, the recovery criteria for winter-run Chinook salmon includes a mean annual spawning abundance over any 13 consecutive years of at least 10,000 females with a concurrent geometric mean of the cohort replacement rate greater than 1.0.

d. *Population Trend – Central Valley Spring-run Chinook Salmon*

Historically, the predominant salmon run in the Central Valley was the spring-run Chinook salmon, which occupied the upper and middle reaches (1,000 to 6,000 feet) of the San Joaquin, American, Yuba, Feather, Sacramento, McCloud and Pit Rivers, with smaller populations in most tributaries with sufficient habitat for over-summering adults (Stone 1874; Rutter 1904; Clark 1929). The Central Valley drainage as a whole is estimated to have supported spring-run

Chinook salmon runs as large as 600,000 fish between the late 1880s and 1940s (CDFG 1998). Before the construction of Friant Dam, nearly 50,000 adults were counted in the San Joaquin River alone (Fry 1961). Construction of other low elevation dams in the foothills of the Sierras on the American River, Mokelumne River, Stanislaus River, Tuolumne River and Merced River extirpated Central Valley spring-run Chinook salmon from these watersheds. Naturally-spawning populations of Central Valley spring-run Chinook salmon currently are restricted to accessible reaches of the upper Sacramento River, Antelope Creek, Battle Creek, Beegum Creek, Big Chico Creek, Butte Creek, Clear Creek, Deer Creek, Feather River, Mill Creek, and Yuba River (CDFG 1998).

On the Feather River, significant numbers of spring-run Chinook salmon, as identified by run timing, return to the FRH. In 2002, the FRH reported 4,189 returning spring-run Chinook salmon, which is 22 percent below the 10-year average of 4,727 fish. However, coded-wire tag (CWT) information from these hatchery returns indicates substantial introgression has occurred between fall-run and spring-run Chinook salmon populations within the Feather River system due to hatchery practices. Because Chinook salmon are not temporally separated in the hatchery, spring-run Chinook and fall-run Chinook are spawned together, thus compromising the genetic integrity of the spring-run Chinook salmon stock. The number of naturally spawning spring-run Chinook salmon in the Feather River has been estimated only periodically since the 1960's, with estimates ranging from 2 fish in 1978 to 2,908 in 1964. However, the genetic integrity of this population is questionable because of the significant temporal and spatial overlap between spawning populations of spring-run and fall-run Chinook salmon (NMFS 2003). For the reasons discussed above, the Feather River spring-run Chinook population numbers are not included in the following discussion of ESU abundance.

Since 1969, the Central Valley spring-run Chinook salmon ESU (excluding Feather River fish) has displayed broad fluctuations in abundance ranging from 25,890 in 1982 to 1,403 in 1993 (CDFG unpublished data). Even though the abundance of fish may increase from one year to the next, the overall average population trend has a negative slope during this time period (see Appendix B: Figure 6). The average abundance for the ESU was 12,499 for the period of 1969 to 1979, 12,981 for the period of 1980 to 1990, and 6,542 for the period of 1991 to 2001. In 2002 and 2003, total run size for the ESU was 13,218 and 8,775 adults respectively, well above the 1991-2001 average.

Evaluating the ESU as a whole masks significant changes that are occurring among basin metapopulations. For example, while the mainstem Sacramento River population has undergone a significant decline, the tributary populations have demonstrated substantial increases. The average population abundance of Sacramento River mainstem spring-run Chinook salmon has recently declined from a high of 12,107 fish for the period 1980 to 1990, to a low of 609 for the period between 1991 and 2001, while the average abundance of Sacramento River tributary populations increased from a low of 1,227 to a high of 5,925 over the same period. Although tributaries such as Mill and Deer Creeks have shown positive escapement trends since 1991, recent escapements to Butte Creek, including 20,259 in 1998, 9,605 in 2001 and 8,785 in 2002, are responsible for the overall increase in tributary abundance (CDFG 2002a, 2004b; CDFG, unpublished data). The Butte Creek estimates, which account for the majority of this ESU, do not include prespawning mortality. In the last several years as the Butte Creek population has increased, mortality of adult spawner has increased from 21 percent in 2002 to 60 percent in 2003 due to over-crowding and diseases associated with high water temperatures. This trend may indicate that the population in Butte Creek may have reached its carrying capacity (Ward *et al.* 2003) or has reached historical population levels (*i.e.*, Deer and Mill creeks). Table 2 shows the population trends from the three tributaries since 1986, including the moving 5 year average, cohort replacement rate, and estimated juvenile production (JPE).

Table 2. Spring-run Chinook salmon population estimates from CDFG Grand Tab (February 2005) with corresponding cohort replacement rates for years since 1986.

Year	Deer/Mill/Butte Creek Escapement Run Size	5-Year Moving Average of Population Estimate	Cohort Replacement Rate	5-Year Moving Average of Cohort Replacement Rate	NMFS Calculated Juvenile Production Estimate (JPE)[a]
1986	24,263	-	-	-	4,396,998
1987	12,675	-	-	-	2,296,993
1988	12,100	-	-	-	2,192,790
1989	7,085	-	0.29	-	1,283,960
1990	5,790	12,383	0.46	-	1,049,277
1991	1,623	7,855	0.13	-	294,124
1992	1,547	5,629	0.22	-	280,351
1993	1,403	3,490	0.24	0.27	254,255
1994	2,546	2,582	1.57	0.52	461,392
1995	9,824	3,389	6.35	1.70	1,780,328
1996	2,701	3,604	1.93	2.0.6	489,482
1997	1,431	3,581	0.56	2.13	259,329
1998	24,725	8,245	2.52	2.58	4,480,722
1999	6,069	8,950	2.25	2.72	1,099,838
2000	5,457	8,077	3.81	2.21	988,930
2001	13,326	10,202	0.54	1.94	2,414,969
2002	13,218	12,559	2.18	2.26	2,395,397
2003	8,902	9,9394	1.63	2.08	1,613,241
2004	9,872	10,155	0.74	1.78	1,789,027
median	7,085	8,077	1.15	2.07	1,283,960

[a] NMFS calculated the spring-run JPE using returning adult escapement numbers to Mill, Deer, and Butte Creeks for the period between 1986 and 2004, and assuming a female to male ratio of 6:4 and pre-spawning mortality of 25 percent. NMFS utilized the female fecundity values in Fisher (1994) for spring-run Chinook salmon (4,900 eggs/female). The remaining survival estimates used the winter-run values for calculating JPE.

The extent of spring-run Chinook salmon spawning in the mainstem of the upper Sacramento River is unclear. Very few spring-run Chinook salmon redds (less than 15 per year) were observed from 1989-1993, and none in 1994, during aerial redd counts (FWS 2003a). Recently, the number of redds in September has varied from 29 to 105 during 2001 though 2003 depending on the number of survey flights (CDFG, unpublished data). In 2002, based on RBDD ladder counts, 485 spring-run Chinook salmon adults may have spawned in the mainstem Sacramento River or entered upstream tributaries such as Clear or Battle Creek (CDFG 2004b). In 2003, no adult spring-run Chinook salmon were believed to have spawned in the mainstem Sacramento River. Due to geographic overlap of ESUs and resultant hybridization since the construction of Shasta Dam, Chinook salmon that spawn in the mainstem Sacramento River during September are more likely to be identified as early fall-run rather than spring-run Chinook salmon.

e. *Status of Spring-run Chinook Salmon*

The initial factors that led to the decline of spring-run Chinook salmon in the Central Valley were related to the loss of upstream habitat behind impassable dams. Since this initial loss of habitat, other factors have contributed to the instability of the spring-run Chinook salmon population and have negatively affected the ESU's ability to recover. These factors include a combination of physical, biological, and management factors such as climatic variation, water management activities, hybridization with fall-run Chinook salmon, predation, and over-harvesting (CDFG 1998). Since spring-run Chinook salmon adults must hold over for months in small tributaries before spawning, they are much more susceptible to the effects of high water temperatures.

During the drought from 1986 to 1992, Central Valley spring-run Chinook salmon populations declined substantially. Reduced flows resulted in warm water temperatures that impacted adults, eggs, and juveniles. For adult spring-run Chinook salmon, reduced instream flows delayed or completely blocked access to holding and spawning habitats. Water management operations (*i.e.* reservoir release schedules and volumes) and the unscreened and poorly-screened diversions in the Sacramento River, Delta, and tributaries compounded drought-related problems by reducing river flows, elevating river temperatures, and entraining juveniles into the diversions.

Several actions have been taken to improve habitat conditions for spring-run Chinook salmon, including: improved management of Central Valley water (*e.g.*, through use of CALFED EWA and CVPIA (b)(2) water accounts); implementing new and improved screen and ladder designs at major water diversions along the mainstem Sacramento River and tributaries; and changes in ocean and inland fishing regulations to minimize harvest. Although protective measures likely have contributed to recent increases in spring-run Chinook salmon abundance, the ESU is still below levels observed from the 1960s through 1990. Threats from hatchery production (*i.e.,* competition for food between naturally-spawned and hatchery fish, run hybridization and genomic homogenization), climatic variation, high temperatures, predation, and water diversions still persist. Because the Central Valley spring-run Chinook salmon ESU is confined to relatively few remaining watersheds and continues to display broad fluctuations in abundance, the population is at a moderate risk of extinction.

2. Steelhead

a. *General Life History*

Steelhead can be divided into two life history types, based on their state of sexual maturity at the time of river entry and the duration of their spawning migration, stream-maturing and ocean-maturing. Stream-maturing steelhead enter freshwater in a sexually immature condition and require several months to mature and spawn, whereas ocean-maturing steelhead enter freshwater with well-developed gonads and spawn shortly after river entry. These two life history types are more commonly referred to by their season of freshwater entry (*i.e.* summer [stream-maturing] and winter [ocean-maturing] steelhead). Only winter steelhead currently are found in Central Valley rivers and streams (McEwan and Jackson 1996), although there are indications that summer steelhead were present in the Sacramento river system prior to the commencement of large-scale dam construction in the 1940s (Interagency Ecological Program [IEP] Steelhead Project Work Team 1999). At present, summer steelhead are found only in North Coast drainages, mostly in tributaries of the Eel, Klamath, and Trinity River systems (McEwan and Jackson 1996).

Winter steelhead generally leave the ocean from August through April, and spawn between December and May (Busby *et al.* 1996). Timing of upstream migration is correlated with higher flow events, such as freshets or sand bar breaches, and associated lower water temperatures. In general, the preferred water temperature for adult steelhead migration is 46^{o}F to 52^{o}F (McEwan and Jackson 1996; Myrick 1998; and Myrick and Cech 2000). Thermal stress may occur at temperatures beginning at 66 ^{o}F and mortality has been demonstrated at temperatures beginning at 70 ^{o}F, although some races of steelhead may have higher or lower temperature tolerances depending upon their evolutionary history. Lower latitudes and elevations would tend to favor fish tolerant of higher ambient temperatures (see Matthews and Berg (1997) for discussion of *O. mykiss* from Sespe Creek in Southern California). The preferred water temperature for steelhead spawning is 39^{o}F to 52^{o}F, and the preferred water temperature for steelhead egg incubation is 48^{o}F to 52^{o}F (McEwan and Jackson 1996; Myrick 1998; and Myrick and Cech 2000). The minimum stream depth necessary for successful upstream migration is 13 cm (Thompson 1972). Preferred water velocity for upstream migration is in the range of 40-90 cm/s, with a maximum velocity, beyond which upstream migration is not likely to occur, of 240 cm/s (Thompson 1972; Smith 1973).

Unlike Pacific salmon, steelhead are iteroparous, or capable of spawning more than once before death (Busby *et al.* 1996). However, it is rare for steelhead to spawn more than twice before dying; most that do so are females (Nickleson *et al.* 1992; Busby *et al.* 1996). Iteroparity is more common among southern steelhead populations than northern populations (Busby *et al.* 1996). Although one-time spawners are the great majority, Shapolov and Taft (1954) reported that repeat spawners are relatively numerous (17.2 percent) in California streams. Most steelhead spawning takes place from late December through April, with peaks from January though March (Hallock *et al.* 1961). Steelhead spawn in cool, clear streams featuring suitable gravel size, depth, and current velocity, and may spawn in intermittent streams as well (Everest 1973; Barnhart 1986).

The length of the incubation period for steelhead eggs is dependent on water temperature, DO concentration, and substrate composition. In late spring and following yolk sac absorption, fry emerge from the gravel and actively begin feeding in shallow water along stream banks (Nickelson *et al.* 1992).

Steelhead rearing during the summer takes place primarily in higher velocity areas in pools, although young-of-the-year also are abundant in glides and riffles. Winter rearing occurs more uniformly at lower densities across a wide range of fast and slow habitat types. Productive steelhead habitat is characterized by complexity, primarily in the form of large and small woody debris. Cover is an important habitat component for juvenile steelhead both as velocity refugia and as a means of avoiding predation (Shirvell 1990, Meehan and Bjornn 1991). Some older juveniles move downstream to rear in large tributaries and mainstem rivers (Nickelson *et al.* 1992). Juveniles feed on a wide variety of aquatic and terrestrial insects (Chapman and Bjornn 1969), and older juveniles sometimes prey upon emerging fry.

Steelhead generally spend two years in freshwater before emigrating downstream (Hallock *et al.* 1961; Hallock 1989). Rearing steelhead juveniles prefer water temperatures of 45EF to 58EF and have an upper lethal limit of 75EF. They can survive up to 81 EF with saturated DO conditions and a plentiful food supply. Reiser and Bjornn (1979) recommended that DO concentrations remain at or near saturation levels with temporary reductions no lower than 5.0 mg/l for successful rearing of juvenile steelhead. During rearing, suspended and deposited fine sediments can directly affect salmonids by abrading and clogging gills, and indirectly cause reduced feeding, avoidance reactions, destruction of food supplies, reduced egg and alevin survival, and changed rearing habitat (Reiser and Bjornn 1979). Bell (1973) found that silt loads of less than 25 mg/l permit good rearing conditions for juvenile salmonids.

Juvenile steelhead emigrate episodically from natal streams during fall, winter, and spring high flows. Emigrating Central Valley steelhead use the lower reaches of the Sacramento River and the Delta for rearing and as a migration corridor to the ocean. Some may utilize tidal marsh areas, non-tidal freshwater marshes, and other shallow water areas in the Delta as rearing areas for short periods prior to their final emigration to the sea. Barnhart (1986) reported that steelhead smolts in California range in size from 140 to 210 mm (fork length). Hallock *et al.* (1961) found that juvenile steelhead in the Sacramento River Basin migrate downstream during most months of the year, but the peak period of emigration occurred in the spring, with a much smaller peak in the fall.

b. *Population Trends – Central Valley Steelhead*

Steelhead historically were well-distributed throughout the Sacramento and San Joaquin Rivers (Busby *et al.* 1996). Steelhead were found from the upper Sacramento and Pit River systems (now inaccessable due to Shasta and Keswick Dams) south to the Kings and possibly the Kern River systems (now inaccessible due to extensive alterations from numerous water diversion projects) and in both east and west-side Sacramento River tributaries (Yoshiyama *et al.* 1996). The present distribution has been greatly reduced (McEwan and Jackson 1996). The California Advisory Committee on Salmon and Steelhead (1988) reported a reduction of steelhead habitat from 6,000 miles historically to 300 miles. Historically, steelhead probably ascended Clear Creek past the French Gulch area, but access to the upper basin was blocked by Whiskeytown Dam in 1964 (Yoshiyama *et al.* 1996).

Historic Central Valley steelhead run sizes are difficult to estimate given the paucity of data, but may have approached one to two million adults annually (McEwan 2001). By the early 1960s the steelhead run size had declined to about 40,000 adults (McEwan 2001). Over the past 30 years, the naturally-spawned steelhead populations in the upper Sacramento River have declined substantially (see Appendix B: Figure 7). Hallock *et al.* (1961) estimated an average of 20,540 adult steelhead through the 1960s in the Sacramento River, upstream of the Feather River. Steelhead counts at the RBDD declined from an average of 11,187 for the period of 1967 to 1977, to an average of approximately 2,000 through the early 1990s, with an estimated total annual run size for the entire Sacramento-San Joaquin system, based on RBDD counts, to be no more than 10,000 adults (McEwan and Jackson 1996; McEwan 2001). Steelhead escapement surveys at RBDD ended in 1993 due to changes in dam operations.

Nobriga and Cadrett (2003) compared CWT and untagged (wild) steelhead smolt catch ratios at Chipps Island trawl from 1998-2001 to estimate that about 100,000 to 300,000 steelhead juveniles are produced naturally each year in the Central Valley. In the draft *Updated Status Review of West Coast Salmon and Steelhead* (NMFS 2003), the Biological Review Team (BRT) made the following conclusion based on the Chipps Island data:

> "If we make the fairly generous assumptions (in the sense of generating large estimates of spawners) that average fecundity is 5,000 eggs per female, 1 percent of eggs survive to reach Chipps Island, and 181,000 smolts are produced (the 1998-2000 average), about 3,628 female steelhead spawn naturally in the entire Central Valley. This can be compared with McEwan's (2001) estimate of 1 million to 2 million spawners before 1850, and 40,000 spawners in the 1960s".

The only consistent data available on steelhead numbers in the San Joaquin River basin come from CDFG mid-water trawling samples collected on the lower San Joaquin River at Mossdale. These data (see Appendix B: Figure 8) indicate a decline in steelhead numbers in the early 1990s, which have remained low through 2002 (CDFG 2003). In 2003, a total of 12 steelhead smolts were collected at Mossdale (CDFG, unpublished data).

Existing wild steelhead stocks in the Central Valley are mostly confined to the upper Sacramento River and its tributaries, including Antelope, Deer, and Mill Creeks and the Yuba River. Populations may exist in Big Chico and Butte Creeks and a few wild steelhead are produced in the American and Feather Rivers (McEwan and Jackson 1996).

Recent snorkel surveys (1999 to 2002) indicate that steelhead are present in Clear Creek (J. Newton, FWS, pers. comm. 2002, as reported in NMFS 2003). Because of the large resident *O. mykiss* population in Clear Creek, steelhead spawner abundance has not been estimated.

Until recently, steelhead were thought to be extirpated from the San Joaquin River system. Recent monitoring has detected small self sustaining populations of steelhead in the Stanislaus, Mokelumne, Calaveras, and other streams previously thought to be devoid of steelhead (McEwan 2001). On the Stanislaus River, steelhead smolts have been captured in rotary screw traps at Caswell State Park and Oakdale each year since 1995 (Demko *et al.* 2000). After 3 years of operating a fish counting weir on the Stanislaus River only one adult steelhead has been observed moving upstream, although several large rainbow trout have washed up on the weir in late winter (S.P. Cramer 2005). It is possible that naturally spawning populations exist in many other streams but are undetected due to lack of monitoring programs (IEP Steelhead Project Work Team 1999). Incidental catches and observations of steelhead juveniles also have occurred on the Tuolumne and Merced Rivers during fall-run Chinook salmon monitoring activities, indicating that steelhead are widespread, if not abundant, throughout accessible streams and rivers in the Central Valley (NMFS 2003).

c. *Status - Central Valley Steelhead*

Both the BRT (NMFS 2003) and the Artificial Propagation Evaluation Workshop (69 FR 33102) concluded that the Central Valley steelhead ESU presently are "in danger of extinction. Steelhead have been extirpated from most of their historical range in this region. Habitat concerns in this ESU focus on the widespread degradation, destruction, and blockage of freshwater habitat within the region, and water allocation problems. Widespread hatchery steelhead production within this ESU also raises concerns about the potential ecological interactions between introduced stocks and native stocks. Because the Central Valley steelhead population has been fragmented into smaller isolated tributaries without any large source population and the remaining habitat continues to be degraded by water diversions, the population remains at an elevated risk for future population declines.

C. Habitat Condition and Function for Species' Conservation

The freshwater habitat of salmon and steelhead in the Sacramento River, San Joaquin River, and Suisun Marsh watershed drainages varies in function depending on location. Spawning areas are located in accessible, upstream reaches of the Sacramento or San Joaquin Rivers and their watersheds where viable spawning gravels and water quality are found. Spawning habitat condition is strongly affected by water flow and quality, especially temperature, DO, and silt load, all of which can greatly affect the survival of eggs and larvae. High quality spawning habitat is now inaccessible behind large dams in these watersheds, which limits salmonids to spawning in marginal tailwater habitat below the dams. Despite often intensive management efforts, the existing spawning habitat below dams is highly susceptible to inadequate flows and high temperatures due to competing demands for water, which impairs the habitat function.

Migratory corridors are downstream of the spawning area and include the Delta and Suisun Marsh. These corridors allow the upstream passage of adults and the downstream emigration of juveniles. Migratory habitat conditions are impaired in each of these drainages by the presence of barriers, which can include dams, unscreened or poorly-screened diversions, inadequate water flows, and degraded water quality.

Both spawning areas and migratory corridors comprise rearing habitat for juveniles, which feed and grow before and during their outmigration. Non-natal, intermittent tributaries also may be used for juvenile rearing. Rearing habitat condition is strongly affected by habitat complexity, food supply, and presence of predators of juvenile salmonids. Some complex, productive habitats with floodplains remain in the Sacramento and San Joaquin River systems (*e.g.*, the lower Cosumnes River, Sacramento River reaches with setback levees [*i.e.*, primarily located upstream of the City of Colusa] and the Yolo and Sutter bypasses). However, the channelized, leveed, and rip-rapped river reaches and sloughs that are common in the Delta and Suisun Marsh systems typically have low habitat complexity, low abundance of food organisms, and offer little protection from either fish or avian predators.

IV. ENVIRONMENTAL BASELINE

A. Factors Affecting the Species and Habitat

A number of documents have addressed the history of human activities, present environmental conditions, and factors contributing to the decline of salmon and steelhead species in the Central Valley and Suisun Marsh. For example, NMFS prepared range-wide status reviews for west coast Chinook salmon (Myers *et al.* 1998) and steelhead (Busby *et al.* 1996). Also, the NMFS BRT published a draft updated status review for west coast Chinook salmon and steelhead in November 2003 (NMFS 2003). Information also is available in Federal Register notices announcing ESA listing proposals and determinations for some of these species and their critical habitat (*e.g.*, 58 FR 33212; 59 FR 440; 62 FR 24588; 62 FR 43937; 63 FR 13347; 64 FR 24049; 64 FR 50394; 65 FR 7764). The Final Programmatic Environmental Impact Statement/Report (EIS/EIR) for the CALFED Bay-Delta Program (CALFED 1999), and the Final Programmatic EIS for the CVPIA (Department of Interior [DOI] 1999), provide an excellent summary of historical and recent environmental conditions for salmon and steelhead in the Central Valley.

The following general description of the factors affecting Sacramento River winter-run Chinook salmon, Central Valley spring-run Chinook salmon, and Central Valley steelhead and their habitat is based on a summary of these documents.

In general, the human activities that have affected the listed anadromous salmonids and their habitats consist of: (1) dam construction that blocks previously accessible habitat; (2) water development and management activities that affect water quantity, flow timing, and quality; (3) land use activities such as agriculture, flood control, urban development, mining, road construction, and logging that degrade aquatic and riparian habitat; (4) hatchery operation and practices; (5) harvest activities; and (6) ecosystem restoration actions.

1. Habitat Blockage

Hydropower, flood control, and water supply dams of the CVP, SWP, and other municipal and private entities have permanently blocked or hindered salmonid access to historical spawning and rearing grounds. Clark (1929) estimated that originally there were 6,000 linear miles of salmon habitat in the Central Valley system and that 80 percent of this habitat had been lost by 1928. Yoshiyama *et al.* (1996) calculated that roughly 2,000 linear miles of salmon habitat was actually available before dam construction and mining, and concluded that 82 percent is not accessible today.

In general, large dams on every major tributary to the Sacramento River, San Joaquin River, and Delta block salmon and steelhead access to the upper portions of the respective watersheds. On the Sacramento River, Keswick Dam blocks passage to historic spawning and rearing habitat in the upper Sacramento, McCloud, and Pit rivers. Whiskeytown Dam blocks access to the upper watershed of Clear Creek. Oroville Dam and associated facilities block passage to the upper Feather River watershed. Nimbus Dam blocks access to most of the American River basin. Friant Dam construction in the mid-1940s has been associated with the elimination of spring-run Chinook salmon in the San Joaquin River upstream of the Merced River (DOI 1999). On the Stanislaus River, construction of Goodwin Dam (1912), Tulloch Dam (1957) and New Melones Dam (1979) blocked both spring- and fall-run Chinook salmon (CDFG 2001) as well as Central Valley steelhead. Similarly, La Grange Dam (1893) and New Don Pedro Dam (1971) blocked upstream access to salmonids on the Tuolumne River. Upstream migration on the Merced River was blocked in 1910 by the construction of Merced Falls and Crocker-Huffman Dams and later New Exchequer Dam (1967) and McSwain Dam (1967).

As a result of the dams, winter-run Chinook salmon, spring-run Chinook salmon, and steelhead populations on these rivers have been confined to lower elevation mainstems that historically only were used for migration. Population abundances have declined in these streams due to decreased quantity and quality of spawning and rearing habitat. Higher temperatures at these lower elevations during late-summer and fall are a major stressor to adults and juvenile salmonids.

The Suisun Marsh Salinity Control Gates (SMSCG), located on Montezuma Slough, were installed in 1988, and are operated with gates and flashboards to decrease the salinity levels of managed wetlands in Suisun Marsh. The SMSCG have delayed or blocked passage of adult Chinook salmon migrating upstream (Edwards *et al.* 1996; Tillman *et al.* 1996; California Department of Water Resources [DWR] 2002).

2. Water Development

The diversion and storage of natural flows by dams and diversion structures on Central Valley waterways have depleted streamflows and altered the natural cycles by which juvenile and adult salmonids base their migrations. As much as 60 percent of the natural historical inflow to Central Valley watersheds and the Delta have been diverted for human uses. Depleted flows have contributed to higher temperatures, lower DO levels, and decreased recruitment of gravel and large woody debris. More uniform flows year round have resulted in diminished natural channel formation, altered foodweb processes, and slower regeneration of riparian vegetation. These stable flow patterns have reduced bedload movement (Ayers 2001), caused spawning gravels to become embedded, and decreased channel widths due to channel incision, all of which has decreased the available spawning and rearing habitat below dams.

Water diversions for irrigated agriculture, municipal and industrial use, and managed wetlands are found throughout the Central Valley. Hundreds of small and medium-size water diversions exist along the Sacramento River, San Joaquin River, and their tributaries. Although efforts have been made in recent years to screen some of these diversions, many remain unscreened. Depending on the size, location, and season of operation, these unscreened diversions entrain and kill many life stages of aquatic species, including juvenile salmonids. For example, as of 1997, 98.5 percent of the 3,356 diversions included in a Central Valley database were either unscreened or screened insufficiently to prevent fish entrainment (Herren and Kawasaki 2001). Most of the 370 water diversions operating in Suisun Marsh are unscreened (FWS 2003b).

Outmigrant juvenile salmonids in the Delta have been subjected to adverse environmental conditions created by water export operations at the CVP/SWP. Specifically, juvenile salmonid survival has been reduced by the following: (1) water diversion from the mainstem Sacramento River into the Central Delta via the Delta Cross Channel; (2) upstream or reverse flows of water in the lower San Joaquin River and southern Delta waterways; (3) entrainment at the CVP/SWP export facilities and associated problems at Clifton Court Forebay; and (4) increased exposure to introduced, non-native predators such as striped bass (*Morone saxatilis*), largemouth bass (*Micropterus salmoides*), and sunfishes (*Centrarchidae* spp.).

3. Land Use Activities

Land use activities continue to have large impacts on salmonid habitat in the Central Valley watershed. Until about 150 years ago, the Sacramento River was bordered by up to 500,000 acres of riparian forest, with bands of vegetation extending outward for four or five miles (California Resources Agency 1989). By 1979, riparian habitat along the Sacramento River diminished to 11,000 to 12,000 acres, or about 2 percent of historic levels (McGill 1987). The degradation and fragmentation of riparian habitat had resulted mainly from flood control and bank protection projects, together with the conversion of riparian land to agriculture. Removal of snags and driftwood in the Sacramento River and San Joaquin River basins has reduced sources of large woody debris (LWD) needed to form and maintain stream habitat that salmon depend on for various life stages.

Increased sedimentation resulting from agricultural and urban practices within the Central Valley is a primary cause of salmonid habitat degradation (NMFS 1996). Sedimentation can adversely affect salmonids during all freshwater life stages by: clogging or abrading gill surfaces, adhering to eggs, hampering fry emergence (Phillips and Campbell 1961), burying eggs or alevins, scouring and filling in pools and riffles, reducing primary productivity and photosynthesis activity (Cordone and Kelley 1961), and affecting intergravel permeability and DO levels. Excessive sedimentation over time can cause substrates to become embedded, which reduces successful salmonid spawning and egg and fry survival (Waters 1995).

Land use activities associated with road construction, urban development, logging, mining, agriculture, and recreation have significantly altered fish habitat quantity and quality through the alteration of streambank and channel morphology; alteration of ambient water temperatures; degradation of water quality; elimination of spawning and rearing habitat; fragmentation of available habitats; elimination of downstream recruitment of LWD; and removal of riparian vegetation, resulting in increased streambank erosion (Meehan 1991). Urban stormwater and agricultural runoff may be contaminated with herbicides and pesticides, petroleum products, sediment, *etc*. Agricultural practices in the Central Valley have eliminated large trees and logs and other woody debris that would otherwise be recruited into the stream channel (NMFS 1998). LWD influences stream morphology by affecting channel pattern, position, and geometry, as well as pool formation (Keller and Swanson 1979; Bilby 1984; Robison and Beschta 1990).

Since the 1850s, wetlands reclamation for urban and agricultural development has caused the cumulative loss of 79 and 94 percent of the tidal marsh habitat in the Delta downstream and upstream of Chipps Island, respectively (Conomos *et al.* 1985, Nichols *et al.* 1986, Wright and Phillips 1988, Monroe *et al.* 1992; Goals Project 1999). Prior to 1850, approximately 1400 km^2 of freshwater marsh surrounded the confluence of the Sacramento and San Joaquin Rivers, and another 800 km^2 of saltwater marsh fringed San Francisco Bay's margins. Of the original 2,200 km^2 of tidally influenced marsh, only about 125 km^2 of undiked marsh remains today. In Suisun Marsh, salt water intrusion and land subsidence gradually has led to the decline of agricultural production. Presently, Suisun Marsh consists largely of tidal sloughs and managed wetlands for duck clubs, which first were established in the 1870s in western Suisun Marsh (Goals Project 1999).

Juvenile salmonids are exposed to increased water temperatures in the Delta during the late spring and summer due to the loss of riparian shading, and by thermal inputs from municipal, industrial, and agricultural discharges. Studies by DWR on water quality in the Delta over the last 30 years show a steady decline in the food sources available for juvenile salmonids and an increase in the clarity of the water. These conditions have contributed to increased mortality of juvenile Chinook salmon and steelhead as they move through the Delta.

4. Water Quality

The water quality of the Delta has been negatively impacted over the last 150 years. Increased water temperatures, decreased DO levels, and increased turbidity and contaminant loads have degraded the quality of the aquatic habitat for the rearing and migration of salmonids. The Regional Board, in its 1998 Clean Water Act §303(d) list characterized the Delta as an impaired waterbody having elevated levels of chlorpyrifos, DDT, diazinon, electrical conductivity, Group A pesticides (aldrin, dieldrin, chlordane, endrin, heptachlor, heptachlor epoxide, hexachlorocyclohexane (including lindane), endosulfan and toxaphene), mercury, low DO, organic enrichment, and unknown toxicities (Regional Board 1998, 2001).

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

Sediments can either act as a sink or as a source of contamination depending on hydrological conditions and the type of habitat the sediment occurs in. Sediment provides habitat for many aquatic organisms and is a major repository for many of the more persistent chemicals that are introduced into the surface waters. In the aquatic environment, most anthropogenic chemicals and waste materials including toxic organic and inorganic chemicals eventually accumulate in sediment (Ingersoll 1995).

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

Low DO levels are frequently observed in the portion of the DWSC extending from Channel Point, downstream to Turner and Columbia Cuts. Over a five-year period, starting in August 2000, a DO meter has recorded channel DO levels at Rough and Ready Island (Dock 20 of the West Complex). Over the course of this time period, there have been 297 days in which violations of the 5 mg/l DO criteria for the protection of aquatic life in the San Joaquin River between Channel Point and Turner and Columbia Cuts have occurred during the September through May migratory period for salmonids in the San Joaquin River. The data derived from the California Data Exchange Center (CDEC) files indicate that DO depressions occur during all migratory months, with significant events occurring from November through March when listed Central Valley steelhead adults and smolts would be utilizing this portion of the San Joaquin River as a migratory corridor (see Appendix A: Table 4).

Potential factors that contribute to these DO depressions are reduced river flows through the ship channel, released ammonia from the City of Stockton Wastewater Treatment Plant, upstream contributions of organic materials (*e.g.*, algal loads, nutrients, agricultural discharges) and the increased volume of the dredged ship channel. During the winter and early spring emigration period, increased ammonia concentrations in the discharges from the City of Stockton Waste Water Treatment Facility lowers the DO in the adjacent DWSC near the West Complex. In addition to the adverse effects of the lowered DO on salmonid physiology, ammonia is in itself toxic to salmonids at low concentrations. Likewise, adult fish migrating upstream will encounter lowered DO in the DWSC as they move upstream in the fall and early winter due to low flows and excessive algal and nutrient loads coming downstream from the upper San Joaquin River watershed. Levels of DO below 5 mg/L have been reported as delaying or blocking fall-run Chinook salmon in studies conducted by Hallock *et al.* (1970). As the river water and its constituents move downstream from the San Joaquin River channel to the DWSC, the channel depth increases from approximately 8 to 10 feet to over 35 feet. The water column is no longer mixed adequately to prevent DO from decreasing by contact with the air–water interface only. Photosynthesis by suspended algae is diminished by increased turbidity and circulation below the photosynthetic compensation depth. This is the depth to which light penetrates with adequate intensity to carry on photosynthesis in excess of the oxygen demands of respiration. As the oxygen demand from respiration, defined as biological oxygen demand, exceeds the rate at which oxygen can be produced by photosynthesis and mixing, then the level of DO in the water column will decrease. Additional demands on oxygen are also exerted in non-biological chemical reactions in which compounds consume oxygen in an oxidation-reduction reaction.

5. Hatchery Operations and Practices

Five hatcheries currently produce Chinook salmon in the Central Valley and four of these also produce steelhead. Releasing large numbers of hatchery fish can pose a threat to wild Chinook salmon and steelhead stocks through genetic impacts, competition for food and other resources between hatchery and wild fish, predation of hatchery fish on wild fish, and increased fishing pressure on wild stocks as a result of hatchery production (Waples 1991). The genetic impacts of artificial propagation programs in the Central Valley primarily are caused by straying of hatchery fish and the subsequent interbreeding of hatchery fish with wild fish. In the Central Valley, practices such as transferring eggs between hatcheries and trucking smolts to distant sites for release contribute to elevated straying levels (DOI 1999). For example, Nimbus Hatchery on the American River rears Eel River steelhead stock and releases these fish in the Sacramento River basin. One of the recommendations in the Joint Hatchery Review Report (NMFS and CDFG 2001) was to identify and designate new sources of steelhead brood stock to replace the current Eel River origin brood stock.

Hatchery practices as well as spatial and temporal overlaps of habitat use and spawning activity between spring- and fall-run fish have led to the hybridization and homogenization of some subpopulations (CDFG 1998). As early as the 1960s, Slater (1963) observed that early fall- and spring-run Chinook salmon were competing for spawning sites in the Sacramento River below Keswick Dam, and speculated that the two runs may have hybridized. The FRH spring-run Chinook salmon have been documented as straying throughout the Central Valley for many years (CDFG 1998), and in many cases have been recovered from the spawning grounds of fall-run Chinook salmon, an indication that FRH spring-run Chinook salmon may exhibit fall-run life history characteristics. Although the degree of hybridization has not been comprehensively determined, it is clear that the populations of spring-run Chinook salmon spawning in the Feather River and counted at RBDD contain hybridized fish.

The management of hatcheries, such as Nimbus Hatchery and FRH, can directly impact spring-run Chinook salmon and steelhead populations by oversaturating the natural carrying capacity of the limited habitat available below dams. In the case of the Feather River, significant redd superimposition occurs in-river due to hatchery overproduction and the inability to physically separate spring- and fall-run Chinook salmon adults. This concurrent spawning has led to hybridization between the spring- and fall-run Chinook salmon in the Feather River. At Nimbus Hatchery, operating Folsom Dam to meet temperature requirements for returning hatchery fall-run Chinook salmon often limits the amount if water available for steelhead spawning and rearing the rest of the year.

The increase in Central Valley hatchery production has reversed the composition of the steelhead population, from 88 percent naturally-produced fish in the 1950s (McEwan 2001) to an estimated 23 to 37 percent naturally-produced fish currently (Nobriga and Cadrett 2001). The increase in hatchery steelhead production proportionate to the wild population has reduced the viability of the wild steelhead populations, increased the use of out-of-basin stocks for hatchery production, and increased straying (NMFS and CDFG 2001). Thus, the ability of natural populations to successfully reproduce and continue their genetic integrity has likely been diminished.

The relatively low number of spawners needed to sustain a hatchery population can result in high harvest-to-escapements ratios in waters where fishing regulations are set according to hatchery population. This can lead to over-exploitation and reduction in the size of wild populations existing in the same system as hatchery populations due to incidental bycatch (McEwan 2001).

Hatcheries also can have some positive effects on salmonid populations. Artificial propagation has been shown to be effective in bolstering the numbers of naturally spawning fish in the short term under specific scenarios, artificial propagation programs can also aid in conserving genetic resources and guarding against catastrophic loss of naturally spawned populations at critically low abundance levels, as was the case with the Sacramento River winter-run Chinook salmon population during the 1990s. However, relative abundance is only one component of a viable salmonid population.

6. Commercial and Sport Harvest

a. *Ocean Harvest*

Extensive ocean recreational and commercial troll fisheries for Chinook salmon exist along the Central California coast, and an inland recreational fishery exists in the Central Valley for Chinook salmon and steelhead. Ocean harvest of Central Valley Chinook salmon is estimated using an abundance index, called the Central Valley Index (CVI). The CVI is the ratio of Chinook salmon harvested south of Point Arena (where 85 percent of Central Valley Chinook salmon are caught) to escapement. CWT returns indicate that Sacramento River salmon congregate off the California coast between Point Arena and Morro Bay.

Since 1970, the CVI for winter-run Chinook salmon has generally ranged between 0.50 and 0.80. In 1990, when ocean harvest of winter-run Chinook salmon was first evaluated by NMFS and the Pacific Fisheries Management Council (PFMC), the CVI harvest rate was near the highest recorded level at 0.79. NMFS determined in a 1991 biological opinion that continuance of the 1990 ocean harvest rate would not prevent the recovery of winter-run Chinook salmon. Through the early 1990s, the ocean harvest index was below the 1990 level (*i.e.*, 0.71 in 1991 and 1992, 0.72 in 1993, 0.74 in 1994, 0.78 in 1995, and 0.64 in 1996). In 1996 and 1997, NMFS issued a biological opinion which concluded that incidental ocean harvest of winter-run Chinook salmon represented a significant source of mortality to the endangered population, even though ocean harvest was not a key factor leading to the decline of the population. As a result of these opinions, measures were developed and implemented by the PFMC, NMFS, and CDFG to reduce ocean harvest by approximately 50 percent.

Ocean fisheries have affected the age structure of spring-run Chinook salmon through targeting large fish for many years and reducing the numbers of four- and five-year-old fish (CDFG 1998). There are limited data on spring-run Chinook salmon ocean harvest rates. An analysis of 6 tagged groups of FRH spring-run Chinook salmon by Cramer and Demko (1997) indicated that harvest rates of 3-year-old fish ranged from 18 percent to 22 percent, four-year-old fish ranged from 57 percent to 84 percent, and 5-year-olds ranged from 97 percent to 100 percent. The almost complete removal of 5-year-olds from the population effectively reduces the age structure of the species, which reduces its resiliency to factors that may impact a particular year class (*e.g.*, pre-spawning mortality from lethal instream water temperatures).

b. *Freshwater Sport Harvest*

Historically in California, almost half of the river sportfishing effort was in the Sacramento-San Joaquin River system, particularly upstream from the city of Sacramento (Emmett *et al.* 1991). Since 1987, the Fish and Game Commission has adopted increasingly stringent regulations to reduce and virtually eliminate the in-river sport fishery for winter-run Chinook salmon. Present regulations include a year-round closure to Chinook salmon fishing between Keswick Dam and the Deschutes Road Bridge and a rolling closure to Chinook salmon fishing on the Sacramento River between the Deschutes River Bridge and the Carquinez Bridge. The rolling closure spans the months that migrating adult winter-run Chinook salmon are ascending the Sacramento River to their spawning grounds. These closures have virtually eliminated impacts on winter-run Chinook salmon caused by recreational angling in freshwater.

In 1992, the California Fish and Game Commission adopted gear restrictions (all hooks must be barbless and a maximum of 5.7 cm in length) to minimize hooking injury and mortality of winter-run Chinook salmon caused by trout anglers. That same year, the Commission also adopted regulations which prohibited any salmon from being removed from the water to further reduce the potential for injury and mortality.

In-river recreational fisheries historically have taken spring-run Chinook salmon throughout the species' range. During the summer, holding adult spring-run Chinook salmon are easily targeted by anglers when they congregate in large pools. Poaching also occurs at fish ladders, and other areas where adults congregate; however, the significance of poaching on the adult population is unknown. Specific regulations for the protection of spring-run Chinook salmon in Mill, Deer, Butte and Big Chico creeks were added to the existing CDFG regulations in 1994. The current regulations, including those developed for winter-run Chinook salmon, provide some level of protection for spring-run fish (CDFG 1998).

There is little information on steelhead harvest rates in California. Hallock *et al.* (1961) estimated that harvest rates for Sacramento River steelhead from the 1953-54 through 1958-59 seasons ranged from 25.1 percent to 45.6 percent assuming a 20 percent non-return rate of tags. Staley (1975) estimated the harvest rate in the American River during the 1971-72 and 1973-74 seasons to be 27 percent. The average annual harvest rate of adult steelhead above Red Bluff Diversion Dam for the 3 year period from 1991-92 through 1993-94 was 16 percent (McEwan and Jackson 1996). Since 1998, all hatchery steelhead have been marked with an adipose fin clip allowing anglers to distinguish hatchery and wild steelhead. Current regulations restrict anglers from keeping unmarked steelhead in Central Valley streams (CDFG 2004c). Overall, this regulation has greatly increased protection of naturally produced adult steelhead.

7. Predation

Accelerated predation may also be a factor in the decline of winter-run Chinook salmon and spring-run Chinook salmon, and to a lesser degree steelhead. Human-induced habitat changes such as alteration of natural flow regimes and installation of bank revetment and structures such as dams, bridges, water diversions, piers, and wharves often provide conditions that both disorient juvenile salmonids and attract predators (Stevens 1961; Decato 1978; Vogel *et al.* 1988; Garcia 1989).

On the mainstem Sacramento River, high rates of predation are known to occur at RBDD, ACID, GCID, areas where rock revetment has replaced natural river bank vegetation, and at south Delta water diversion structures (*e*.g., Clifton Court Forebay; CDFG 1998). Predation at RBDD on juvenile winter-run Chinook salmon is believed to be higher than normal due to factors such as water quality and flow dynamics associated with the operation of this structure. Due to their small size, early emigrating winter-run Chinook salmon may be very susceptible to predation in Lake Red Bluff when the RBDD gates remain closed in summer and early fall (Vogel *et al.* 1988). In passing the dam, juveniles are subject to conditions which greatly disorient them, making them highly susceptible to predation by fish or birds. Sacramento pikeminnow (*Ptychocheilus grandis*) and striped bass (*Morone saxatilis*) congregate below the dam and prey on juvenile salmon in the tail waters.

FWS found that more predatory fish were found at rock revetment bank protection sites between Chico Landing and Red Bluff than at sites with naturally eroding banks (Michny and Hampton 1984). From October 1976 to November 1993, CDFG conducted ten mark/recapture studies at the SWP's Clifton Court Forebay to estimate pre-screen losses using hatchery-reared juvenile Chinook salmon. Pre-screen losses ranged from 69 percent to 99 percent. Predation by striped bass is thought to be the primary cause of the loss (Gingras 1997).

Other locations in the Central Valley where predation is of concern include flood bypasses, post-release sites for salmonids salvaged at the State and Federal fish facilities, and the SMSCG. Predation on salmon by striped bass and pikeminnow at salvage release sites in the Delta and lower Sacramento River has been documented (Orsi 1967; Pickard *et al.* 1982); however, accurate predation rates at these sites are difficult to determine. CDFG conducted predation studies from 1987-93 at the SMSCG to determine if the structure attracts and concentrates predators. The dominant predator species at the SMSCG was striped bass, and the remains of juvenile Chinook salmon were identified in their stomach contents (NMFS 1997).

8. Environmental Variation

Natural changes in the freshwater and marine environments play a major role in salmonid abundance. Recent evidence suggests that marine survival among salmonids fluctuates in response to 20- to 30-year cycles of climatic conditions and ocean productivity (Hare *et al*. 1999, Mantua and Hare 2002). This phenomenon has been referred to as the Pacific Decadal Oscillation. In addition, large-scale climatic regime shifts, such as the El Niño condition, appear to change productivity levels over large expanses of the Pacific Ocean. A further confounding effect is the fluctuation between drought and wet conditions in the basins of the American west.

During the first part of the 1990s, much of the Pacific Coast was subject to a series of very dry years, which reduced inflows to watersheds up and down the west coast.

A key factor affecting many West Coast stocks has been a general 30-year decline in ocean productivity. The mechanism whereby stocks are affected is not well understood, partially because the pattern of response to these changing ocean conditions has differed among stocks, presumably due to differences in their ocean timing and distribution. It is presumed that survival in the ocean is driven largely by events occurring between ocean entry and recruitment to a subadult life stage.

Salmon and steelhead are exposed to high rates of natural predation, particularly during freshwater rearing and migration stages. Ocean predation may also contribute to significant natural mortality, although it is not known to what extent. In general, salmonids are prey for pelagic fishes, birds, and marine mammals, including harbor seals, sea lions, and killer whales. There have been recent concerns that the rebound of seal and sea lion populations following their protection under the Marine Mammal Protection Act of 1972 has increased the number of salmonid deaths.

Finally, unusual drought conditions may warrant additional consideration in California. Flows in 2001 were among the lowest flow conditions on record in the Central Valley. The available water in the Sacramento watershed and San Joaquin watershed was 70 percent and 66 percent of normal, according to the Sacramento River Index and the San Joaquin River Index, respectively. Back-to-back drought years could be catastrophic to small populations of listed salmonids that are dependent upon reservoir releases for their success (*e.g.*, winter-run Chinook salmon). Therefore, reservoir carryover storage (usually referred to as end-of-September storage) is a key element in providing adequate reserves to protect salmon and steelhead during extended drought periods. In order to buffer the effect of drought conditions and over allocation of resources, NMFS has in the past recommended that minimum carryover storage be maintained in Shasta and other reservoirs to help alleviate critical flow and temperature conditions in the fall.

9. Ecosystem Restoration

a. *California Bay-Delta Authority*

Two programs included under CALFED; the Ecosystem Restoration Program (ERP) and the EWA, were created to improve conditions for fish, including listed salmonids, in the Central Valley. Restoration actions implemented by the ERP include the installation of fish screens, modification of barriers to improve fish passage, habitat acquisition, and instream habitat restoration. The majority of these actions address key factors affecting listed salmonids and emphasis has been placed in tributary drainages with high potential for steelhead and spring-run Chinook salmon production. Additional ongoing actions include new efforts to enhance fisheries monitoring and directly support salmonid production through hatchery releases. Recent habitat restoration initiatives sponsored and funded primarily by the CALFED-ERP Program have resulted in plans to restore ecological function to 9,543 acres of shallow-water tidal and marsh habitats within the Delta. Restoration of these areas primarily involves flooding lands previously used for agriculture, thereby creating additional rearing habitat for juvenile salmonids. Similar habitat restoration is imminent adjacent to Suisun Marsh (*i.e.*, at the confluence of Montezuma Slough and the Sacramento River) as part of the Montezuma Wetlands project, which is intended to provide for commercial disposal of material dredged from San Francisco Bay in conjunction with tidal wetland restoration.

A sub-program of the ERP called the Environmental Water Program (EWP) has been established to support ERP projects through enhancement of instream flows that are biologically and ecologically significant. This program is in the development stage and the benefits to listed salmonids are not yet clear. Clear Creek is one of five watersheds in the Central Valley that has been targeted for action during Phase I of the EWP.

The EWA is designed to provide water at critical times to meet ESA requirements and incidental take limits without water supply impacts to other users. In early 2001, the EWA released 290 thousand acre feet of water from San Luis Reservoir at key times to offset reductions in south Delta pumping implemented to protect winter-run Chinook salmon, delta smelt, and splittail. However, the benefit derived by this action to winter-run Chinook salmon in terms of number of fish saved was very small. The anticipated benefits to other Delta fisheries from the use of the EWA water are much higher than those benefits ascribed to listed salmonids by the EWA release.

b. *Central Valley Project Improvement Act*

The CVPIA, implemented in 1992, requires that fish and wildlife get equal consideration with other demands for water allocations derived from the CVP. From this act arose several programs that have benefited listed salmonids: the Anadromous Fish Restoration Program (AFRP), the Anadromous Fish Screen Program (AFSP), and the Water Acquisition Program (WAP). The AFRP is engaged in monitoring, education, and restoration projects geared toward recovery of all anadromous fish species residing in the Central Valley. Restoration projects funded through the AFRP include fish passage, fish screening, riparian easement and land acquisition, development of watershed planning groups, instream and riparian habitat improvement, and gravel replenishment. The AFSP combines federal funding with State and private funds to prioritize and construct fish screens on major water diversions mainly in the upper Sacramento River. The goal of the WAP is to acquire water supplies to meet the habitat restoration and enhancement goals of the CVPIA and to improve the DOI’s ability to meet regulatory water quality requirements. Water has been used successfully to improve fish habitat for spring-run Chinook salmon and steelhead by maintaining or increasing instream flows in Butte and Mill Creeks and the San Joaquin River at critical times.

c. *Iron Mountain Mine Remediation*

EPA's Iron Mountain Mine remediation involves the removal of toxic metals in acidic mine drainage from the Spring Creek Watershed with a state-of-the-art lime neutralization plant. Contaminant loading into the Sacramento River from Iron Mountain Mine has shown measurable reductions since the early 1990s (see Appendix J, Bureau of Reclamation [Bureau] 2004). Decreasing the heavy metal contaminants that enter the Sacramento River should increase the survival of salmonid eggs and juveniles. However, during periods of heavy rainfall upstream of the Iron Mountain Mine, Reclamation substantially increases Sacramento River flows in order to dilute heavy metal contaminants being spilled from the Spring Creek debris dam. This rapid change in flows can cause juvenile salmonids to become stranded or isolated in side channels below Keswick Dam.

d. *State Water Project Delta Pumping Plant Fish Protection Agreement (Four-Pumps Agreement)*

The Four Pumps Agreement Program has approved about $49 million for projects that benefit salmon and steelhead production in the Sacramento-San Joaquin basins and Delta since the agreement inception in 1986. Four Pumps projects that benefit spring-run Chinook salmon and steelhead include water exchange programs on Mill and Deer Creeks; enhanced law enforcement efforts from San Francisco Bay upstream to the Sacramento and San Joaquin Rivers and their tributaries; design and construction of fish screens and ladders on Butte Creek; and screening of diversions in Suisun Marsh and San Joaquin tributaries. Predator habitat isolation and removal, and spawning habitat enhancement projects on the San Joaquin tributaries benefit steelhead (see Chapter 15, Bureau 2004).

The Spring-run Salmon Increased Protection Project provides overtime wages for CDFG wardens to focus on reducing illegal take and illegal water diversions on upper Sacramento River tributaries and adult holding areas, where the fish are vulnerable to poaching. This project covers Mill, Deer, Antelope, Butte, Big Chico, Cottonwood, and Battle Creeks, and has been in effect since 1996. Through the Delta-Bay Enhanced Enforcement Program (DBEEP), initiated in 1994, a team of ten wardens focus their enforcement efforts on salmon, steelhead, and other species of concern from the San Francisco Bay Estuary upstream into the Sacramento and San Joaquin River basins. These two enhanced enforcement programs have had significant, but unquantified benefits, to spring-run Chinook salmon attributed by CDFG (see Chapter 15, Bureau 2004).

The Mill and Deer Creek Water Exchange projects are designed to provide new wells that enable diverters to bank groundwater in place of stream flow, thus leaving water in the stream during critical migration periods. On Mill Creek several agreements between Los Molinos Mutual Water Company (LMMWC), Orange Cove Irrigation District (OCID), CDFG, and DWR allows DWR to pump groundwater from two wells into the LMMWC canals to pay back LMMWC water rights for surface water released downstream for fish. Although the Mill Creek Water Exchange project was initiated in 1990 and the agreement allows for a well capacity of 25 cfs, only 12 cfs has been developed to date (Reclamation and OCID 1999). In addition, it has been determined that a base flow of greater than 25 cfs is needed during the April through June period for upstream passage of adult spring-run Chinook salmon in Mill Creek (Reclamation and OCID 1999). In some years, water diversions from the creek are curtailed by amounts sufficient to provide for passage of upstream migrating adult spring-run Chinook salmon and downstream migrating juvenile steelhead and spring-run Chinook salmon. However, the current arrangement does not ensure adequate flow conditions will be maintained in all years. DWR, CDFG, and FWS have developed the Mill Creek Adaptive Management Enhancement Plan to address the instream flow issues. A pilot project using 1 of the 10 pumps originally proposed for Deer Creek was tested in summer 2003. Future testing is planned with implementation to follow.

10. Non-native Invasive Species

As currently seen in the San Francisco estuary, non-native invasive species (NIS) can alter the natural food webs that existed prior to their introduction. Perhaps the most significant example is illustrated by the Asiatic freshwater clams *Corbicula fluminea* and *Potamocorbula amurensis*. The arrival of these clams in the estuary disrupted the normal benthic community structure and depressed phytoplankton levels in the estuary due to the highly efficient filter feeding of the introduced clams (Cohen and Moyle 2004). The decline in the levels of phytoplankton reduces the population levels of zooplankton that feed upon them, and hence reduces the forage base available to salmonids transiting the Delta and San Francisco estuary which feed either upon the zooplankton directly or their mature forms. This lack of forage base can adversely impact the health and physiological condition of these salmonids as they emigrate through the Delta region to the Pacific Ocean.

Attempts to control the NIS also can adversely impact the health and well being of salmonids within the affected water systems. For example, the control programs for the invasive water hyacinth and *Egeria densa* plants in the Delta must balance the toxicity of the herbicides applied to control the plants to the probability of exposure to listed salmonids during herbicide application. In addition, the control of the nuisance plants have certain physical parameters that must be accounted for in the treatment protocols, particularly the decrease in DO resulting from the decomposing vegetable matter left by plants that have died.

11. Summary

For Sacramento River winter-run Chinook salmon, Central Valley spring-run Chinook salmon, and Central Valley steelhead, the construction of high dams for hydropower, flood control, and water supply resulted in the loss of vast amounts of upstream habitat (*i.e.*, approximately 80 percent, or a minimum linear estimate of over 1,000 stream miles), and often resulted in precipitous declines in affected salmonid populations. For example, the completion of Friant Dam in 1947 has been linked with the extirpation of spring-run Chinook salmon in the San Joaquin River upstream of the Merced River within just a few years. The reduced populations that remain below Central Valley dams are forced to spawn in lower elevation tailwater habitats of the mainstem rivers and tributaries that were previously not used for this purpose. This habitat is entirely dependent on managing reservoir releases to maintain cool water temperatures suitable for spawning, and/or rearing of salmonids. This requirement has been difficult to achieve in all water year types and for all life stages of affected salmonid species. Steelhead, in particular, seem to require the qualities of small tributary habitat similar to what they historically used for spawning; habitat that is largely unavailable to them under the current water management scenario. All species considered in this consultation have been adversely affected by the production of hatchery fish associated with the mitigation for the habitat lost to dam construction (*e.g.*, from genetic impacts, increased competition, exposure to novel diseases, *etc*.).

Land-use activities such as road construction, urban development, logging, mining, agriculture, and recreation are pervasive and have significantly altered fish habitat quantity and quality for Chinook salmon and steelhead through alteration of streambank and channel morphology;

alteration of ambient water temperatures; degradation of water quality; elimination of spawning and rearing habitat; fragmentation of available habitats; elimination of downstream recruitment of LWD; and removal of riparian vegetation resulting in increased streambank erosion. Human-induced habitat changes, such as:alteration of natural flow regimes; installation of bank revetment; and building structures such as dams, bridges, water diversions, piers, and wharves, often provide conditions that both disorient juvenile salmonids and attract predators. Harvest activities, ocean productivity, and drought conditions provide added stressors to listed salmonid populations. In contrast, various ecosystem restoration activities have contributed to improved conditions for listed salmonids (*e.g.*, various fish screens). However, some important restoration activities (*e.g.*, Battle Creek) have not yet been initiated. Benefits to listed salmonids from the EWA have been smaller than anticipated.

B. Existing Monitoring Programs

Salmon-focused monitoring efforts are taking place throughout the Sacramento and San Joaquin River basins, and the Suisun Marsh. Many of these programs incidentally gather information on steelhead but a focused, comprehensive steelhead monitoring program has not been funded or implemented in the Central Valley. The existing salmonid monitoring efforts are summarized in Table 5 (Appendix A) by geographic area and target species. Information for this summary was derived from a variety of sources:

- 1999 IEP Steelhead Project Work Team report on monitoring, assessment, and research on steelhead: status of knowledge, review of existing programs, and assessment of needs (IEP 1999);
- CDFG Plan;
- U.S. Forest Service Sierra Nevada Framework monitoring plan;
- ESA section 10 and section 4(d) scientific research permit applications;
- Trinity River Restoration Program biological monitoring; and
- Suisun Marsh Monitoring Program.

C. Presence of Listed Salmonids in the Action Area

The Port is situated at the terminus of the dredged DWSC and the undredged upper portion of the San Joaquin River at RM 41. Channel Point is considered the juncture between the DWSC and the upper river sections. All of the listed Central Valley steelhead in the San Joaquin River watershed originating from the Stanislaus, Tuolumne or Merced Rivers have the potential to pass through the Port on both their downstream emigration to the ocean as smolts or on their upstream spawning migrations as adults. Those few adults that survive to spawn a second time would also pass through this portion of the river again. There is the potential for fish to make their way through either Old River or Middle River to access the upper San Joaquin watershed above the Head of Old River, but their success depends on whether or not the Head of Old River Barrier is in place. At some point in their upstream or downstream migrations, listed steelhead from either the San Joaquin River or Calaveras River watersheds would have to enter the mainstem of the San Joaquin River, downstream of the Port. Smolts are more likely than adults to stay within the mainstem during their migrations, as they follow the prevailing current out to the ocean. Upstream migrating adults have the option of following either the Sacramento River or San

Joaquin River upon their entry into the Delta. This commingling of water sources can result in milling behavior as fish seek out the olfactory cues of their natal stream.

Based on fish monitoring studies, Sacramento River winter-run Chinook salmon, Central Valley spring-run Chinook salmon and Central Valley steelhead juveniles and smolts from the Sacramento River watershed frequently enter into the San Joaquin River system based on river flows and SWP and CVP pumping rates. Fish from the Sacramento River can access the San Joaquin River from several points, the Delta Cross Channel via the North and South Forks of the Mokelumne River, Georgiana Slough, Three Mile Slough, and the mouth of the San Joaquin River near Antioch and Sherman Island. Fish entering into the San Joaquin River main channel would be exposed to the shipping effects of this project while they migrated within the DWSC. In addition, adults of these ESUs would also be exposed to the conditions of the DWSC if they entered into the San Joaquin River channel by mistake while trying to find their way upstream.

V. EFFECTS OF THE ACTION

Pursuant to section 7(a)(2) of the ESA (16 U.S.C. §1536), Federal agencies are directed to ensure that their activities are not likely to jeopardize the continued existence of any listed species or result in the destruction or adverse modification of critical habitat. This biological and conference opinion assesses the effects of the Port’s West Complex Dredging project and the interrelated activities of the West Complex Redevelopment project on endangered Sacramento River winter-run Chinook salmon, threatened Central Valley spring-run Chinook salmon, threatened Central Valley steelhead and their designated or proposed critical habitats. The proposed action is likely to adversely affect listed species and habitat primarily through the dredging activities in the DWSC, increased shipping traffic, construction and operation of the Port’s berthing facilities to accommodate the additional shipping activity, and the increased volume of stormwater effluent associated with the industrialized development of the 1500 acre West Complex adjacent to the ship channel. In the *Description of the Proposed Action* section of this opinion, NMFS provided an overview of the action. In the *Status of the Species* and *Environmental Baseline* sections of this opinion, NMFS provided an overview of the threatened and endangered species and critical habitats that are likely to be adversely affected by the activity under consultation.

Regulations that implement section 7(a)(2) of the ESA require that biological opinions evaluate the direct and indirect effects of Federal actions and actions that are interrelated with or interdependent to the Federal action to determine if it would be reasonable to expect them to appreciably reduce listed species’ likelihood of surviving and recovering in the wild by reducing their reproduction, numbers, or distribution (16 U.S.C. §1536; 50 CFR §402.02).

NMFS generally approaches “jeopardy” analyses in a series of steps. First, NMFS evaluates the available evidence to identify direct and indirect physical, chemical, and biotic effects of the proposed actions on individual members of listed species or aspects of the species’ environment (these effects include direct, physical harm or injury to individual members of a species; modifications to something in the species’ environment - such as reducing a species’ prey base, enhancing populations of predators, altering its spawning substrate, altering its ambient temperature regimes; or adding something novel to a species' environment - such as introducing exotic competitors or a sound). Once NMFS has identified the effects of the action, the available evidence is evaluated to identify a species' probable response, including behavioral reactions, to these effects. These responses then will be assessed to determine if they can reasonably be expected to reduce a species' reproduction, numbers, or distribution (for example, by changing birth, death, immigration, or emigration rates; increasing the age at which individuals reach sexual maturity; decreasing the age at which individuals stop reproducing; among others). The available evidence is then used to determine if these reductions, if there are any, could reasonably be expected to appreciably reduce a species' likelihood of surviving and recovering in the wild.

A. Approach to Assessment

1. Information Available for the Assessment

To conduct the assessment, NMFS examined an extensive amount of evidence from a variety of sources. Detailed background information on the status of these species and critical habitat has been published in a number of documents including peer reviewed scientific journals, primary reference materials, governmental and non-governmental reports, scientific meetings, and environmental reports submitted by the project proponents. Additional information investigating the effects of the project's actions on the listed salmonid species in question, their anticipated response to these actions, and the environmental consequences of the actions as a whole was obtained from the aforementioned resources.

2. Assumptions Underlying This Assessment

In the absence of definitive data or conclusive evidence, NMFS must make a logical series of assumptions to overcome the limits of the available information. These assumptions will be made using sound, scientific reasoning that can be logically derived from the available information. The progression of the reasoning will be stated for each assumption, and supporting evidence cited.

In assessing the impacts of anthropogenic noise on the listed salmonid species, NMFS used the available data for several different species of fish for which acoustic experimental data is available, including the hearing specialist, fathead minnow (*Pimephales promelas*) and the hearing generalist, pink snapper (*Pagrus auratus*). Protective acoustic levels were then determined that were appropriate for fish in general, due to the lack of data specific to salmonids. In a recent review of available information on the effects of anthropogenic sound (*i.e.*, pile driving) generated by construction activities on the west coast of North America, Hastings and Popper (2005) specifically cited the lack of salmonid data as a critical gap in the scientific record for evaluating noise impacts, and recommended increased and focused studies on this group of fish.

In assessing the impacts of shipping traffic on listed salmonids, NMFS evaluated available literature on these effects from studies conducted on the upper Mississippi River and Illinois River systems by the Corps. Additional information from fish monitoring studies conducted by the FWS and CDFG regarding salmonid density in the San Joaquin River and Sacramento River was incorporated into the calculations for risk assessment. Certain assumptions were made regarding the size and propulsion characteristics of ships expected to call on the Port. The values used in the risk assessment are based on shipping profiles available from the literature and the United States Coast Guard.

B. Assessment

The Port's redevelopment of the West Complex, including the associated upland development, is expected to adversely affect listed salmonids during both the construction and port operation phases of the project. Initial dredging of the West Complex is expected to take several weeks to complete. Subsequent maintenance dredging actions will occur intermittently, with an average dredging cycle of two to three years between actions. The construction phase is expected to require several years to complete, whereas the long-term operation of the port and the effects of the developed West Complex will occur indefinitely. The primary impacts of the project on listed salmonids are expected to result from the ongoing dredging effects and Port activities. The impacts will encompass short- and long-term effects on water quality and other habitat components of the DWSC and adjacent waterways.

1. Presence of Listed Salmonids in the Action Area

All Central Valley steelhead from the San Joaquin River drainage and Calaveras River have the potential to be exposed to the Port's dredged basin. Some San Joaquin River fish may move through the Old River channel prior to its closure in October and again in April when the Head of Old River Barrier is installed. NMFS anticipates that all of these populations will experience some adverse effects associated with the altered habitat and forage base.

During the period between September and the end of December, adult steelhead may be in the proximity of the dredging operations as proposed. Adult steelhead begin to migrate into the region's watersheds (Calaveras and San Joaquin Rivers) during this period, particularly when increased attractant flows are being released by San Joaquin River reservoirs to enhance fall-run Chinook salmon spawning runs in the San Joaquin River tributaries or early winter rains create increased flows in the system. Prior to the fall attractant flows, low DO conditions may occur and cause adult steelhead to linger downstream of the West Complex site while they wait for more favorable water quality conditions.

The peak of juvenile Central Valley steelhead emigration from their tributaries in the San Joaquin Valley occurs during the period between February and May. Therefore, dredging during the proposed period between June 1 and December 31 should avoid impacts to the majority of juvenile Central Valley steelhead smolts in this locale. There are, however, larger steelhead smolts that migrate at other times of the year, including the fall and early winter period (S.P. Cramer 2005), and thus may be exposed to the dredging activities during their passage through the Port's West Complex area.

The total number of steelhead exposed to adverse effects associated with the altered habitat and forage base could range from several hundred to a few thousand individuals, depending on the run size for that year. Some smaller number of adults and larger smolts that migrate during the fall/early winter period also may be exposed to suspended sediments directly associated with the dredging activities.

All salmonids migrating through the DWSC, either to or from the Calaveras River and the San Joaquin River watersheds, have the potential to be exposed to the increased shipping activities and stormwater discharges from the upland redevelopment of the West Complex. Although the San Joaquin River and DWSC are outside of the ESU limits for Sacramento River winter-run Chinook salmon and Central Valley spring-run Chinook salmon, these fish also may be drawn into the lower San Joaquin River and DWSC along with Central Valley steelhead originating from the Sacramento River drainage. As discussed in the *Environmental Baseline* section, both adults migrating upstream to spawning areas and juvenile outmigrants from the Sacramento River are drawn into the central and south Delta due to SWP and CVP pumping activities and associated operations such as opening the Delta Cross Channel gates. The duration of exposure for straying adults to the effects of the proposed project likely would be on the order of days. The duration of exposure for downstream juvenile migrants is anticipated to last no longer than two weeks, based on data from the Vernalis Adaptive Management Plan (VAMP) mark and recapture experiments on fall-run Chinook salmon smolts.

2. Dredging Actions

a. *Immediate Effects of the Action*

The initial dredging action will remove accumulated sediments from in front of the West Complex's docks. The applicant has anticipated the amount of sediment removed to be approximately 576,000 cy. The area under consideration has not had any dredging actions for several decades, resulting in the accumulation of sediment along the north shore of Rough and Ready Island. Depths have decreased to an average of -20 feet MLLW with some shoaling to approximately -15 feet MLLW. The dredged area will extend approximately 125 feet from the boundary of the ship channel shoreward toward the docks at a nominal depth of -35 feet MLLW. Maintenance dredging is expected to take place every 2 to 2.5 years to remove accumulated sediment. The volume of the DWSC within the area of the dredging impacts is expected to increase by approximately 16 percent over the current volume (see Appendix A: Table 6).

(1) ***Sediment Characteristics***. The Port has characterized the sediments that will be dredged as moderately contaminated. Elevated levels of metals, particularly arsenic, barium, copper, mercury, lead, nickel, zinc, and hexavalent chromium have been found in representative core samples (Jones and Stokes 2004b; Regional Board 2004). In addition, elevated levels of ammonia, volatile and semi-volatile organic carbon compounds have been detected in the sediment samples. In particular, the organochlorine pesticide Endosulfan II was detected in samples from Dock 19 (please see Table 7A).

The strata of sediment material (horizon) at -35 MLLW that are to be exposed after dredging also were found to have elevated levels of contaminants, although generally at lower levels than the existing horizon. Dredging of the dock sections will extend laterally up to the base of the existing dock piling structure. It is likely that the edges of the dredged cut will eventually slump to a stable configuration, exposing new horizons of contaminated sediment to the overlying water column. Dredging along the section of the West Complex between Dock 20 and Burns Cutoff will extend laterally almost to the levee foot. As with the dock sections, the dredge cut is expected to eventually slump until a stable conformation is assumed, exposing new sediment horizons to the water column. The applicant has calculated the expected concentration of the contaminants in water column overlying the newly exposed sediment horizon (please see Appendix A: Table 8)

The initial dredging of the dock sections and the western end of the West Complex may potentially change the bottom structure and substrate composition. Currently, the existing horizon is composed mostly of organic material with a minor percentage being comprised of sand (see Appendix A: Table 9). A decrease in the organic particulate matter available to detrital feeders may alter the structure of the current foodweb in the project area provided that sediment contaminants and hypoxic water conditions do not preclude invertebrate assemblages completely in the DWSC. Currently, data are unavailable for determining site specific benthic invertebrate assemblages in the DWSC in the vicinity of the Port's West Complex.

The following two sections describe the contaminants found in the sediments tested within the proposed dredging sites that are of sufficiently elevated concentrations to be of concern to NMFS. Of the metals examined (*i.e.*, arsenic, barium, copper, mercury, lead, nickel, zinc, and hexavalent chromium), only copper is sufficiently elevated in the sediment to pose a significant risk to migrating salmonids. Likewise, the only organic compound that poses a reasonably certain level of risk to migrating salmonids are the ammonia levels in the sediment. The analysis of sediment constituents that were excluded from this narrative are described in full in a technical memorandum to the administrative file.

Copper – The Regional Board has indicated that copper has the potential to impact receiving waters. The elutriate tests indicate that copper levels in dredge disposal effluent may exceed 33.1 µg/l. Sediment copper concentrations ranged from a minimum of 34.3 mg/kg to 73.2 mg/kg with a median concentration of 49.0 mg/kg of sediment. In both cases, the copper concentrations exceed the criteria levels for dissolved copper in the water column (10 µg/l) and the sediment safety guidelines for the threshold of adverse effects (31.6 mg/kg - 35.7 mg/kg).

Pacific salmonids (*Oncorhynchus* spp.) are very susceptible to copper toxicity, having the lowest LC_{50} threshold of any group of freshwater fish species tested by the EPA in their Biotic Ligand Model (BLM; EPA 2003) with a Genus Mean Acute Value (GMAV) of 29.11 µg/l of copper. In comparison, fathead minnows (*Pimephales promelas*), the standard EPA test fish for aquatic toxicity tests, have a GMAV of 72.07 µg/l of copper. The BLM standardizes water chemistry parameters such as pH, dissolved organic carbon (DOC), percentage of humic acid, temperature, major cations (Ca^{+2}, Mg^{+2}, Na^{+}, and K^{+}), major anions (SO_4^{-2}, Cl^{-}), dissolved inorganic carbon, and sulfide in calculating the lethal toxicity criteria, thus allowing direct comparisons between species' sensitivities to copper that have been tested in different water qualities. Water hardness has frequently been cited as an ameliorating factor in reducing copper toxicity, perhaps due to the competition between the divalent cations in the carbonate complexes (*i.e.*, $CaCO_3$) and the divalent copper ions for ligand binding sites on the fish's cellular membranes. Marr *et al.* (1999) analyzed the bioavailability and acute toxicity of copper to rainbow trout (*O. mykiss*) in the presence of organic acids and concluded that the low-affinity ligands act in a similar fashion, that the toxicity of copper is determined by the binding affinities of specific DOC components relative to copper-binding affinities of the fish's gill epithelium.

In addition to the elevated risk of mortality to Pacific salmonids from relatively low concentrations of copper, this genus of salmonids are also prone to incur substantial sublethal physiological effects from slightly elevated concentrations of copper above natural environmental levels. Hansen *et al.* (2002) exposed rainbow trout to sub-chronic levels of copper in water with nominal water hardness of 100 mg/l (as $CaCO_3$). Growth, whole body copper concentrations and mortality were measured over an 8 week trial period. Significant mortality occurred in fish exposed to 54.1 µg/l Cu (47.8 percent mortality) and 35.7 µg/l Cu (11.7 percent mortality). Growth and body burden of copper were also dose dependent with a 50 percent depression of growth occurring at 54.0 µg/l, but with significant depressions in growth still occurring at copper doses as low as 14.5 µg/l after the 8 week exposure. In a separate series of studies, Hansen *et al.* (1999a, b) examined the effects of low dose copper exposure to the electrophysiological and histological responses of rainbow trout and Chinook salmon olfactory bulbs, and the two fish species behavioral avoidance response to low dose copper. Chinook salmon were shown to be more sensitive to dissolved copper than rainbow trout and avoided copper levels as low as 0.7 µg/l copper (water hardness of 25 mg/l), while the rainbow trout avoided copper at 1.6 µg/l. Avoidance response was lost in Chinook salmon at a copper concentration above 44 µg/l, while rainbow trout lost their avoidance response at concentrations above 180 µg/l of copper. Long-term acclimation to low dose copper (2 µg/l) for 25 to 30 days prior to exposure diminished all avoidance response in Chinook salmon at any of the levels tested (3.4 to 21.0 µg/l) when the alternative was either the long-term exposure water (1.6 µg/l) or "clean" test water (0 µg/l). In contrast, rainbow trout retained their avoidance of any copper levels higher than the control concentration of 1.6 µg/l. The intensity of avoidance responses were similar to those of naive fish which had not been acclimated to copper beforehand.

Concentrations of copper below the acutely toxic levels needed to elicit mortality or morbidity have been shown to significantly reduce the olfactory response of exposed salmonids. Diminished olfactory sensitivity reduces the ability of the exposed fish to detect predators and to respond to chemical cues from the environment, including the imprinting of smolts to their home waters, avoidance of chemical contaminants, and diminished foraging behavior (Hansen *et al.* 1999b). The electrophysiological responses of Chinook salmon and rainbow trout to concentrations of copper ranging from 25 to 300 µg/l were examined in a subsequent series of experiments. The olfactory bulb electroencephalogram (EEG) responses to the stimulant odor, L-serine (10^{-3} M), were initially reduced by all copper test concentrations, and completely eliminated in Chinook salmon exposed to $50 µg/l and in rainbow trout exposed to $200 µg/l within 1 hour of exposure. Following copper exposure, the EEG response recovery to the stimulus odor were slower in fish exposed to higher copper concentrations. Histological examination of Chinook salmon exposed to 25 µg/l copper for 1 and 4 hours indicated a substantial decrease in the number of receptors in the olfactory bulb due to cellular necrosis. Similar receptor declines were seen in rainbow trout at higher copper concentrations during the one hour exposure, and were nearly identical after four hours of exposure. A more recent olfactory experiment (Baldwin *et al.* 2003) examined the effects of low dose copper exposure on coho salmon (*O. kisutch*) and their neurophysiological response to natural odorants. The inhibitory effects of copper (1.0 to 20.0 µg/l) were dose dependent and were not influenced by water hardness. Declines in sensitivity were apparent within 10 minutes of the initiation of copper exposure and maximal inhibition was reached in 30 minutes. The experimental results from the multiple odorants tested indicated that multiple olfactory pathways are inhibited and that the threshold of sublethal toxicity was only 2.3 to 3.0 µg/l above the dissolved copper background. The results of these experiments indicate that even when copper concentrations are below lethal levels, substantial adverse effects occur to salmonids exposed to these low levels. Reduction in olfactory response is expected to increase the likelihood of morbidity and mortality in exposed fish by impairing their homing ability and consequently migration success, as well as by impairing their ability to detect food and predators.

As the elevated levels of copper in the previously buried sediment horizons are exposed by the proposed dredging activities to the overlying water column, several chemical and biological transformations are anticipated (please see Appendix B: Figure 9). Exposure to oxygen will create chemical oxidation/ reduction reactions in previously reduced chemical compounds. Some of these reactions are expected to release copper compounds contained in the sediment to the overlying water column by increasing the solubility of the copper metal complexes. These reactions will continue to take place until chemical equilibrium is established between the sediment and the overlying water column. Similarly, biological reactions, particularly those due to microbial actions, are expected to increase the availability of copper in the DWSC. Based on chemical equilibrium data provided by the applicant, dissolved copper levels that are equivalent to the levels of copper shown to reduce growth or impair olfactory responses in laboratory experiments are expected.

In addition to these physiological responses to copper in the water, Sloman *et al.* (2002) found that the adverse effect of copper exposure was also linked to the social interactions of salmonids. Subordinate rainbow trout in experimental systems had elevated accumulations of copper in both their gill and liver tissues, and the level of adverse physiological effects were related to their social rank in the hierarchy of the tank. The increased stress levels of subordinate fish, as indicated by stress hormone levels, is presumed to lead to increased copper uptake across the gills due to elevated ion transport rates in chloride cells. Furthermore, excretion rates of copper may also be inhibited, thus increasing the body burden of copper. Sloman *et al.* (2002) concluded that not all individuals within a given population will be affected equally by the presence of waterborne copper, and that the interaction between dominant and subordinate fish will determine, in part, the physiological response to the copper exposure.

The levels of copper in the sediment phase which will be partitioned to the aqueous phase following exposure via dredging and the return of dredging decant waters from the DMP sites indicate that demonstrable adverse effects can occur to salmonids exposed to these conditions. These effects range from alterations of behavior and olfactory response to acute mortality. As previously explained, copper, as well as other compounds sequestered in the sediment, will come into chemical equilibrium with the overlying water column. The changes in oxygen content and pH, as well as the concentration gradient between the sediment and the water are expected to mobilize chemical constituents. Activity by biological processes, such as bio-perturbation or microbial metabolism can further accelerate the mobilization of compounds from these sediment horizons which were previously below the zone of biotic activity into the aquatic environment.

Ammonia-- Ammonia is a common aquatic pollutant which enters natural waters with municipal, agricultural, fish-cultural, and industrial wastes. It is also a natural degradation product of nitrogenous organic matter and protein metabolism. Organic materials that fall out of the water column and settle to the bottom are colonized by microbes. These microbes metabolize the organic material, producing ammonia from the metabolism of nitrogenous materials (*i.e.*, proteins). Perturbation of the bottom aerobic and anaerobic layers in the sediments can release significant quantities of the highly soluble ammonia into the overlying water. The Regional Board has indicated that ammonia levels may reach levels as high as 25.5 mg/l in the filtered liquid samples (elutriate) obtained from mixing deionized water with the dredge material samples. In an aqueous solution, ammonia assumes both an ionized form (NH_4^+) and an un-ionized form (NH_3). The ratio between the two species of ammonia is pH sensitive. The more acidic (lower pH) the aqueous solution is, the greater the equilibrium equation is shifted towards the formation of NH_4^+, as would be expected of a weak base.

Salmonids are very sensitive to the level of un-ionized ammonia in the aqueous environment. Thurston and Russo (1983) found median acute toxicity levels of NH_3 in rainbow trout (*O. mykiss*) to range from 0.16 to 1.1 mg/liter in 96-hour exposures. The exposed fish ranged from 1-day old fry (<0.1 g) to 4-year old adults (2.6 kg). Sensitivity to NH_3 decreased as the fish developed from fry to juveniles, and then subsequently increased as fish matured. Sensitivity to ammonia as measured by the concentration lethal to 50 percent of the exposed population (LC_{50}) (Rand *et al.* 1995) did not appreciably change in concurrent exposures for 12- and 35-day test by the same authors. Thurston *et al.* (1984) measured chronic toxicity of rainbow trout to several low dose concentrations of ammonia (0.01-0.07 mg/l un-ionized ammonia) over a 5-year period, exposing 3 successive generations of trout to the toxicant. The trout exhibited dose dependent changes in the level of ammonia in their blood, and fish exposed to ammonia concentrations of 0.04 mg/l or higher of un-ionized ammonia exhibited pathological lesions in their gills and kidneys. There were no gross signs of toxicity at any of the test dose exposures, even though the histological examinations indicated abundant sublethal pathologies.

Lesions within the gill tissues create adverse conditions for oxygen exchange in exposed fish. Common types of pathologies observed in chronically exposed trout were “clumping” of gill filaments, separation of epithelial cells from their underlying basement membranes, and micro-aneurisms (Thurston *et al.* 1984). The resulting abnormalities in the gill tissues can be expected to reduce the efficiency of oxygen transfer across the gill epithelial cells, and thus make the fish more susceptible to adverse effects from low DO conditions. In addition, the injured tissues are more susceptible to pathogens and increase the likelihood of morbidity in exposed fish.

Lesions in the renal tissues of the exposed trout included nephrosis, degeneration of renal tubule epithelia, and partial occlusions of the lumen of the renal tubules. These lesions can be expected to impair glomerular blood flow and filtration, and eventually induce renal failure. In an anadromous fish, such as steelhead or Chinook salmon, a properly functioning renal system is imperative for osmotic regulation in its freshwater life stages. The renal system produces the dilute urine necessary to maintain the proper level of hydration. Without the ability to produce dilute urine, the fish will continue to absorb water until the osmotic pressure between the outside aquatic environment is balanced by the internal tissue osmolality.

The ammonia concentrations developed in the elutriate tests are sufficiently elevated to cause acute toxicity to exposed salmonids in the water column. Lower concentrations below the lethal thresholds will cause tissue and cellular damage.

(2) ***Turbidity and Sediment Resuspension.*** The dredging activity will create conditions that will increase local turbidity through the resuspension of sediment. The Port has estimated that approximately 0.21 to 0.78 percent of the total sediment dredged will be resuspended in the overlying water column (Jones and Stokes 2004b). Based on the total amount of dredged material estimated by the Port (*i.e.* 576,000 cy), this will amount to a volume of 1,210 to 4,380 cy of sediment resuspended into the DWSC which is equivalent to a concentration of 2.4 mg/L of suspended solids. The Port has indicated that the background concentration of suspended solids in the DWSC is approximately 24 mg/L, therefore the dredging action will result in a 10 percent increase in total suspended solids downstream of the dredging action (Regional Board 2004).

Suspended sediments can adversely affect salmonids in the area by clogging sensitive gill structures (Nightingale and Simenstad 2001) but are generally confined to turbidity levels in excess of 4,000 mg/L. Based on the information received from the Port, NMFS does not anticipate that turbidity levels associated with the dredging action itself will increase to levels that are directly causing adverse effects upon exposed salmonids. However, resuspension of contaminated sediments may have adverse effects upon salmonids that encounter the sediment plume, even at low turbidity levels. Lipophilic compounds in the fine organic sediment, such as toxic polyaromatic hydrocarbons (PAHs), can be preferentially absorbed through the lipid membranes of the gill tissue, providing an avenue of exposure to salmonids experiencing the sediment plume. Similarly, charged particles such as metals (*e.g.*, copper), may interfere with ion exchange channels on sensitive membrane structures like gills or olfactory rosettes and increases in ammonia from the sediment may create acutely toxic conditions for salmonids in the channel.

In addition to the direct effects of suspended sediments to exposed fish, the suspended sediment will increase the chemical oxygen demand (COD) within the waters of the DWSC. Data provided by the Port to the Regional Board indicates that the additional suspended sediment from the dredging action will increase COD approximately 0.74 mg/L to 1.8 mg/L of oxygen for the old sediment horizon, 0.5 mg/L to 1.0 mg/L for the composite sediment sample, and 0.08 mg/L to 0.5 mg/L for the new sediment horizon. The addition of this oxygen demand upon the DO in the channel will exacerbate the frequently low DO levels seen in the channel during the periods between September and December when adult steelhead maybe moving upstream through the DWSC near the West Complex. NMFS anticipates that the addition of this extra COD will increase the frequency of DO depressions below the 5 mg/L DO standard in the California Water Quality Control Plan for the Central Valley (Basin Plan) (*i.e.*, which also is the minimum requirement for salmonids), therefore increasing the frequency of delayed migration for Central Valley steelhead into the Calaveras River and San Joaquin River.

In order to offset this depression of the DO in the channel created by dredging operations, the Port intends to operate an aerator within 1,000 feet of the dredge during operations. The aerator will be capable of delivering approximately 500 pounds of oxygen per day to the water column. The zone of effect for these aerators has not been verified by *in situ* measurements, and benefits to salmonids passing through the dredging action area are unclear. Similar aerators used in the DWSC, operating at much higher volumes, have not proven to be able to demonstrably increase DO in the water column beyond a range of a few dozen meters from the aerator.

Based on the timing of the dredging actions (June through December), NMFS expects the majority of the immediate impacts created by dredging activity to be experienced by adult Central Valley steelhead migrating upstream to the watersheds of the Calaveras and San Joaquin Rivers. Although some steelhead smolts may be migrating downstream at this time, their numbers are expected to be low compared to the peak of migration in spring and would tend to be associated with rain events or pulse flow operations on the tributaries. Increased flows in the main channel of the San Joaquin, as a result of pulse flows or precipitation, are expected to ameliorate the negative effects of the dredging action by shortening the duration of migration through the action area and diluting the resuspendend sediments in the water column.

(3) ***Entrainment by Dredges***. The hydraulic cutterhead dredge operates by pulling water through the cutterhead assembly, upwards through the intake pipeline, past the hydraulic pump and down the outflow pipeline to the DMD site. The suction creates a field of influence around the head of the dredge intake pipe. The size of the field of influence surrounding the cutterhead is dependent on the diameter of the pipeline, the power of the pump, and how deep the cutterhead is extended into the sediment layer. The Port has indicated that the hydraulic dredge that is to be used in this project will have a 16 inch diameter intake pipe that is powered by a 2,000 hp hydraulic suction pump (Jones and Stokes 2004b). According to estimates supplied by the Port, this will discharge approximately 4.3 to 6.6 cfs from the end of the pipeline. This is equivalent to 2.7 to 4.2 feet per second (ft/sec) flow velocity at the mouth of the cutterhead.

The Corps interactive model (available at: http://el.erdc.usace.army.mil/dots/doer/flowfields) calculates that the flow fields surrounding a cutterhead with a hemisphere above the sediment surface (half of the cutterhead diameter) will have a velocity of 38 cm/sec at 0.5 meters from the intake with a given suction pipe velocity of 15 ft/sec (approximately 4 times greater than anticipated for this project). At about 1.5 meters from the cutterhead, flow velocities are reduced to 4.2 cm/sec. If the average size steelhead smolt is approximately 150 mm, then the flow velocity, even within 0.5 meters of the cutterhead, are below the burst swimming speed of 10 body lengths (BL)/sec for salmonids. Modeling a quarter hemisphere flow field for a deeper entrenched cutterhead, the Corps model calculates that flow velocities will be 76 cm/sec at 0.5 meters and 8.4 cm/sec at 1.5 meters. The velocities within 0.5 meters of the cutterhead are still below the critical 10 BL/sec burst swimming speed for salmonids (Webb 1995). Therefore, it is unlikely that a steelhead smolt that detects the presence of the cutterhead would be unable to escape its field of influence, unless its swimming ability was in some way compromised. Furthermore, most dredging will take place in water deeper than 20 feet. It is not anticipated that steelhead smolts would be at this depth during their seaward migration, thus further insulating them from the effects of the flow fields surrounding the cutterhead. Adult salmonids that may encounter the hydraulic dredge would likewise be able to avoid and escape entrainment due to their greater swimming speed.

Notwithstanding this set of information, the Corps modeling indicates that smaller salmonids may be at risk as the flow velocities may exceed the burst swimming capabilities of the fish. Earlier Corps studies of juvenile salmonid entrainment in the lower Fraser River, British Columbia, Canada indicated that dredging in confined waters, such as narrow constricted channels where fish occupied the entire channel, could result in substantial entrainment rates of salmon (Dutta and Sookachoff (1975) in Reine and Clark 1998). Estimates of entrainment rates by hydraulic dredging ranged from 0.00004 to 0.4 percent of the total out-migration of fry and smolts (Arsenault (1981) in Reine and Clark 1998). The Corps report (Reine and Clark 1998) estimated that for chum salmon (*O. keta*) entrainment rates for hydraulic pipeline dredging were 0.008 fish/cy of dredged material. This would be equivalent to approximately 4,200 salmon juveniles entrained for the entire 526,000 cy of dredged material proposed, if salmon fry and juveniles were present during the dredging action. The Corps report also concluded that for upland confined dredging material disposal, as is proposed for this project, entrainment mortality would be 100 percent.

In addition to salmonids, other organisms would be entrained by the hydraulic suction dredge, particularly small demersal fish and benthic invertebrates. The Corps report (Reine and Clark 1998) estimated that the mean entrainment rate of a typical benthic invertebrate, represented by the grass shrimp (*Crangon* spp.), when the cutterhead was positioned at or near the bottom was 0.69 shrimp/cy but rose sharply to 3.4 shrimp/cy when the cutterhead was raised above the substrate to clean the pipeline and cutterhead assembly. Likewise, benthic infauna, such as clams, would be entrained by the suction dredge in rates equivalent to their density on the channel bottom, as they have no ability to escape. The loss of benthic food resources for juvenile steelhead and salmon, such as amphipods or isopods, could be significant, depending on the density of the animal assemblages on the channel bottom. NMFS believes that small invertebrates such as annelids, crustaceans (amphipods, isopods), and other benthic fauna would be unable to escape the suction of the hydraulic dredge and be lost to the system. Also, many benthic invertebrates have pelagic, surface-oriented larvae; therefore the loss of these benthic invertebrates may reduce the abundance of localized zooplankton populations in the upper regions of the water column where juvenile salmonids migrate through the DWSC. The timing of the dredging cycle (summer-fall) may preclude forage base replacement by recruitment from surrounding populations prior to the following winter and spring migration period of juvenile steelhead through the dredging action area (Nightingale and Simenstad 2001).

(4) ***Acoustic Impacts of Dredging***. High levels of underwater acoustic noises have been shown to have adverse impacts upon fish within close proximity of the noise source. The Port has indicated that the dredging action will operate continuously for several days while dredging the project area. Even though the suction dredge may not be in constant operation (estimated at eight to ten hours daily), other activities aboard the dredge will continue on a 24-hour cycle such as cleaning the cutterhead, repositioning the dredge itself, and conducting maintenance work. Within the West Complex dredging area, the DWSC is approximately 150 meters wide (500 feet) and 36 feet deep. This represents a fairly confined volume of water for sound propagation.

In general, underwater sound dissipates with distance from the source. In an ideal model, the intensity of the sound energy produced at the point source spreads itself out over a spherical surface so that by conservation of energy, the total energy spread over the spherical surface at any given distance from the point source is equal to the energy at the point source. In the real world, this simple model is complicated by the water surface and channel bottom reflecting sound energy back into the water column and the formation of constructive and destructive sound wave interference. Studies conducted by the Corps (Clarke *et al.* 2002) measured sounds produced by different dredging methods, including hydraulic cutterhead dredges. Clarke *et al.* (2002) measured sound energy in the 70 to 1,000 Hz range from the dredging activity. The sound energy peaked at a level of 100 to 110 dB (presumably at re:1µPa, although it was not cited in the report text) at an unspecified distance from the dredge. Assuming that the measurements for the cutterhead hydraulic dredge were made at similar distances as the other dredge methods, the closest distance was 40 meters (131 feet) for the hopper dredge measurements. Based on this distance, the calculated point source level of sound energy is equal to 153 dB. Conversely, if the finding that the sounds emitted by the hydraulic dredge were barely detectable at 500 meters, as Clarke states in his paper, then the point source noise energy is equal to 125 dB, assuming that the background noise is between 50 and 60 dB. Transient noise associated with machinery and deck activities may be substantially above these energy levels, as indicated by the bucket dredge data. Sounds created from topside activities can be easily and efficiently transferred through the barge hull to the surrounding water column, particularly from metal to metal contact.

Recent studies by Scholik and Yan (2002) studied the effects of boat engine noise on the auditory sensitivity of the fathead minnow. The majority of noise generated from the motor is derived from the cavitation of the propeller as it spins in the water. Fish were exposed to a recording of the noise generated by a 55 hp outboard motor over a period of two hours. The noise level was adjusted to 142 dB (re:1µPa), which was equivalent to the noise levels measured at 50 meters from a 70 hp outboard motor. The experimental fish suffered a drop in hearing sensitivity over the range of frequencies normally associated with their hearing capabilities. These responses were measured using electrophysiological responses of their auditory nerves under general anesthesia. Studies by McCauley, Fewtrell, and Popper (2003) on the marine pink snapper, indicated that high-energy noise sources (approximately 180 dB [re:1µPa] maximum) can damage the inner ears of aquatic vertebrates by ablating the sensory hairs on their inner ear epithelial tissue as revealed by electron microscopy. Damage remained apparent in fish held up to 58 days after exposure to the intense sound. Although little data from studies utilizing salmonids is available, NMFS assumes that some level of adverse impacts to salmonids can be inferred from the above results. Exposures of these other fish species can serve as surrogates for salmonids. Adverse effects were measured in these surrogates following as little as 2 hours of exposure to 142 dB (re:1µPa) sound energy.

The loss of hearing sensitivity may adversely affect a salmonid's ability to orient itself (*i.e.,* due to vestibular damage), detect predators, locate prey, or sense their acoustic environment. Fish also may exhibit noise-induced avoidance behavior that causes them to move into less-suitable habitat. In the Port's project, this may result in salmonids fleeing the dredging associated noises and moving into the central channel habitat which harbors open water predators such as striped bass. Likewise, chronic noise exposure can reduce their ability to detect piscine predators either by reducing the sensitivity of the auditory response in the exposed salmonid or masking the noise of an approaching predator. Disruption of the exposed salmonid's ability to maintain position or swim with the school will enhance its potential as a target for predators. Unusual behavior or swimming characteristics single out an individual fish and allow a predator to focus its attack upon that fish more effectively.

(5) ***Dredge Material Disposal***. The DMD site selected by the Port for disposal of the dredged material consists of a 40-acre sedimentation basin and an additional 80-acre overflow basin for the decant water on Roberts Island. Roberts Island is a Delta island located southwest of the Port. The island's topography slopes in a southeast to northwest direction, reaching a minimum of -16 feet below MSL in the northwestern corner of the island. Agricultural drain water and ground water are intercepted by island-wide system of agricultural drainage canals. The intercepted water is pumped off the island into the surrounding Delta channels to maintain "dry" land within the perimeter of the levee banks.

The Roberts Island DMD site has been in use for several years, and contaminants from several different dredging cycles have had the opportunity to leach downward through the sediment and into the underlying soils. NMFS is concerned that the capacity for the native soil to capture contaminants and hold them in place may have been saturated, thus allowing the leachate constituents to migrate with the island's groundwater into the agricultural drainage canals that discharge into the San Joaquin River. Leachate is defined as interphase transfer of contaminants from dredged material solids to the pore water surrounding the solids and the subsequent transport of these contaminants by pore water seepage (Schroeder 2000).

Contaminants in the aqueous phase are convected with the pore water in the dredged material as leachate. As leachate is transported through porous media, redistribution of the contaminants between the advected pore water (leachate) and the new solids encountered (the surrounding porous media) occurs, and a new equilibrium between the leachate and solids is reached (Schroeder 2000). Within the overlying dredge material, various chemical reactions influence the potential movement of contaminants. Dredge material placed by hydraulic dredging rarely add sufficient oxygen to overcome the sediment oxygen demand of polluted sediments. Therefore, dredged material is typically anaerobic except for a thin surface crust that develops as the DMD site is dewatered by evaporation and decanting. However, as this crust thickens while drying out, materials in the dredged material become oxidized. If iron or manganese compounds are present in the dredged material, then their oxidation will produce hydrogen ions. Likewise if sulfides are present in the dredged material, oxidation will produce sulfates. The production of these oxidation reactions will increase acidity. Acidic conditions favor the creation of free metal ions, but also the creation of insoluble hydrous oxides that tend to reduce the concentration of metal ions in solution by adsorbing them. These two reactions work in opposition to each other.

The current soil conditions on the DMD site indicate that the soils are acidic (pH ranges from 5.2 to 5.8). Attempts to neutralize the acidity by the application of lime were only temporarily successful, the acidic conditions returned in the months following the applications (Regional Board 2004). Testing detected arsenic, barium, copper, lead, mercury, and nickel at levels that have the potential to impact groundwater.

The DMD site also will have a decant water discharge to the San Joaquin River downstream of the dredging site at the West Complex at latitude 37^{o} 59' 09.97" N and longitude 121^{o} 23' 38.03" W. Data supplied to the Regional Board by the Port indicates that the receiving waters of the

Delta may be impacted by the following metals: arsenic, barium, cadmium, copper, lead, mercury, and nickel. In addition, as previously indicated, the organochlorine pesticide Endosulfan II was detected in elutriates from Dock 19 dredge materials. The volume of water that will be discharged to the San Joaquin River has been estimated to be 2 million gallons per day (mgd). Complete mixing is assumed to occur within a 24-hour period due to two tidal cycles mixing the water column. The Port has estimated dilution ratios to range from 46:1 in January to 181:1 in December based on river flow volumes. However, since the portion of the San Joaquin River that accepts the effluent return from the DMD site is tidally influenced, the extended residency time of the water within the channel may confound the calculations for dilution rates, resulting in higher loadings than calculated. As previously stated, at low flow rates, the residency time for water in the DWSC ranges from a few days to several weeks. Material discharged into the channel with the decant water may reside in the channel for up to several weeks, moving back and forth in the channel several times, before being flushed from the system, providing it remains in a soluble state. This may cause contaminants to accumulate in the sediment surrounding the outfall as material is flocculated or precipitated in the ambient river water, which may cause elevated contaminant concentrations in the surrounding water column. Furthermore, the discharges are expected to occur for several months following the dredging operation due to water content of the dredge material and local precipitation on the DMD site and Roberts Island and are likely to coincide with juvenile steelhead migrating downstream during the wet season (January through May).

b. *Long-Term Effects of the Action*

(1) ***Bathymetry Changes***. NMFS estimates that removing 576,000 cy of material will increase the volume of the West Complex's basin within the affected portion of the action area by approximately 16 percent (see Appendix A: Table 6). The increased volume created by the deepening of the dock area is expected to increase the residency time of water within the immediate area of the West Complex. Although the increase in residence time for water may not be linear with the volume increase, because no other information is available, NMFS assumes that an increase in the basin volume of 16 percent will produce a corresponding increase in residence time.

Under current conditions, the residence time for water in the DWSC to travel from Channel Point to Turner Cut (approximately 7 miles) is inversely proportional to flow in the channel. As flow decreases, the residence time for water traveling between Channel Point and Turner Cut increases. This relationship is expected to continue after the proposed dredging is completed. Lee and Jones-Lee (2005) estimated that at a flow of 250 cfs, a unit of water would take approximately 32 days to travel the 7 miles downstream to Turner Cut. At a flow of 1,000 cfs, this travel time would be reduced to 8 days. These estimates of residency time would be altered by changing the cross section and volume of the DWSC by dredging additional areas. As the volume of the channel increases, the residency time will increase, provided flows entering the channel at Channel Point remain the same.

As residency time increases for water in the DWSC, NMFS anticipates an inverse decline in water quality, particularly DO. Even with aerators supplying oxygen to the water column, the proposed 0.2 mg/L DO increase is not expected to alleviate the currently seen DO sags in most instances from the perspective of listed salmonids. There will be little demonstrable benefit to listed salmonids once DO drops below 5 mg/L in the DWSC. As shown by the 5 years of DO data available on the CDEC website (Appendix A: Table 4), frequent depressions of the DO level below 5 mg/l oxygen occur throughout the steelhead migratory season in the DWSC (November through May) and the magnitude of the depressions are typically greater than the 0.2 mg/l DO available from the use of the aerators at Channel Point as projected by the Port.

(2) ***Repeated Disturbance.*** The long-term effects of the dredging action on sediment characteristics and benthic communities may be cyclical in nature. Over the course of the two-year maintenance dredging cycle, new sediments will be deposited and some benthic recolonization may occur along the docks of the West Complex, and then will be removed. The main effects that are anticipated to affect listed salmonids are possible spikes in contaminant levels, DO sags, and benthic food availability, which were discussed under short-term effects.

(3) ***Dredged Material Disposal.*** Over the long term, the Port envisions the continued use of the DMD site on Roberts Island for the disposal of maintenance dredging materials from the Port facilities, both the East and West Complexes. In addition to the Port facilities, the Corps will utilize the Roberts Island DMD site to dispose of the dredge materials from the maintenance dredging of the DWSC. Currently, the DMD site on Roberts Island is near full dredge material capacity and dredging cycles must be scheduled to allow for the decant water to drain off of the site prior to the next round of dredging. NMFS anticipates that over the long term, this site may require substantial enlargement of its footprint or increasing the height of its retaining berms surrounding the facility, unless a safe reuse of its dredge materials can be found.

3. Indirect Effects

a. Shipping Effects

(1) ***Overview***. The Port has anticipated in their EIR that the West Complex redevelopment will result in an approximate doubling of the shipping traffic volume that is now currently calling on the Port's facilities. At the current volume, approximately 150 to 250 ships per year call on the Port (an average of 0.4 to 0.7 vessels per day). This number is expected to increase by approximately 130 vessels per year after the dredging and new berths become available. This increases the daily average of vessels calling on the Port to 0.9 to 1.2 vessels per day. The information provided by the Port indicates that these ships will be traveling at an approximate speed of 8 to 10 knots (9 to 11.5 mph) within the DWSC.

The DWSC extends downstream for 37 river miles to the City of Antioch in Contra Costa County, where the dredged ship channel leaves the main channel of the San Joaquin River at RM 4 and follows New York Slough to its mouth on the Sacramento River near Pittsburgh, California. The DWSC is maintained at -35 feet MLLW by the Corps along its entire length. Dredged channel widths will vary from between 400 to 600 feet in the lower reaches of the DWSC near Antioch to only 225 feet in the middle reaches of the DWSC near Empire Tract and Rindge Tract. According to the NOAA navigation charts for the Delta, most of the channel averages 225 to 250 feet in width through the Delta. On either side of the dredged channel, the average depth of the San Joaquin River is generally less than 10 feet deep, according to NOAA charts for the region (NOAA Chart 18661). This is particularly true for reaches closer to the Port. These shallow water flats may extend for several hundred feet to either side of the dredged channel. A general river width for the San Joaquin River is approximately 600 feet in the reach between the Port and Prisoners Point. Westward of Prisoners Point, the channel widens between the levee banks to over 1000 feet in most reaches, with shallow water conditions on either side of the dredged channel.

The anticipated adverse effects associated with increased shipping that may impact listed salmonids include the following: increased turbulence, waves, shear forces, and pressure; propeller entrainment; increased sediment resuspension resulting in turbidity and contaminant exposure; increased pollution due to spills and discharges; introduction of non-native invasive species from ballast waters; and increased underwater acoustic noise from shipping sources. These topics will be analyzed in the following sections.

(2) ***Shipping Related Changes in Channel Hydrodynamics.*** The passage of a ship hull through the water creates a series of complex pressure fields surrounding the hull. Factors such as hull shape, vessel speed, channel geometry, and hull displacement all contribute to the behavior of water as it flows around the hull. The forward movement of the hull displaces water both forward and laterally. The wake produced by a ship's passage produces both a diverging surface wave that originates at the bow of the ship and spreads at an angle to the sailing line, and a transverse wake that is propagated in the sailing direction but is perpendicular to the sailing line (Seelig 2002). Smaller recreational motorboats have a greater proportion of diverging wakes than larger commercial ships. Conversely, large commercial ships have a greater transverse wake component than recreational boats do. The maximum wave heights along the sailing line occur where the transverse waves intersect the diverging waves along a cusp locus line. This point varies with ship speed and hull shape. In addition to these effects, vessels operated in confined channels with minimal under keel clearance are subjected to additional forces. The passage of a large hull displaces a large volume of water away from the sailing line of the ship. As the ship passes a given point on the nearby channel bank, the water forced away from the hull's passage surges back towards the sailing line of the ship to "fill in" the void left by the hull's passage. This creates "drawdown" of the water level along the bank, followed by the sharp jump in the water level created by the following transverse wave front. These effects are accentuated by increased ship speeds, shallow channel depths, shallow-water berms along the channel edge and the proximity to the sailing line of the vessel.

The velocity of water flow along the surface of the hull responds much like air flowing over a wing. As the hull passes through the water, the velocity along the surface of the hull accelerates from the bow towards the stern according to Bernoulli's Law compared to water further away from the hull itself. Likewise, in the small under keel clearance typically seen in the DWSC with large draft vessels (24 to 35 foot draft), the speed of water under the hull accelerates towards the stern. According to Bernoulli's Law, this results in a drop of ambient hydrostatic pressure resulting in the phenomena called "stern squat". The stern is actually pulled down towards the bottom from the resulting low pressure field between the hull bottom and the channel substrate.

The jet of water produced by the propeller's thrust also creates a turbulent wake field behind the ship. This turbulent body of water persists for several minutes after the passage of the ship, and aerial photos have indicated that this feature can exist for several miles behind a passing ship depending on speed and water conditions. The field of effects for hull generated turbulence and other hydrodynamic forces extend to at least to the beam of the ship, and based on research done by the Corps for the Upper Mississippi River studies, may extend at least another 25 percent of the ship's beam away from the sailing line (Maynord 2000a,c). Therefore, the wider the hull, the greater the dimensions of the body of water affected by its passage.

Shear Forces: The creation of the large pressure fields surrounding the passage of the ship's hull and their resulting velocity flows create shear forces along the different velocity gradients. These physical forces create hydrodynamic conditions in the DWSC that can result in adverse conditions for listed salmonids, as well as for the aquatic biota that make up their forage base. The passage of large barge tows on the upper Mississippi created substantial shear forces around the barge hulls and the tug pushing them. As the barge hull moved forward in the water, a boundary layer sets up along the sides of the hull where velocities are greatly reduced. At the hull surface, velocity is at or near zero due to hull friction. Shear forces are greatest at this point. As the distance from the hull increases, the water velocity in the boundary layer increases and the shear forces decline to near zero. Since the boundary layer thickness grows with distance from the point of initiation (bow), the amount of flow in the boundary layer increases with distance from the initiation point. The flow in the boundary layer is turbulent except for a short distance near the bow where flow is generally laminar. Turbulent flow along the hull is characterized by eddies having sizes ranging from minute to about the size of the boundary layer thickness (Maynord 2000b). Shear forces along the hull increase with vessel speed or in the reduction of under keel clearance.

Turbidity and Resuspended Sediments: Studies on barge tows in the Mississippi River indicated that flow fields created around the hulls of the barge tow were sufficient to cause increases in turbidity through bottom disturbances resulting from shear forces on the bottom sediment (Corps 2004). Drag created by the passage of the hull through the water creates turbulent flow fields adjacent to the skin of the hull, which continue to be propagated astern of the ship. Additional turbulence is created between the different layers of water adjacent to the hull. Vessels with large cross sections, such as the commercial vessels calling on the Port, set up these fields of turbulent flow within confined ship channels due to their interactions with the channel bottom and the channel edges. The effects increase in proportion to the ratio of the ship's cross-sectional area (SA) to the channel cross sectional area (CA). The greater the SA/CA, the more pronounced the turbulent effects of the ship's passage are on the sediment of the channel's bottom.

In addition, the propeller jet that is generated by the propeller wash creates a turbulent flow field behind the ship that persists for many minutes. When the propeller is within close proximity to the channel bottom, it "plows" the bottom with the propeller created vortex of water flowing off of the propeller blades. The sediment is captured by the flow fields in the jet and is drawn up into the water column. The depth to which the sediment is disturbed is a function of the distance between the propeller tips and the bottom, the velocity of the water as it exits the propeller disc, and the characteristics of the bottom sediment. The closer the propeller tips are to the bottom or the higher the flow velocities are in the propeller jet, the larger the diameter of sediment on the channel bottom that can be dislodged and carried up into suspension (Hamill *et al.* 1999). Fine detritus, such as seen in the upper DWSC near the Port are easily resuspended by the passage of the ships within the DWSC. This resuspension of bottom detritus and sediments can be accentuated by confining structures such as sheetpile walls or rock quays. Recent studies have indicated that propeller washes that are directed at confining structures like levee banks or dock structures or in tight quarters requiring extensive maneuvering accelerate erosion of the bottom substrate (Hamill *et al.* 1999).

This characteristic of ship passage resuspending bottom sediments exacerbates the exposure of contaminated sediments to salmonids within the DWSC. Any contaminant present in the exposed sediment horizon will be continually injected into the overlying water column, as much as once per day, where it can undergo both chemical and biological transformations. If the settling rate of fine detritus is slower than the frequency of ship passage through the DWSC, then the fine detritus may remain in suspension continuously due to the frequent passage of large ships. The greater exposure time to aerobic conditions will allow greater proportions of reduced compounds in the fine detritus to become oxidized, with the potential of becoming more biologically available to exposed organisms. Biological transformations, such as the methylation of mercury, may occur more readily as compounds are redistributed from hypoxic or anoxic horizons to aerobic conditions with their associated fauna and flora. The fine detritus also becomes a food source for any filter or detrital feeder within the larger DWSC area due to river and tidal currents. This will expose a greater proportion of the DWSC's fauna to the contaminated sediments in the Port's domain.

The continual disruption of the benthic sediment layers by shipping traffic also will inject organic and reduced materials into the overlying water column, as well as deepening the aerobic zone in the underlying sediment horizons due to mechanical disturbances (*i.e.*, propeller wash). The oxidation of this additional material will exacerbate the already depleted oxygen content in the overlying water column by consuming oxygen from the overlying water column through either microbial metabolism or chemical reduction-oxidation (redox) reactions. First, increasing the frequency of availability of organic substrates to the process of microbial decomposition in the overlying aerobic water will consume additional DO from the water column. Secondly, reduced compounds that are oxidized in the aerobic portion of the water column decrease the available DO in the water column. These conditions are expected to exacerbate the DO decline already predicted by the Port's data for the dredging (0.1 to 1.8 mg/l of DO). The regular disturbance of the DWSC's bottom by the passage of deep draft hulls is expected to preclude the bottom sediments from reaching an equilibrium state and forming stable aerobic and anaerobic layers in the sediment

(3) ***Pollution from Shipping***. Shipping activities have an inherent risk of creating additional sources of water pollution in port waterways. Among the more prevalent sources of pollution from shipping activities are the return waters from engine cooling, fuel leaks and spills, discharge of wash waters from decks and superstructures, and contaminants in discharged bilge waters.

The discharge of cooling waters back into the surrounding waters creates an avenue for the introduction of contaminants from the cooling circuit into surface waters. Bad seals and gaskets within the cooling circuit allow lubricants, fuel, and combustion by-products from the propulsion unit to enter the coolant water stream. Most of the petroleum products that end up as contaminants in the coolant stream are known toxicants to aquatic life. In addition to leaks within the coolant circuit, corrosion and rust of the piping used within the cooling circuit can introduce heavy metals into the water stream. Salt water is highly corrosive and eventually will attack the metal fittings and piping within the circuit, even those which are "sealed" to inhibit this corrosion. This slow degradation of exposed metal surfaces releases metal into the coolant water.

Fuel leaks occur frequently from shipping activities, although most are minor in size. These leaks are often the result of damaged fuel line connections, small punctures in fuel tanks, and sloppy fueling procedures. When these spills occur, they are often discharged into surrounding waters via two different routes; from overflow water used in washing down decks and superstructures or by discharging bilge waters while in port. Materials spilled on the topsides of a ship's decks are subject to both rain and the routine washing of the decks with hoses. Both events will carry any deposited fuel or petroleum products overboard through the deck scuppers into the surrounding waters. Materials that leak out from the fuel tanks are frequently deposited in the bilge, where they contaminate the water that gathers there. When this water is discharged from the ship, it carries with it the contaminant load.

(4) ***Non-native Invasive Species***. The San Francisco Bay estuary has one of the highest rates of invasion by non-native species of any water body on earth (Cohen 1997, Cohen and Moyle 2004). Currently the estuary is host to over 200 different NIS. In some areas of the estuary these NIS account for 40 to 100 percent of the common species encountered during sampling. A major pathway responsible for the introduction of NIS organisms into California waters is the transport of organisms in the ballast waters of ships (Cohen 1997).

The Port has indicated that approximately 20 to 25 percent of the ships calling on the Port have discharged ballast water totaling approximately three million gallons per year (Jones and Stokes 2004b). Current regulations require discharges to occur outside of the 200 mile exclusive economic zone in open ocean waters for vessels originating outside the Pacific Coast of North America (Pacific Coast Region). Vessels whose port of origin is within the Pacific Coast Region are to discharge ballast water in near coastal waters (more than 50 nm from land and greater than 200 meters deep) prior to entering California ports. Based on projected shipping increases in the Port, the number of ships discharging ballast water can be as high as 80 to 100 ships per year. At sea exchange of ballast water does not guarantee that all organisms are exterminated within the ballast tanks. Furthermore, the regulations do not have any methodology to guarantee that discharges have occurred as recorded in the ship's documents and that any discharges occurring in port are free of NIS.

(5) ***Propeller Entrainment.*** The increase in shipping traffic to the Port resulting from the proposed project will increase the encounter rate of salmonids with ship propellers of ships. Although the exact number of fish entrained into a propeller's zone of influence is impossible to determine, certain assumptions and modeling of the propeller entrainment zone can be made to give ranges for the numbers of affected fish. In order to make a simple assessment of the number of salmonids subject to propeller entrainment, NMFS determined the length of the route transited by ships in the San Joaquin River DWSC, and the range of ship propeller sizes and pitches, vessel speeds, and engine characteristics of commercial vessels commonly seen on ships calling on the Port, and then applied the recorded density of Chinook salmon in the Delta from published data provided by the FWS to characterize the salmonid entrainment numbers for vessel traffic within the DWSC.

Ships calling on the Port have a maximum size limit reflected by the Panamax constraints (Length overall: 965 feet [294 meters]; Beam [width] 106 feet [32.3 meters] and Draft 39.5 feet [12 meters]) and according to the Port's documents have an average speed of 8 to 10 miles per hour (mph) while transiting the DWSC from Pittsburgh to Stockton (Jones and Stokes 2004b). The diameter of a propeller (d) is related to the maximum draft (D) of the ship it propels. Typically d/D is less than 0.65 for bulk carriers and 0.74 for container ships. The largest propellers currently manufactured rarely exceed 10 meters in diameter due to strength and power limitations (Man B&W 2004). Therefore, for a ship with a 35 foot draft, the maximum propeller size would be approximately 22.5 feet in diameter or roughly 7 meters. NMFS used 3 different propeller sizes (4, 5, and 6 meters in diameter) in this assessment. These three propeller diameters span the middle range of expected propeller diameters. They would correspond to ships with drafts from 6.6 meters (21.7 feet) to approximately 10 meters (33 feet). Propeller pitch ratios are the ratio between the distance a fixed point on the propeller tip would move forward in one revolution of the propeller in a solid medium without any slippage and the diameter of the circle swept by the propeller wheel. Typical pitch ratios range between 0.5 and 1.5 for most propellers. Above and below these ratios, the efficiency of the propeller is very low. Power curves for several types of propellers (Man B&W 2004) show typical operating speeds of between 100 to 250 rpm for the propeller. For fixed pitch propellers with a given diameter, speed is determined by the speed of the propeller shaft. Higher revolutions of the propeller shaft will increase the speed of the ship through the water. Variable pitch propellers can alter the pitch ratio of the propeller while underway, thus increasing speed while maintaining the same shaft revolutions. NMFS assigned 2 different engine speeds to the entrainment model: 150 and 200 rpm's. Without specific data for individual ship speed with the given variables of hull efficiency and propeller efficiency, NMFS arbitrarily assigned hull speeds of 5 mph to the 150 rpm shaft speed, and 8 mph to the 200 rpm shaft speed to calculate the volume of water entrained by the different propeller sizes and pitches. NMFS designed a three (propeller diameter) by three (pitch ratio) by two (ship speed) matrix to analyze salmonid entrainment.

NMFS calculated the volume of water that is swept through the propeller disc during three legs of the transit distance between the Port of Pittsburg and the Port of Stockton; the Port of Pittsburg (RM 0) to Blind Point, Blind Point to channel marker "47" at the mouth of the South Fork of the Mokelumne River, and channel marker "47" to the Port of Stockton (RM 41). These volumes were then multiplied by the different Chinook salmon densities, as measured by the FWS during their monitoring efforts at Chipps Island, Jersey Point, and Prisoners Point (FWS 2003b; Cadrett 2005). The products of these calculations were then adjusted for slippage, a measurement of propeller performance (Man B&W 2004) and the projected rate of mortality for smolting salmonids between 85 and 250 mm in length passing through the blades of a propeller or turbine (Gloss and Wahl 1983; Holland 1986; Giorgi *et al.* 1988; Cada 1990; Dubois and Gloss 1993; Killgore *et al.* 2001; Gutreuter *et al.* 2003) to derive the number of salmon mortalities for one year's volume of ship traffic in the DWSC. NMFS used a value of 80 percent efficiency for propellers to determine slippage and a mortality value of 40 percent for fish that passed through the area of the disc swept by the propeller's blades.

Dubois and Gloss (1993) reported immediate turbine induced mortalities of 66 percent for 85 mm long threadfin shad, 16 percent for striped bass 67 to 83 mm in length and 39 percent for striped bass 136 mm in length immediately after passage through the blades of a turbine. After 24 hours, mortalities for the striped bass increased to approximately 60 to 70 percent for both size classes, indicating a significant delayed mortality effect on these fish. Gloss and Wahl (1983) reported similar results for salmonids with mortality ranging from 15 percent for salmonids 85 mm in length to over 70 percent for salmonids 280 mm in length. In this study mortality occurred quickly (75 percent of the mortality was considered instantaneous) and did not appear to have a latency period like the striped bass study. Like the previous study though, increasing length increased the risk of mortality from propeller strikes for entrained fish.

In addition to physical contact with the blades of the propeller, pressure changes and cavitation associated with the propeller also can cause mortality. Cada (1990) reviewed studies of turbine related mortality on fish and found that while pressurization and decompression from the propeller's actions may cause mortality, it is generally low, while that of the propeller's cavitation may cause upwards of 50 percent mortality in juvenile salmonids exposed to the explosive collapse of the vapor bubbles. The zone of cavitation is small for turbine blades, but is considerably larger for ship propellers, thus presenting a greater opportunity for exposure. Based on the above examples, NMFS believes that 40 percent mortality for propeller entrainment is a reasonable level to use in the modeling.

NMFS realizes that this model is crude in its estimates. The zones of effects for water entrainment by the propellers (inflow zone) are calculated only for the diameter of a given propeller along the length of the ship channel. Studies by Maynord (2000c) indicated that the inflow zone for barge tows on the Mississippi River extends slightly beyond the beam of the tow (about 20 percent wider than the beam of the tow from centerline). Therefore, NMFS calculations may be underestimating the true volume of water entrained by the ship's propeller during its transit of the DWSC. Likewise, NMFS does not have any data for potential avoidance of juvenile and adult salmonids to oncoming shipping. However, the data gathered by the FWS trawls should represent a reasonable approximation of fish density that a ship would encounter in the channel. The trawling activities involve motorized vessels dragging a net through the waters of the San Joaquin River channel, which creates a substantial disturbance within the water column. The speed of the trawl is quite slow, generally less than 5 mph, providing ample opportunity for fish to escape the net by either moving laterally or vertically in the water column. Oncoming shipping would be moving at a faster rate than the trawl vessels and would take up a considerably greater percentage of the channel's cross section (approximately 30 percent for a 90 foot wide beam). The deep draft of the commercial shipping would preclude fish from moving vertically into deeper waters to avoid the oncoming ship, and the greater beam would necessitate moving greater lateral distances to avoid the oncoming ship.

As stated by the Port, ships moving through the channel would be traveling at 8 to 10 mph (3,600 mm to 4,500 mm per second). This is equivalent to approximately 40 to 50 times the length of an average sized smolt (90 mm). A smolt located along the sailing line of a vessel would have to swim at least 18,000 mm to escape the predicted zone of inflow for a ship with a beam of 30 meters. The maximum burst swimming speed for juvenile salmonids is approximately 10 times their body length (Webb 1995) or 900 mm/sec. At maximum swimming velocity, a 90 mm smolt would take 20 seconds to cover the distance from the ship's sailing line to the outside margins of the zone of inflow. Twenty seconds is at the limit of salmonid burst swimming duration (approximately 15 seconds) and any fish that exerted this type of energetic output would be expected to be exhausted by the activity. In 20 seconds, the vessel would have moved 72,000 to 90,000 mm (72 to 90 meters or approximately one football field in length) forward along its course of travel. Any fish along the centerline of travel would have to initiate its escape response at least 100 meters ahead of the ship in order to assure its movement out of the inflow zone. Although a salmonid would easily be able to detect the ship's propulsion system at these distances, data is lacking as to the critical distances at which a salmonid would exhibit escape responses as a result of the increasing noise levels. At 100 meters in front of the bow of an oncoming ship, the propulsion unit of a ship and its propeller will be an additional 100 to 200 meters further distant from this point due to the length of the ship. Therefore the noise source as detected by the fish 100 meters in front of the ship actually would be 200 to 300 meters distant.

Fish densities, as calculated by the FWS during their salmon monitoring trawls in the San Joaquin River and at Chipps Island indicate that the relative density of fish in the river water column is quite low (Please see Appendix A: Table 10). The FWS calculated Chinook salmon densities per 10,000 m^3 of water sampled for their mid-water and Kodiak trawls. Fish densities for beach seines in different locations in the Delta were typically higher than the data from the trawls; however, this may be a reflection of the different capture efficiencies of the two methods as well as behavioral characteristics of the fish. Fish density data was presented by year, month and run-type in the FWS annual reports (FWS 2001b, 2003b) and also by total capture (Cadrett 2005). From Tables 11(a-d) in Appendix A, it is apparent that the highest mortalities are expected to occur during the winter-spring emigration period for juvenile salmonids, and are likely to occur at the western edge of the Delta. This is a reflection of the different contributions that the San Joaquin River basin stocks and Sacramento River basin stocks make to the overall fish density measurements. Further up the San Joaquin River near Jersey Point and Prisoners Point, the majority of fish are most likely from the San Joaquin River basin, although some will have Sacramento River origins due to the cross Delta flows created by the State and Federal pumping facilities in the south Delta. In order to account for this, NMFS weighted fish densities from the available data for Chipps Island and the San Joaquin River sites and extrapolated fish densities at the San Joaquin River sites for months in which sampling did not occur on the San Joaquin River. The fish densities for each reach were then used to calculate the expected rate of entrainment for each river segment over a 1-year period.

The projected entrainment values for Chinook salmon on the San Joaquin River due to the increased shipping activity represent a substantial adverse effect on this population of fish. Sacramento River winter-run Chinook salmon will encounter annual entrainment mortalities in the lower segment of the San Joaquin River between Blind Point and the Port of Pittsburg ranging between 443 fish (*i.e.*, assuming an 8 mph transit with a 4 meter propeller and a pitch ratio of 0.5) to almost 5,400 fish (*i.e.* assuming an 5 mph transit with a 6 meter propeller and a pitch ratio of 1.5). Central Valley spring-run and fall-run Chinook salmon will have a combined estimated mortality rate of nearly 33,000 fish to almost 400,000 fish under the same two scenarios, respectively. Also, in the upstream portions of the San Joaquin River between Blind Point and the Port an additional 11,000 fish to approximately 111,000 fall-/spring-run Chinook salmon will be entrained using the same two scenarios described above.

In order to approximate the entrainment of steelhead smolts in the San Joaquin River, a rough rule of thumb for the ratio between Chinook salmon captured in trawls and steelhead captured is 1000 Chinook salmon to 1 steelhead (D. Marston, CDFG 2004). Due to the lack of specific density data for steelhead due to their rare level of capture in trawls, NMFS uses this as a "best guess" estimate for deriving the impacts to steelhead in the DWSC. Therefore, the best estimate NMFS can make for steelhead is a range of 40 to 500 steelhead smolts on an annual basis for the expected increase in shipping traffic using the two scenarios described above. The confidence in this range is low based on the different swimming characteristics between smaller Chinook salmon smolts and larger steelhead smolts. Although larger steelhead smolts should be able to avoid the passage of ships more readily than Chinook salmon smolts, those that do encounter the propellers will have a much higher mortality rate than the smaller salmon smolts, as indicated by the results of previous turbine mortality studies (Gloss and Wahl 1983; Dubois and Gloss 1993).

(6) ***Shipping Noise***. Ships under power produce a substantial amount of mechanical and flow induced noise from the power plant, propeller, and hull turbulence. Measurements of sound intensity from commercial shipping have shown levels of 180 dB (ref. 1 µPa) at the point source. This level of noise can damage sensory hairs in a fish's inner ears as previously described in this opinion. Behavioral changes and loss of hearing sensitivity have been documented in some fish species at sound levels above 145 dB. The narrow confines of the channel would indicate that the excessive noise levels generated by the passage of a commercial vessel would extend essentially from bank to bank in the DWSC, thus subjecting all fish within the confines of the channel to adverse noise conditions. The rapid passage of the ship past a given point will somewhat attenuate the adverse effects by decreasing the duration of the intense sound levels, but some temporary and permanent effects can be anticipated to occur, depending on the proximity of the exposed fish to the sound source.

As stated previously for dredging associated noises, the loss of hearing sensitivity may adversely affect a salmonid's ability to orient itself (*i.e.*, due to vestibular damage), detect predators, locate prey, or sense their acoustic environment. Fish also may exhibit noise-induced avoidance behavior that causes them to move into less suitable habitat. In the proposed action, this may result in salmonids fleeing the shipping associated noises and moving into the channel's shallowest margins. In the delta, the channel margins have characteristics such as submerged and emergent vegetation (*e.g. Egeria*) and rock rip-rapped levees where predators such as largemouth bass and sunfish are likely to occur in greater numbers than the nearshore waters. This scenario increases the smolts exposure to predation by these piscine predators. Likewise, chronic noise exposure can reduce their ability to detect piscine predators either by reducing the sensitivity of the auditory response in the exposed salmonid or masking the noise of an approaching predator.

b. Effects of Upland Actions

(1) *Stormwater Discharge.* The Port has proposed an extensive redevelopment of the 1,500 acre Rough and Ready Island parcel described in section II. NMFS believes that the primary impact associated with the upland portion of the redevelopment plan will be the increase in stormwater associated pollution being discharged to the waters of the San Joaquin River and Burns Cutoff.

The build out of the Port development will convert approximately 1,500 acres of current mixed use land to industrial development. This is expected to increase the relative percentage of impervious surface within the action area. The 2000 Maryland Stormwater Design Manual (Maryland Department of the Environment [MDE] 2000) states:

"*development dramatically alters the local hydrologic cycle. The hydrology of a site changes during the initial clearing and grading that occur during construction. Trees, meadow grasses, and agricultural crops that had intercepted and absorbed rainfall are removed and natural depressions that had temporarily ponded water are graded to a uniform slope. Cleared and graded sites erode, are often severely compacted, and can no longer prevent rainfall from being rapidly converted into stormwater runoff.*"

As the impervious surface area increases, the time to peak flow in the region's watershed following a rain event decreases, hence, less recharge of the groundwater occurs in the affected area. As the infiltration rates of rainwater into the aquifer decrease, groundwater flows to streambeds likewise decrease, and stream base flow diminishes during the dry periods compared to an undisturbed watershed. The increase in surface flow over the impervious area results in an increase in pollutant concentrations in the runoff. The California Department of Transportation (Caltrans) has indicated that the following classes of pollutants typically increased in watersheds with an increase in urbanization and impervious surface area (Caltrans 2003; see Table 12 in Appendix A for additional information):

- Total suspended solids,
- Nutrients (phosphorus and nitrogen compounds),
- Pesticides and herbicides,
- Particulate metals,
- Dissolved metals,
- Pathogens (bacteria and viruses),
- Litter and rubbish,
- Biological and chemical oxygen demand, and
- Total dissolved solids,

In a typical urbanized watershed, the decline in the physical habitat, coupled with lower base flows and higher stormwater pollutant loads, results in severe impacts to the health and structure of the aquatic community. Recent studies have indicated that the following general changes in aquatic ecology occur following urbanization of a watershed (MDE 2000; Stormwater Center 2003):

- decline in aquatic insect and freshwater invertebrate diversity,
- decline in fish diversity, and
- degradation of aquatic habitat

A major component of urban stormwater runoff contamination comes from vehicular use of roadways and the subsequent deposition of toxic compounds upon the roadway from car emissions, brake linings, and lubrication fluids. The increased density of commercial businesses and increased Port activities for the proposed West Complex redevelopment will substantially increase both vehicular and rail traffic within the project area. Currently, vehicular access to the West Complex site is along one road, Navy Boulevard, which carries 2,704 vehicle trips per day. Following completion of the development, traffic is expected to increase by nearly 51,000 additional trips per day on the project area’s roadways by 2020, which includes an alternative route into the West Complex from the south along the new Dagget Road Bridge over Burns Cutoff. The “no project” projections for traffic volume are approximately 6,000 trips less (Environmental Science Associates 2003) for the same time period, a reduction of approximately 12 percent over the full project development. Substantial amounts of sediment and pollutants are generated during daily roadway use, scheduled repair, and maintenance operations. These pollutants threaten local water quality by contributing heavy metals, hydrocarbons, sediment, and debris to stormwater runoff that typically enters local and regional waterways. In California, the highly toxic “first flush” events that correspond to the first rainfall after a period of dry weather carry the accumulated contaminants on the roadbed into the nearest watercourse. Table 13 (Appendix A) indicates some of the more typical contaminants that can be found in highway runoff and their primary sources (Stormwater Center 2003).

There are numerous engineering and management techniques currently employed across the country to avoid or minimize the degradative effects of urban stormwater runoff. Planning manuals have been developed by several states and municipalities that address the design and construction of suitable stormwater management trains that control and remove the potential contaminants from the stormwater waste stream before they enter into natural water courses (MDE 2000; Caltrans 2003).

The removal efficiencies of different urban stormwater BMPs have been compiled in a national database (Brown and Schueler 1997), which indicates that vegetated swales are fairly efficient in removing total suspended solids (TSS) from the stormwater effluent (81 percent), but perform poorly for total (34 percent) and soluble (38 percent) phosphorus, and for nitrate and nitrite-nitrogen (31 percent) carried in the stormwater stream. Vegetated swales also removed about half of the metals and hydrocarbons in the effluent, but tended to remove lower proportions of soluble metals than particulate metals. Interestingly, vegetated swales tend to export bacteria to their receiving waters rather than reducing the bacterial load of the incoming stormwater. The Port has indicated that they will adaptively manage their proposed BMPs to ensure that they perform as anticipated. Should any of the BMPs fail to meet expectations, then they shall be redesigned, or new BMPs implemented, to achieve the expected result.

The Port is currently defined as a “bulk port” which differs from a “container port” in that the materials transported to and from the Port are in mass quantities and generally are unconfined. For example, tenants at the Port unload large amounts of elemental sulfur and store it in large, free-standing piles. Other bulk goods transferred at the Port include, but are not limited to, coal, lumber, sweetener, anhydrous ammonia, fertilizer, and produce. Other industrial activities in the action area include, but are not limited to, salvage operations, manufacturing, and power generation. The current operations typically are exposed to the elements and are mobilized into storm runoff from their storage areas or from the unloading docks. The current level of stormwater contamination from the break bulk operations is expected to continue into the future as bulk operations are expected to continue at levels equivalent to current operational levels. The proposed project, however, will include new activities more indicative of a container port. The materials associated with containerized shipping have different pollutant potentials, with particular input from increased trucking traffic or rail traffic to move the containerized materials. This new source of contaminants will be in addition to the already existing sources of contaminants from the bulk operations.

The current Port monitoring plan for stormwater pollution requires three wet-season water samples as mandated by their present discharge permit, with one being the first significant rainfall event of the year. Monitors are required to be available to collect discharge water samples from 7 am to 5 pm, Monday through Friday. The turn around time for chemical analysis of the collected water samples is several days to weeks. If a contaminated water sample is found, the Port's plan indicates that at the next monitored rain event, the Port's monitors would try to identify the source of the contaminant, if possible, by tracking the inflow to the discharge points back upstream to its source and testing for contamination. The present system does not allow the prevention of a second contaminated discharge while the inflows are being tested.

Due to the assimilation capacity of the DWSC, effects to salmonids primarily are expected to be sublethal in nature. Substantial dilution would occur in the Delta waterways surrounding the action area; reducing contaminants from potentially acutely toxic levels in the stormwater discharge to less than acutely toxic in the channel itself. For instance heavy metals, petroleum based contaminants, or organic debris are expected to be carried off of the West Complex site into the channel, where the volume of the stormwater discharge will be diluted by several orders of magnitude in the larger volume of the river. However, these compounds can be expected to adversely affect water quality even upon dilution. Even at sublethal concentrations, contaminants from industrial and urbanized watersheds can negatively impact the health of exposed salmonids: organic matter can lower DO (via bacterial decomposition), heavy metals and pesticides can affect neurological pathways, petroleum products and detergents can alter endocrine function, and PAHs can cause cancer by activating oncogenes or forming DNA adducts in aquatic organisms. Individual salmonids exposed to these conditions have a higher likelihood of developing physiological conditions that adversely affect their long-term health and survival,

(2) ***Sanitary Sewer System.*** The Port has indicated that the West Complex's sanitary sewer system currently suffers from infiltration problems. Leakage of untreated sanitary sewer system discharges into the groundwater may provide an avenue for contamination of surrounding surface waters, particularly in regards to the stormwater retention basins that are currently below sea level at their basin invert elevations. There is continuity between surface and groundwater at soil surface elevations at or below sea level throughout the Delta which requires groundwater

water seepage to be actively pumped from these low lying areas (*i.e.*, unlined retention basins) to prevent ponding. This effluent is typically discharged to the surrounding Delta waterways.

Untreated sewage typically carries several inorganic and organic chemical contaminants (ammonia, nitrogenous compounds, salts, detergents, *etc*.) as well as biological contaminants such as bacteria and viruses. These contaminants can have substantial adverse effects upon aquatic organisms exposed to the untreated discharge. Until the sanitary sewer infiltration problem is fixed, the increased population projected to occur due to employment by the West Complex buildout will only exacerbate the groundwater contamination issue due to the greater number of sanitary hookups to the sewer system and the increased sanitary water volume. Although this contamination of groundwater is expected to occur year round, NMFS expects it to be elevated during the rainy season due to the elevated groundwater table and subsequent increased seepage into low lying areas within the project area. This additional water volume, which is subsequently pumped off of the West Complex into the Delta, serves as a vector to carry sewage contaminants into the San Joaquin River aquatic ecosystem. The period of this elevated discharge corresponds to the time period when central Valley steelhead smolts are emigrating downstream past the West Complex due to increased precipitation driven flows in the San Joaquin River basin tributaries.

(3) ***Electrical System Renovation.*** The renovation of the West Complex's old electrical system poses threats to the surrounding surface and ground water resources. The electrical circuit on the former Navy base dates back to the mid-1960s. Old electrical transformers frequently used poly chlorinated biphenyl (PCB) oils as coolants in the transformers. Usage of PCBs in transformers was discontinued in 1977 when it became evident that these compounds built up in the environment and had severe health effects on different organisms that were exposed to the compound (EPA 2004). PCBs have been linked to increased levels of cancer, dermatological irritation, immunotoxicity, reproductive toxicity, neurological effects, and endocrine effects in several different species of organisms, including salmonids, following exposure to this class of chemicals (Spacie *et al*. 1995).

PCBs are long-lived contaminants that are not readily degraded in natural systems and thus can persist for long periods of time after their initial discharge into the environment. They also have a high propensity to bioaccumulate in organisms and subsequently bioconcentrate in higher trophic organisms, such as steelhead, that feed upon contaminated forage species. Body burdens can reach high levels, frequently several orders of magnitude above the environmental concentrations. NMFS anticipates that leakage of this oil during the demolition and removal of the old electrical circuit has the potential to lead to surface soil contamination, and hence surface water contamination during the rainy season as suspended sediments are washed into surrounding water bodies or into the stormwater collection system. The period of this elevated stormwater discharge corresponds to the time period when central Valley steelhead smolts are emigrating downstream past the West Complex due to the increased precipitation driven flows in the basin tributaries. Individual fish have the potential to incorporate the PCBs either through direct contact with the compound via the gills or gastrointestinal tract, or from ingested contaminated prey species.

(4) ***Upland Demolition and Construction.*** The demolition and removal of old structures, some of which may contain high levels of asbestos, lead in paints, and other contaminants, may contribute to substantial site contamination. These compounds, as well as others commonly used in the building trades in the 1950s and 1960s (*i.e*. mercury in electrical switches and fluorescent light ballasts), can enter the environment through dust, spills, or debris lost to the site during demolition. Ground and rain water can carry these compounds directly into surrounding water bodies via sheetflow or indirectly through effluent discharges from stormwater collection facilities. The introduction of these contaminants can have substantial adverse effects upon the aquatic environment. Construction can also increase the amount of silt that can be discharged into surrounding water bodies during rain events if proper BMPs are not employed to control and retain sediment laden runoff. The Port has stated that they will require standard construction BMPs to be employed in all West Complex development and that these will comply with standards set by the State Board in their permitting process (Environmental Science Associates 2004).

NMFS anticipates that contaminants related to upland demolition and construction will be introduced to the aquatic system during the rainy winter months as a result of precipitation driven discharge events. It is also during this period when Central Valley steelhead smolts are moving downstream past the West Complex on their migration to the ocean, thus placing them at risk for exposure to these compounds. Individual fish may experience different adverse health effects to these contaminants, depending upon their exposure histories. The longer a fish is exposed to these contaminants, or is subjected to a concentrated first flush event, the more likely the exposure will result in adverse health effects.

VI. CUMULATIVE EFFECTS

For purposes of the ESA, cumulative effects are defined as the 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 consultations pursuant to section 7 of the ESA.

Non-Federal actions that may affect the action area include ongoing agricultural activities and increased urbanization. Agricultural practices in the Delta may adversely affect riparian and wetland habitats through upland modifications of the watershed that lead to increased siltation or reductions in water flow in stream channels flowing into the Delta. Unscreened agricultural diversions throughout the Delta entrain fish including juvenile salmonids. Grazing activities from dairy and cattle operations can degrade or reduce suitable critical habitat for listed salmonids by increasing erosion and sedimentation as well as introducing nitrogen, ammonia, and other nutrients into the watershed, which then flow into the receiving waters of the Delta. Stormwater and irrigation discharges related to both agricultural and urban activities contain numerous pesticides and herbicides that may adversely affect salmonid reproductive success and survival rates (Dubrovsky *et al.* 1998, 2000; Daughton 2003).

The Delta and East Bay regions, which include portions of Contra Costa, Alameda, Sacramento, San Joaquin, Solano, Stanislaus and Yolo counties, are expected to increase in population by nearly 3 million people by the year 2020 (California Commercial, Industrial and Residential Real Estate Services Directory 2002). Increases in urbanization and housing developments can impact habitat by altering watershed characteristics, and changing both water use and stormwater runoff patterns. The project site is within the region controlled by San Joaquin County Council of Governments. The General Plans for the City of Stockton and surrounding communities anticipate rapid growth for several decades to come. The anticipated growth will occur along both the I-5 and US-99 transit corridors.

Increased urbanization also is expected to result in increased wave action and propeller wash in Delta waterways due to increased recreational boating activity. This potentially will degrade riparian and wetland habitat by eroding channel banks and mid-channel islands, thereby causing an increase in siltation and turbidity. Wakes and propeller wash also churn up benthic sediments thereby potentially resuspending contaminated sediments and degrading areas of submerged vegetation. This in turn would reduce habitat quality for the invertebrate forage base required for the survival of juvenile salmonids. Increased recreational boat operation in the Delta is anticipated to result in more contamination from the operation of engines on powered craft entering the water bodies of the Delta.

VII. INTEGRATION AND SYNTHESIS

A. Dredging

The short-term effects of the proposed project are expected from dredging the West Complex waterfront adjacent to docks 14-20 and the shoreline from dock 20 westward to the Burns Cutoff confluence. The dredging will introduce approximately 1,200 to 4,400 cy of sediment into the water column during the dredging activities. This amount will be equivalent to an increase of 2.4 mg/L of TSS over the ambient level of 24 mg/L (an increase of approximately 10 percent of ambient). NMFS does not consider this to be a substantial increase over already low background turbidity and should not have any adverse effects upon listed salmonids in the project area due to turbidity levels. As previously stated, turbidity levels in excess of 4,000 mg/L are needed to elicit the “cough response” in salmonids (Nightingale and Simenstad 2001) and the current turbidity levels are substantially less than this.

In contrast, the contaminants associated with the dredge materials may adversely affect exposed aquatic organisms. Of the several contaminants identified in the sediment only copper and ammonia are sufficiently elevated to pose a direct risk to migrating salmonids in the DWSC. Both the copper and ammonia constituents are expected to exceed the in-stream water quality criteria protective of aquatic organisms for the Basin Plan or recommended sediment quality guidelines (Buchman 1999; MacDonald *et al.* 2000). The other levels of contaminants present in the sediment may not always exceed the acute toxicity concentrations or the different water and sediment quality guidelines, but their elevated concentrations do present an increased risk to the health of exposed salmonids.

In general, the adverse impacts to steelhead in the DWSC will be substantially attenuated by the work window proposed by the Port. Dredging activities are to be restricted to the period between June 1 and December 31. This work window will avoid the majority of steelhead migration through the DWSC adjacent to the West Complex. In this area, adult and juvenile steelhead are expected to be exposed primarily during November and December, when cool and rainy weather is likely to promote migration. The following sections describe the impacts to adult and juvenile steelhead more thoroughly.

1. Adult Central Valley Steelhead

Adult Central Valley steelhead may be present within the action area during the period between September and December, with most fish passing through the region between November and December. During this period, dredging operations will resuspend sediments and expose new sediment horizons that are contaminated with chemicals of concern (COCs). This situation will cause the adult steelhead in the area to be exposed to the COCs, leading to increased levels of external stressors. These elevated stressors may degrade the fish’s health and its reproductive potential.

Since the populations of adult steelhead that migrate into the Calaveras and San Joaquin Rivers are quite small, even the loss of a few adult fish may have substantial adverse effects on juvenile age class sizes in succeeding years. Estimates of adult escapement of steelhead to these watersheds are typically only a few dozen or so. This is reflected by the low number of smolts captured by monitoring activities throughout the year in different tributaries (*i.e.* rotary screw traps on the Stanislaus, Tuolumne, Merced and Calaveras Rivers and the Mossdale trawls on the San Joaquin River below the confluence of the three east side tributaries) in which only a few dozen smolts to several hundred smolts are collected each year (Marston 2004; S.P. Cramer 2005). These capture numbers are extrapolated to estimate an annual population of only a few thousand juvenile steelhead smolts basinwide in the San Joaquin River region. The Stanislaus weir, which is used to count adult steelhead passing through the counting chamber or dead carcasses floating back onto the weir, has only recorded a few adult fish each year it has been in use. This is indicative of the low escapement numbers for adult steelhead in this watershed (S.P. Cramer 2005). The other watersheds are thought to have similar or even lower numbers based on the superiority of the Stanislaus River in terms of habitat and water quality for Central Valley steelhead.

Even though the loss of a few steelhead adults on either the San Joaquin River or Calaveras River watersheds would have significant impacts to future juvenile steelhead year classes in these systems, the overall impact to the Central Valley steelhead ESU population would be minimal. This is due to the relatively small contribution that these watersheds make to the entire ESU. Straying of adults from other watersheds may help to sustain these small runs over the long term.

2. Juvenile Central Valley Steelhead

The potential loss or adverse health effects resulting from exposure of early and late migrating fish (September through December and June) to copper and ammonia will impact the returning escapement numbers of adult steelhead two years hence. Due to the small size of the Central Valley steelhead populations in the Calaveras River and San Joaquin River tributaries, any additional increase in the juvenile mortality rates may reduce the numbers of emigrating juveniles below that required to sustain these watershed populations over the long term.

As described for adults, the San Joaquin River basin steelhead population does not contribute substantially to the overall Central Valley steelhead population. Therefore, loss of juveniles with San Joaquin River basin origins will not substantially affect the entire Central Valley ESU for this species. It is likely that the reproductive potential represented by juveniles lost to the dredging activities would be compensated by straying steelhead adults from other watersheds in the Central Valley.

B. Dredge Material Disposal Site

The DMD site presents several avenues to adversely impact both adult and juvenile Central Valley steelhead. As previously described in the effects analysis, the decant waters from the DMD site have the potential to contain elevated levels of heavy metals and ammonia, as well as endosulan II, an organochlorine pesticide. In addition, the groundwaters surrounding the DMD site may become contaminated with COCs from the dredge spoils and migrate to the agricultural return ditches on Roberts Island.

1. Adult Steelhead

Adult steelhead can encounter the plume of decant water returning to the main channel of the San Joaquin River for weeks to months after the dredging activities end, depending on weather and rainfall. As mentioned previously, this decant water plume may contain elevated levels of heavy metals, ammonia, and endosulfan II. Heavy metals can adversely affect the fish’s ability to navigate to its natal stream by impairing olfactory response (copper) and neurological activities (several different metals and endosulfan II). Other physiological processes can be impaired following metal exposure including reproductive performance and fertility. The level of exposure is complicated by the movement of the adult fish through the plume, the concentration of COCs in the plume, and the duration of the fish’s exposure to the plume.

The decant waters are not expected to be experienced by all migrating adult steelhead to the same degree due to the temporal and spatial variances of the swim path of the fish and the location of the discharge plume. Fish that migrate near the riverbank will be more likely than fish in the middle of the channel to encounter the discharge plume during their upstream movements. Likewise fish that move during periods of discharge will have the potential to encounter the discharge plume compared to fish that move through the river system when there is no discharge. The loss of one individual female fish’s reproductive capacity either through mortality or reproductive failure related to toxicant exposure can have a relatively high impact on a given watershed’s potential population due to the low number of adults returning to each stream. Loss of one female with an expected egg capacity of 5,000 eggs represents approximately 50 to 100 smolts returning to the ocean (NMFS 2003).

As described previously for dredging impacts, loss of adult fish from the Calaveras and San Joaquin River systems does not represent a substantial effect upon the Central Valley steelhead ESU as a whole. The populations in these watersheds comprise only a minor fraction of the entire Central Valley population of steelhead.

2. Juvenile Steelhead

Juvenile steelhead migrating downstream may encounter the decant water plume, particularly if they remain tight to the south bank of the channel. The juveniles can experience the same adverse effects as the adults, as well as the increased potential of predation by striped bass or other large predators due to impaired behavioral and physiological responses. Individuals that appear different in their behavior attract predators, and thus experience higher mortality due to predator attacks. Long-term effects ranging from cancer to reduced reproductive capacity can result in response to heavy metal exposures. Prolonged exposure, as would occur in low-flow conditions when residence time in the DWSC is measured in days to weeks, would enhance the potential uptake of metals and other contaminants from the environment and increase the long-term effects in exposed juveniles.

As described for the adult steelhead previously, impacts to juvenile steelhead would occur predominantly on an individual scale. This reflects the spatial and temporal heterogeneity of the juvenile steelhead emigration behavior. The juvenile steelhead tend to emigrate in pulses, based on behavioral and hydrological cues in their natal streams. As they migrate downstream, they tend to disperse along the channel length and width much more so than do juvenile Chinook salmon. Exposure levels to contaminants are therefore difficult to ascertain, as the juvenile steelhead may encounter the contaminants from the dredge decant waters for varying times and with different hydrology (tides, river flows, *etc*.) which can greatly influence the exposure concentration and the duration of exposure.

However, like adult fish, it does not take a large number of juveniles to be adversely impacted by contaminant exposures to have a negative impact on the future populations of Calaveras River and San Joaquin River tributary populations. The populations of these watersheds are sufficiently depressed that losses of even a few fish could mean that insufficient numbers of individuals will return as adults to continue a viable population of steelhead in these waters.

As described previously for dredging impacts, loss of juvenile fish from the Calaveras and San Joaquin River systems does not represent a substantial effect upon the Central Valley steelhead ESU as a whole. The populations in these watersheds comprise only a minor fraction of the entire Central Valley population of steelhead and the numbers of juveniles contributed by these watersheds are small.

C. Dredge Entrainment

The hydraulic suction head of the dredge creates a zone of inflow around the cutterhead of the dredge. Animals that venture too close to the cutterhead have the potential to be entrained into the suction pipeline of the dredge and carried to the DMD site on shore. As described previously, the Port has indicated that dredging will take place between June 1 and December 31 to avoid the majority of listed salmonids in the DWSC. The dredge will be operated 20 feet below the water surface, with the hydraulic suction and cutterhead operating only in the bottom substrate. The cutterhead may be raised briefly to clear obstructions, but never more than three feet above the substrate. NMFS believe these measures to be sufficiently protective of salmonids that may be within the dredging area. NMFS calculated that the velocity of the inflow water surrounding the orifice of the dredge head is below the critical burst swimming speed of juvenile salmonids, even within 0.5 meters of the cutterhead. Therefore, even if a juvenile salmonid were in close proximity to the cutterhead at the 20 foot depth, which is not likely, the fish would still be able to escape the inflow zone of the dredge and avoid entrainment. It is NMFS' position that fish entrainment by the hydraulic dredging in this project scenario represents a very unlikely source of take due to the timing of dredging, the depth, and the flow fields around this particular dredging operation. In order for entrainment of steelhead (or other salmonids) to occur, the fish would have to be concentrated around the dredge head or the dredge operated at water depths where the salmonids would normally be aggregated.

NMFS believes that the dredging action will remove benthic invertebrates from the nearshore environment adjacent to the docks and levee along the north shore of the West Complex, which represents a loss of forage base to outmigrating steelhead. The time needed to recolonize the dredged area is unknown and is complicated by the maintenance dredging cycle of 2.5 years that may preclude a "natural climax" benthic invertebrate assemblage to re-establish itself. However, outmigrating steelhead should be able to find alternative foods and foraging areas, and are not likely to be adversely affected by the disturbance of approximately 33 acres of benthic habitat.

D. Acoustic Impacts of Dredging

The range of elevated noise around the dredging equipment may cause temporary behavioral or loss of hearing to affected fish. These impacts will be partially mitigated by the seasonal use of the equipment. The primary impact to salmonids will be to adults migrating upstream during the fall while dredging operations are being conducted. As projected by the Port, the dredging activities will be conducted until the end of December, and at a frequency of about every two and half years (initial and maintenance dredging). Migrating adult salmonids may be forced to avoid the elevated noise of the dredging operations by swimming to the opposite side of the DWSC or holding until there is a break in the dredging actions. There is a potential for these fish to suffer a temporary loss of hearing sensitivity at the expected noise levels generated by the dredge. It is not anticipated that a significant number of juveniles will be impacted as the primary migration period will occur after the cessation of dredging activities. However, if dredging is extended past December, increasing numbers of juveniles will be present in the channel and increased levels of fish will be affected by the adverse noise conditions related to dredging activities. Loss of hearing sensitivities in the juvenile fish will expose them to higher risks of predation. Fish with impacted hearing capacities will have a lower ability to detect predators and may be unable to maintain position in the water column (inner ear equilibrium factors).

E. Bathymetry Changes

The changes to the bathymetry of the DWSC and the berths along the north shore of the West Complex are considered long-term changes under the current uses of the Port. Routine maintenance dredging will prevent future shoaling and continue to remove and expose new horizons of sediment. The bathymetry changes will perpetuate the conditions which currently contribute to the degraded water quality in the DWSC. The deepened DWSC will act as a collecting basin for materials carried along by the flow of the San Joaquin River above Channel Point. Furthermore, the expansion of the cross-sectional area of the channel will increase its relative volume compared to current conditions, and thus is expected to further slow down the flushing velocity of the ambient river flow, and allow suspended material to settle out of the water column. The calculated volume increase is on the order of 15 to 18 percent within the project area, and the residence time for water in this reach is expected to increase in a corresponding manner.

The current water quality conditions in the DWSC between the Port and Turner Cut downstream are predominated by a severe low DO condition during low flow conditions. As indicated in Table 4 (Appendix A), there are frequent depressions below the 5 mg/L DO water quality criteria during the period when steelhead migrate through the DWSC adjacent to the West Complex. These conditions will continue into the future under current operations and NMFS anticipates that they will be exacerbated by the increased channel volume and shipping activities. Although the Port has indicated that they intend to operate an aerator in the channel at Channel Point to offset some of this DO depression, their data indicates that the effectiveness of this aerator to enhance DO levels in the channel may be limited. The range to which demonstrable increases in DO levels can be measured is less than 15 meters (approximately 50 feet) from the aerator itself. Salmonids passing close the aerator could benefit from increased DO, but NMFS believes that it is not likely to have a measurable effect at the dredging site along the West Complex waterfront (approximately 1 mile away), nor will it measurably improve the DO-impaired reach of the DWSC downstream of the dredging site. Also, the aerator at Channel Point could serve to concentrate juvenile salmonids, which may attract predators. Overall, the low DO conditions in the main channel are expected to continue to serve as a deterrent to both upstream and downstream migration.

F. Shipping Impacts

NMFS considers that the majority of adverse impacts related to the West Complex redevelopment project will be related to the increase in shipping traffic resulting from the increase of deep water berthing space along the DWSC. The Port has indicated in their EIR and in their BA that shipping traffic is expected to approximately double at the West Complex following the redevelopment of the Port facilities and renewed access to deep water berths.

1. Shipping Related Changes in Channel Hydrodynamics

The passage of large hulled ships through the confines of the DWSC will create hydrodynamic forces on the channel’s sides and bottoms which are expected to adversely affect Sacramento River winter-run Chinook salmon, Central Valley spring-run Chinook salmon and Central Valley steelhead along the length of the channel. Shear forces generated by the movement of the hull through the water will create turbulent flows along the length of the hull. These forces may exceed the threshold at which physical damage can occur to the tissues of the exposed salmonids causing both sublethal and lethal internal injuries. In addition to these obvious physical injuries, the turbulent flow can cause disorientation and erratic swimming behavior following exposure. This can elevate the susceptibility of smaller fish to predation by larger piscivorous fish in the channel, such as striped bass and largemouth bass.

In addition to the turbulent flow along the hull, effects such as bank drawdown and transverse wakes can cause adverse effects in the wake of the ship's passage. The drawdown and following transverse wake can cause issues of stranding where bottom configurations accentuate these physical aspects of the ship's passage. Although studies on the Mississippi and Columbia River systems showed stranding to be a minor impact following ship passage, those river systems predominantly had soft, sloping banks in the study areas. The configuration of the Delta's rock rip-rapped banks may have different results for stranding.

Due to the complex interaction of the ship's hull characteristics, channel geometry, and distance away from the ship's passage, direct enumeration of fish impacted by the passage of the hull through the water is difficult to state. The Port has estimated that on average there will be one ship a day traversing the DWSC on its way to the Port. The period of time it takes for a salmonid to make the journey from the Port to Chipps Island may range from several days to several weeks, with each day spent in the system seeing an average of one ship pass. Therefore, NMFS believes that each fish utilizing the San Joaquin River as a migration corridor will be subjected to numerous ship passages during its migration through the system, whether it is a juvenile or an adult.

In addition to the direct impacts of the hydrodynamic forces on the exposed fish, the passage of vessels through the ship channel will cause substantial resuspension of bottom sediments. As has been previously stated, these sediments, particularly near the Port, are contaminated with several different COCs. The continual bottom disturbance by hull turbulence and propeller jets increases the exposure of these chemicals to the water column, where their presence will impact fish moving through the channel. Furthermore, the suspension of this predominately fine organic material from the bottom will decrease the amount of oxygen in the water column through oxidative processes, both biological and chemical in nature. This will continue to exacerbate the low DO conditions in the DWSC as reduced material is oxidized. This process may also enhance the toxicity of contaminants, as their valence state changes. This condition will be chronic, based on the average of one ship passage per day and the settling rate of this fine particulate matter.

2. Shipping-Related Pollution

The increase in shipping will have a concomitant increase in shipping-related pollution. By doubling the shipping traffic in the DWSC, the rate of pollution related to discharges, spills, or other avenues related to shipping is expected to increase at the same rate. As previously stated, all salmonids making use of the San Joaquin River as a migratory avenue will be subjected to several ship passages during their time in the channel. The heaviest concentration of ship-related pollution is expected to occur within the Port itself, where ships are berthed for extended periods and flushing flows are reduced. This will primarily affect Central Valley steelhead from both the Calaveras River and San Joaquin River watersheds. Sacramento River winter-run and Central Valley spring-run Chinook salmon, as well as Central Valley steelhead originating from the

Sacramento River watershed, will be exposed to pollutants originating from ships in transit along the San Joaquin River further downstream from the Port. All fish within the DWSC will be exposed to some level of these pollutants, although not all fish will experience morbidity or mortality.

Since shipping occurs year round in the Port, both juveniles and adults of the different ESUs will be exposed to the increase in ship-based pollutants. For those fish that survive the immediate pollutant exposure, effects from pollutant exposures may manifest themselves at a later time, after fish have moved out of the DWSC and are apparently “safe” from the pollutants. An example of this pathology is the increased mortality due to viral and bacterial infections (*e.g.*, *vibrio*) in salmon smolts entering the ocean, which have reduced immune responses due to their previous exposure to petroleum products or other pollutants in the estuaries of their natal watersheds (Arkoosh 1998, 2001). These elevated mortality rates were discernible several weeks after the smolts entered the marine environment.

4. Propeller Entrainment

Based on the modeling projections made by NMFS, the increase in shipping traffic in the DWSC could increase mortality of Sacramento River winter-run Chinook salmon juveniles by approximately 450 fish to over 5,000 fish, depending on the size and speed of the ship. Likewise, the combined grouping of juveniles from the Central Valley fall- and spring-run Chinook salmon ESUs could experience additional mortalities ranging from 44,000 fish to 500,000 fish for the projected increases in ship traffic. Based on the relative sizes of the outmigrant populations, NMFS expects approximately 1 percent of these to be spring-run fish. Using the hypothesized ratio of Chinook salmon density to steelhead density in the Delta’s fish monitoring studies, the additional loss of steelhead smolts to propeller entrainment could range from 40 to 500 additional fish in the DWSC.

These take estimates are very conservative as they do not take into account the total zone of inflow around the ship created by the propeller’s pull, nor do they take into account the multiple times a given fish may be exposed to shipping traffic while in the DWSC. In addition, any disorienting effects on the fish’s swimming ability resulting from the turbulent flow fields around the hull or in the propeller wash are not considered. It is reasonable to conclude that additional fish may fall prey to predators after becoming disoriented in the flow fields surrounding the ships.

While the above calculations concern juvenile fish and smolts, adult fish also may suffer injury or mortality from the passage of ships and interactions with the ship’s propellers. Recent discussions with CDFG staff have indicated that adult sturgeon have been recovered with obvious propeller scars, some resulting in death, during fish monitoring surveys (Gingras 2005). These incidents occurred immediately following the passage of large ocean going ships in the San Joaquin River channel.

5. Shipping Noise

The passage of ships within the confines of the DWSC will expose migrating salmonids to excessive levels of underwater acoustic noise. Measurements of ocean-going ships, such as use the DWSC, have indicated that the underwater noise produced by these ships can reach or exceed 180 dB (reference 1 µPa) at the source. This level of noise is sufficient to cause internal inner ear injuries (*e.g.*, ablation of sensory hairs) that appear permanent in nature in other fish species examined (*e.g.*, red snapper). The loss of these sensory hairs reduces the fish's ability to react to the acoustic environment around it, which will reduce its ability to react to predators and prey. The width of the DWSC for the majority of its length is narrow enough to preclude avoidance of the increased noise levels emanating from the ship, thus all fish migrating through the DWSC that encounter a ship passing through the channel will be exposed to potentially damaging noise levels. Listed salmonids passing through the DWSC may encounter several ocean going ships (based on one ship per day traffic) on a multi-day journey through the Delta. Given a channel width of 200 meters (approximately 650 feet) the sound pressure level at each bank will be approximately 140 dB, which is in the range to at least cause behavioral modifications and temporary loss of hearing sensitivities. This acoustic noise level is in addition to the "normal" recreational boating noise generated by personal vessels in the DWSC. The combined level of sound input to the DWSC would indicate that migrating fish are subject to a continual barrage of high-energy noise during their entire migratory passage through the DWSC from both shipping and recreational vessels. The cumulative impacts of this condition may lead to reduced physiological status in the exposed fish based on the stressful nature of chronic noise input.

G. Stormwater Discharge

The increased impervious surface area resulting from the development of the West Complex will increase the volume of surface runoff from the complex during precipitation events. This stormwater will carry contaminants from the industrialized area of the island into the stormwater collection system. Most of the runoff will be collected in retention basins, while other discharges may empty into the channel of the San Joaquin River, particularly those from surface flow on the docks and wharves. The Port has proposed a stormwater management plan which will test discharged waters three times per year.

NMFS expects most precipitation events to occur during the migration period of juvenile and adult salmonids in the San Joaquin River basin. Precipitation events trigger migration by salmonids by increasing flows in the area's watersheds, and generally creating favorable conditions for migration. Stormwater discharges during these periods can have deleterious effects on exposed salmonids. These periods of discharge expose salmonids to potentially adverse conditions which may not be detected by the infrequent monitoring. The extent of exposure is difficult to quantify due to the irregular pattern of precipitation events and the uncertain distribution of migrating salmonids in relation to the point of discharge. The severity of the contaminant exposure is predicated on the contaminant concentration in the runoff, the duration of the exposure, and the types of contaminants in the runoff. The first flush events during the wet season typically have the highest concentrations of contaminants in their discharge, whereas discharges later on in the wet season or after a long period of precipitation tend to have lower contaminant concentrations. This general trend is complicated by industrial activities during the wet season which may introduce additional contaminants to the surface area of the West Complex, even after significant rainfall events. NMFS believes that under the current conditions, there is an ongoing risk of contaminant runoff entering the DWSC at the Port which may have negative impacts to exposed salmonids in the channel. This is expected to be exacerbated by future redevelopment and the increasing industrialization of the West Complex, anticipated increases in automobile and rail traffic, and the current condition of the sanitary sewer and its infiltration problems until repairs to the system are completed.

H. Summary

This project is expected to adversely affect Central Valley steelhead that originate in the San Joaquin River and Calaveras River watersheds and migrate past the project site, and may lead to further population declines because the current population sizes are very small. Central Valley steelhead originating from the Sacramento River drainage and representing the majority of the ESU will be much less affected. The project also may perpetuate the current degraded status of the aquatic habitat in the Port and along the San Joaquin River in the DWSC. NMFS expects that adverse habitat conditions particularly related to poor water quality, including low DO, may continue in the Port and DWSC at levels similar to or worse than the current conditions under the proposed action. However, remedial actions by the Port are currently underway (*i.e.*, modifications of the Channel Point aerator). Increases in DWSC ship traffic are expected to adversely affect Sacramento River winter-run Chinook salmon, Central Valley spring-run Chinook salmon, and Central Valley steelhead primarily through propeller entrainment.

Portions of the San Joaquin River within the influence of the project’s actions have been proposed as critical habitat for both Central Valley spring-run Chinook salmon and Central Valley steelhead. NMFS believes that although the critical habitat for both ESUs in the action area will be degraded, it will not appreciably diminish the capability of other waterways in the critical habitat range to function as migratory corridors for either the Central Valley spring-run Chinook salmon ESU or the Central Valley steelhead ESU. Since the largest population segments of the two ESUs utilize a different river system as their primary migratory corridor (*i.e.*, the Sacramento River), degradation of the San Joaquin River migratory corridor would not appreciably reduce the survival and recovery of the two affected ESUs.

VIII. CONCLUSION

A. Formal Consultation

After reviewing the best available scientific and commercial information, the current status of Sacramento River winter-run Chinook salmon, Central Valley spring-run Chinook salmon, and Central Valley steelhead, the environmental baseline, the effects of the proposed Port of Stockton West Complex Dredging project, and the cumulative effects, it is NMFS’ biological opinion that the Port of Stockton West Complex Dredging project, as proposed, is not likely to jeopardize the continued existence of Sacramento River winter-run Chinook salmon, Central Valley spring-run Chinook salmon, or Central Valley steelhead, or result in the destruction or adverse modification of the designated critical habitat for Sacramento River winter-run Chinook salmon.

B. Conference Consultation

After reviewing the best available scientific and commercial information, the current status of Central Valley spring-run Chinook salmon, and Central Valley steelhead, the environmental baseline, the effects of the proposed Port of Stockton West Complex Dredging project, and the cumulative effects, it is NMFS' biological opinion that the Port of Stockton West Complex Dredging project, as proposed, is not likely to adversely modify proposed critical habitat for Central Valley spring-run Chinook salmon or Central Valley steelhead.

IX. INCIDENTAL TAKE STATEMENT

Section 9 of the ESA and Federal regulation pursuant to section 4(d) of the ESA prohibit the take of endangered and threatened species, respectively, without special exemption. Take is defined as to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture or collect, or to attempt to engage in any such conduct. Harm is further defined by NMFS as an act which kills or injures fish or wildlife. Such an act may include significant habitat modification or degradation where it actually kills or injures fish or wildlife by significantly impairing essential behavioral patterns, including breeding, spawning, rearing, migrating, feeding or sheltering. Incidental take is defined as take that is incidental to, and not the purpose of, the carrying out of an otherwise lawful activity. Under the terms of section 7(b)(4) and section 7(o)(2), taking that is incidental to and not intended as part of the agency action is not considered to be prohibited taking under the ESA provided that such taking is in compliance with the terms and conditions of this Incidental Take Statement.

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

A. Amount or Extent of Take

NMFS anticipates that the proposed Port of Stockton West Complex Dredging project and the associated upland redevelopment and increase in Port activities will result in the incidental take of Sacramento River winter-run Chinook salmon, Central Valley spring-run Chinook salmon, and Central Valley steelhead.

The incidental take is expected to be in the form of death, injury, harassment, and harm from sources such as contaminant resuspension, propeller entrainment, and depleted DO. Direct take from Port dredging activities (*e.g.*, entrainment in the dredge or exposure to resuspended contaminants) is expected to occur only to Central Valley steelhead and only during the month of December, when Central Valley steelhead are likely to occur in the Port. Take from long-term changes to the larger action area (*e.g.*, impeded migration due to exacerbation of the low DO problem resulting from the changed bathymetry of the Port, or increased encounter rate with ship propellers in the DWSC), is expected to affect Sacramento River winter-run Chinook salmon, Central Valley spring-run Chinook salmon, and Central Valley steelhead from November 1 through May 31, which includes the entire period when individuals from one or more of the listed ESUs may be expected to occur in the action area.

The numbers of Sacramento River winter-run Chinook salmon, Central Valley spring-run Chinook salmon, and Central Valley steelhead taken will be difficult to quantify because dead and injured individuals will be difficult to detect and recover. The amount of take, however, can be quantified by the estimated propeller entrainment model, impacts to the approximately 8,000 lineal feet of West Complex shoreline affected by the proposed project through dredging, and the ongoing operations of the Port which includes shipping traffic on the 41 miles (67 kilometers) of shipping channel between the Port and the Port of Pittsburg. Take is expected to include:

1. All Central Valley steelhead juveniles and adults harmed, harassed, or killed due to acoustic damage associated with dredging activities during the initial deepening and subsequent maintenance of the docks along the north shore of the West Complex (docks 14-20 and dock 20 to the Burns Cutoff). Take is expected to occur only during the month of December from acoustic impacts that exceed 150 dB (ref 1 µpascal), which NMFS considers the threshold of behavioral and physiological changes in exposed fish species, as measured at a depth of one meter in the water column and at a distance of 10 m from the dredger. It is expected that fewer than a 100 adults and 1,000 juveniles will pass through the DWSC adjacent to the West Complex during the year. Most of the steelhead in the watersheds of the San Joaquin and Calaveras Rivers move through the region starting in December with the first winter rains. Except for the month of December, it is anticipated that very few steelhead will be present during the dredging work window (June 1 through December 31) based on Stanislaus weir numbers and tributary rotary screw trap data. Therefore, incidental take of Central Valley steelhead originating in the San Joaquin River and Calaveras River watersheds is not expected to exceed 1 percent of the San Joaquin basin population: 1 adult steelhead and 10 juvenile steelhead. At the total ESU population level for Central Valley steelhead, this anticipated level of incidental take is not expected to exceed 0.02 percent for adults (based on most recent population estimates) and 0.006 percent of naturally produced juveniles.

2. All Central Valley steelhead juveniles harmed, harassed, or killed from altered habitat conditions caused by the initial dredging of the West Complex berths. Such conditions may include loss of benthic organism diversity, loss of riparian and shallow water habitat, or increased predation risks. Altered habitat is not expected to exceed the footprint of the dredging project area (approximately 33 acres) as described in the project description included in the BA.

3. All Central Valley steelhead juveniles and adults that are harmed or killed from exposure to contaminants resuspended during initial channel dredging, and subsequent long-term maintenance dredging (twice in the next 5 years) of the deepwater berths (docks 14-20 and dock 20 to the Burns Cutoff). NMFS anticipates that take of listed salmonids, whether in the form of mortality or morbidity, will occur at contaminant levels below the acute and chronic criteria levels for ammonia, copper and DO. The anticipated level of contaminant related mortality is expected to be higher than the mortalities incurred by acoustic and habitat effects. However, except for the month of December, it is anticipated that very few steelhead will be present during the dredging work window (June 1 through December 31) based on Stanislaus weir numbers and tributary rotary screw trap data. Therefore, incidental take of Central Valley steelhead originating in the San Joaquin River and Calaveras River watersheds is not expected to exceed 2 percent of the San Joaquin basin population: 2 adult steelhead and 20 juvenile steelhead. At the total ESU population level for Central Valley steelhead, this anticipated level of incidental take is not expected to exceed 0.03 percent for adults (based on most recent population estimates) and 0.01 percent of naturally produced juveniles.

4. All Central Valley steelhead juveniles and adults that are harmed from exposure to contaminants resulting from intentional releases of stormwater to the waters of the Delta from the West Complex through authorized discharge points. Due to the controllable nature of the stormwater effluent no lethal take of either adult or juvenile Central Valley steelhead is expected. Incidental take of listed salmonids is restricted to water column concentrations of contaminants which do not exceed the published freshwater aquatic organism standards that are most protective of listed salmonids as stipulated in the *California Toxics Rules* (40 CFR §131), California's *Water Quality Goals* (2000), and the *Fourth Edition of the Water Quality Control Plan for the Sacramento River and San Joaquin River Basins* (1998), or criteria found in the scientific literature that are specific for the listed *Oncorhynchus* species.

5. All Sacramento River winter-run Chinook salmon, Central Valley spring-run Chinook salmon, and Central Valley steelhead juveniles harmed, harassed, or killed due to the operation of ocean going vessels within the confines of the Corps' maintained ship channel from the Turning Basin in the Port to the mouth of the ship channel at the Port of Pittsburg. Take is expected to occur from the erosion and degradation of the channel bottom resulting in an increase in turbidity and resuspension of contaminated sediments along the length of the DWSC. Based on the best available information and the results of studies conducted by the Corps on the upper Mississippi River, additional take is expected from entrainment by ship propellers and the turbulent flow created by hull passage through the water column. NMFS has estimated that between 450 and 5,000 juvenile Sacramento River winter-run Chinook salmon may be adversely affected by propeller entrainment (approximately 0.14 to 1.6 percent of the total ESU production). Due to the large variance in the estimate, incidental take is not expected to exceed the mid-point of this range: 2,500 juvenile Sacramento River winter-run Chinook salmon, or approximately 0.8 percent of the total ESU juvenile production. Incidental take is not expected to exceed 250,000 combined spring-run/fall-run sized juvenile Chinook salmon, of which 2 percent (5,000) is expected to be naturally-produced Central Valley spring-run

Chinook salmon juveniles. This incidental take estimate of 5,000 naturally-produced juvenile Central Valley spring-run Chinook salmon represents approximately 0.3 percent of the expected total ESU natural juvenile production. Hatchery reared spring-run Chinook salmon from the Feather River hatchery are not included in this calculation as these fish are released further down in the estuary near the Carquinez Straits. NMFS has estimated that between 40 and 500 juvenile Central Valley steelhead from both the Sacramento River and San Joaquin River watersheds may be adversely affected by propeller entrainment. Incidental take is not expected to exceed 250 juvenile steelhead or approximately 0.14 percent of the total ESU juvenile Central Valley steelhead production.

The cumulative total incidental take associated with Port of Stockton West Complex Dredging project is as follows:

Species	Juveniles		Adults	
	Expected Incidental Take	Percent of Total Population within ESU	Expected Incidental Take	Percent of Total Population within ESU
Sacramento River winter-run Chinook salmon	2,500	0.8	0	0
Central Valley spring-run Chinook salmon	5,000	0.32	0	0
Central Valley steelhead	280	0.15	3	0.15

Other incidental take associated with the operation of ocean going vessels and tugs (*e.g.*, discharges of pollutants from ship engines, introduction of non-native invasive species, *etc.*) or from the proposed West Complex redevelopment and the associated increase in vehicular and rail traffic are not included in this incidental take statement because the Corps does not have the authority to regulate these activities.

B. Effect of the Take

In the accompanying biological and conference opinion, NMFS determined that the level of anticipated take will not result in jeopardy to the species or destruction or adverse modification of designated or proposed critical habitat.

C. Reasonable and Prudent Measures

Pursuant to section 7(b)(4) of the ESA, the following reasonable and prudent measures are necessary and appropriate to minimize take of Sacramento River winter-run Chinook salmon, Central Valley spring-run Chinook salmon, and Central Valley steelhead.

1. Measures shall be taken to avoid, minimize, and monitor the impacts of the initial dredging project and subsequent maintenance dredging upon listed salmonids and their habitat.

2. Measures shall be taken to avoid, minimize, and monitor the adverse effects of stormwater discharge to the waters of the Delta originating from within the West Complex upon listed salmonids and their habitat.

3. Measures shall be taken to monitor the impacts to listed salmonids and their habitat from the operations of ocean going vessels within the DWSC from the Port of Pittsburg to the Turning Basin in the Port.

D. Terms and Conditions

In order to be exempt from the prohibitions of section 9 of the ESA, the Corps and the Port must comply with the following terms and conditions, which implement the reasonable and prudent measures, described above and outline required reporting/monitoring requirements. These terms and conditions are non-discretionary.

1) **Measures shall be taken to avoid, minimize, and monitor the impacts of the initial dredging project and subsequent maintenance dredging upon listed salmonids and their habitat.**

   a) Dredging operations shall be conducted within the applicant's specified work window of June 1 to December 31. If dredging is necessary outside of this window, NMFS will be contacted for approval at least 30 days prior to the activity. The request must be written and include the location and size of the work area within the Port, and estimates of the amount of time required and dredging material to be removed. The request is to be sent to the following address:

      Attn: Supervisor
      National Marine Fisheries Service
      650 Capitol Mall, Suite 8-300
      Sacramento, California 95814-4706

      Office: (916) 930-3601
      Fax: (916) 930-3629

   b) Dredging outside of the applicant's work window of June 1 to December 31 may require the following additional protective measures:

      i) Silt curtains may be employed to surround the dredging area to prevent the spread of suspended sediments into the migration corridor of Central Valley steelhead.

      ii) The Corps and Port may monitor the underwater acoustic noise output of the dredging actions. Sound generated by the dredging action shall not exceed 145 db (ref 1µPa) at one meter depth and ten meters range from the dredge. Noise attenuation methods may be employed to reduce the noise level to acceptable levels.

iii) The Corps and Port may visually monitor the waterway adjacent to the dredge area (*i.e.*, within 300 feet) for any affected fish including, but not limited to, Central Valley steelhead. Observation of one or more affected fish will be reported to NMFS at the address above within 24 hours of the incident. The Corps and Port will coordinate with NMFS to determine the cause of the incident and whether any additional protective measures are necessary to protect Central Valley steelhead. These protective measures shall be implemented within 72 hours of the incident. Affected fish are defined as:

    (1) Dead or moribund fish at the water surface;
    (2) Show signs of erratic swimming behavior or other obvious signs of distress;
    (3) Gasping at the surface; or
    (4) Show signs of other unusual behavior.

c) NMFS shall be sent copies of any sediment, effluent, or water quality monitoring reports required by the Regional Board that are related to the dredging actions of this project at the address above within 60 days of their completion.

2) Measures shall be taken to avoid, minimize, and monitor the adverse effects of stormwater discharge to the waters of the Delta originating from within the West Complex upon listed salmonids and their habitat.

a) The Corps and Port will modify its stormwater management plan to avoid direct discharge of untreated stormwater to the receiving waters of the Delta from the docks and wharves of the project. Control of discharge should allow for retention or treatment of contaminated water prior to its discharge. This may require analysis of retained water in basins prior to its discharge during large rain events, or methods to extract contaminants prior to their discharge (*i.e.*, oil separators). These modifications shall be submitted to NMFS at the address 1(a) for review, comment, and approval prior to implementation by June 1, 2008.

b) During the rainy season, when most salmonids migrate (*i.e.*, November 1 through May 31), personnel and material for the monitoring of precipitation events shall be available 24 hours a day, seven days a week, to avoid missing first flush events of stormwater discharge. Response to rainfall events shall be within the first two hours of discharge to the waters of the San Joaquin River and adjacent water bodies. The Corps and Port will be responsible for monitoring approaching rain events and mobilizing assets to gather samples as appropriate. Sampling frequency should at a minimum include the first discharge of the wet season and each discharge thereafter which follows a minimum of three weeks of dry weather. At a minimum, the Corps and Port should have at least three representative sampling events per a year, as described in their stormwater management plan submitted to the Regional Board. Results of these monitoring events shall be made available to NMFS at the address in 1(a) above within 60 days after they become available.

3) **Measures shall be taken to monitor the impacts to listed salmonids and their habitat from the operations of ocean going vessels within the DWSC from the Port of Pittsburg to the Turning Basin in the Port.**

   a) The Corps and Port shall develop and initiate studies to ascertain the extent of propeller entrainment for listed salmonids within the DWSC. These studies can be performed in conjunction with studies associated with the John F. Baldwin and Stockton DWSC studies and/or the new Delta Long-term Management Strategy (LTMS), and may include, but are not limited to:

      i) Assessment of hull related shear forces and turbulence created by passing ships within the channel of the DWSC, including their zones of influence;

      ii) Defining the zone of inflow surrounding the hulls of ships in which fish can be entrained into the ship's propeller(s);

      iii) Defining the zone around a passing ship in which fish react to the hull's presence and passage; and,

      iv) Assessment of the proportion of fish, including listed salmonids, which are impacted by the passage of ocean going ships, including direct effects of the propeller disc and the turbulence fields surrounding the ship.

   b) The Corps and Port shall develop and initiate studies to examine the impact of ship passage on the resuspension of channel sediments and their impact on water quality within the DWSC. These studies can be performed in conjunction with studies associated with the John F. Baldwin and Stockton DWSC studies and/or the new LTMS, and may include, but are not limited to answering the following questions:

      i) What is the volume/mass of sediment resuspended by the passage of ships in the DWSC in both loaded and unloaded configurations during the year, broken down by month?

      ii) How is this amount of sediment related to "natural" sediment loads in the DWSC?

      iii) What are the settling rates of the different sediment types in the DWSC and how does ship passage affect the time that these sediments remain suspended in the water column?

      iv) How does the resuspension of sediments, including those which are contaminated, affect the health of the aquatic organisms in the DWSC, including listed salmonids and their forage base?

      v) How does the resuspension of sediments affect the water quality in the DWSC, including, DO levels, redox cycling in suspended materials, and nutrient loads?

c) The Port and the Corps will make available to NMFS all study plans for review, comment, and approval prior to implementation by June 1, 2008. NMFS, at its discretion, may seek independent scientific peer review of these study plans and their future findings for scientific soundness. Coordination with CALFED studies, academic institutions, and other State and Federal research is highly encouraged and recommended.

d) All findings will be made available to NMFS upon completion of the studies. Reports will be sent to the address in 1(a) within 60 days after they become available.

X. CONSERVATION RECOMMENDATIONS

Section 7(a)(1) of the ESA directs Federal agencies to utilize their authorities to further the purposes of the ESA by carrying out conservation programs for the benefit of endangered and threatened species. Conservation recommendations are discretionary agency activities to minimize or avoid adverse effects of a proposed action on a listed species or critical habitat or regarding the development of pertinent information.

1) The Corps should support and promote aquatic and riparian habitat restoration within the Delta region, and encourage the Port to modify operation and maintenance procedures through the Corps' authorities so that those actions avoid or minimize negative impacts to salmon and steelhead.

2) The Corps should support anadromous salmonid monitoring programs throughout the Delta and Suisun Bay to improve the understanding of migration and habitat utilization by salmonids in this region.

3) The Corps, with the assistance of the Port, should conduct an analysis of the newly exposed sediment horizons following dredging actions. If sediment contamination levels are at or above the recommended sediment quality guidelines, then the Corps and Port should evaluate and implement additional measures to avoid further contaminant exposure from these newly exposed sediments. Acceptable measures may include over-dredging the sediments of the contaminated area and backfilling with clean sand to entomb the contaminated sediment horizons. Other methodologies that achieve control or containment of contaminated sediment horizons may be appropriate if they do not demonstrably affect listed salmonids in an adverse manner. The recommended maximum level of copper in the sediment is 31.6 mg/kg (Buchman 1999) to 35.7 mg/kg (MacDonald *et al.* 2000). Total ammonia concentration in the water column is not to exceed 8.11 mg N/L at a pH of 7.8 for 1 hour, or 2.89 mg N/L at a pH of 7.8 for 30 days (Basin Plan)

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

XI. REINITIATION OF CONSULTATION

This concludes formal consultation on the actions outlined in the September 19, 2003, request for consultation received from the Corps. This biological opinion is valid for the Port of Stockton, West Complex Dredging project and associated interrelated actions of the West Complex Redevelopment Plan described in the EIR, BA and Corps application package received by NMFS. As provided for in 50 CFR §402.16, 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 taking specified in any incidental take statement 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 previously considered, (3) the agency action is subsequently modified in a manner that causes an effect to the listed species that was not considered in the biological opinion, or (4) a new species is listed or critical habitat is designated that may be affected by the action. In instances where the amount or extent of incidental take is exceeded, formal consultation shall be reinitiated immediately.

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APPENDIX A: Tables 1-13

TABLE 1.

PROPOSED WEST COMPLEX LAND USES

Land Use Type	Acreage Totals
1. Rail to dock	35 acres
2. Break bulk	50 acres
3. Private (existing petroleum plant)	23 acres
4. Commercial and Industrial Park	436 acres
5. Auto facility and 900’ wharf upgrade	65 acres
6. Container facility	105 acres
7. Expanded break-bulk, Ro-Ro, & project cargo	138 acres
8. Container expansion/intermodal transfer	45 acres
9. Water-related future expansion area	93 acres
10. Diversified land use	409 acres
11. Proposed Immigration and Naturalization Service Facility	60 acres
	Total Acres: 1,459

TABLE 2.
ACTIVITIES ADDRESSED UNDER THE PROPOSED REDEVELOPMENT PLAN

Activity Phasing **Development Activities**

Marine Terminal Development

Phase I

- Construct a 50-acre break-bulk facility.
- Perform wharf upgrades.

Phase II

- Replace the break-bulk facility with a container terminal. Would include 900’ wharf upgrade and installation of cranes.
- Develop intermodal rail yard
- Construct new 55-acre break-bulk facility.
- Construct up to 170-acre auto facility. Would include 900’ wharf upgrade.
- Construct expanded break-bulk, Ro-Ro, and project cargo facility to the east of the auto facility.
- Construct a container expansion/intermodal transfer facility between container terminal and intermodal yard.

Phase III

- Expand break-bulk, Ro-Ro, and project cargo operations to 138 acres
- Expand auto facility up to 300 acres
- Expand container expansion/intermodal transfer facility to 45 acres.
- Construct a new 55-acre container facility. Would include wharf upgrades and installation of cranes.
- Leave 93-acre area for future Marine Terminal expansion.

Commercial and Industrial Park Development

Phase A

- Perform building upgrades on existing buildings.
- Construct tilt-up buildings.
- Install new water main.

Phase B

- Develop campus-style office buildings, 1-5 stories in height.
- Construct parking to service campus
- Other alternatives are possible depending upon tenant needs.

Phase C

- Many alternatives are possible depending upon tenant needs.
- Buildings would be up to 75’ high.
- Demolish old buildings.
- Perform utility upgrades.

TABLE 3.
PROPOSED INFRASTRUCTURE IMPROVEMENTS BY PHASE AND CATEGORY

Phase / Category **Infrastructure Improvements**

Mid-Term Access

Navy Drive
- Widen Navy Drive from 2 to 3 lanes (4 lanes between Navy Drive bridge and Washington intersection).
- Construct a raised median in areas not fronted by driveways
- Replacement of Navy Drive bridge (4 lane, fixed bridge).

Daggett Road
- Construct 2 lane road with paved shoulders (4 lane off-Island.
- Construct 4-lane at-grade crossing with gates and flashers at the Daggett Road/BNSF railroad crossing.
- SR 4/Daggett Road intersection improvements to include installing southbound left and right-turn lanes, an eastbound left-turn lane, and a westbound right-turn lane on SR 4.
- Replacement of Daggett Road bridge (4 lane, fixed span bridge).

Long-Term Access
- If not previously completed, widen Navy Drive.
- Widen Daggett Road with curbs, gutters, and drainage improvements.
- Replace the at-grade Daggett Road/BNSF railroad crossing with a grade-separated crossing.

Internal Road System
- Daggett Road would be improved from the bridge to McCloy Avenue.
- Collector roads would be constructed from Daggett Road and McCloy Avenue. The types and placement of future development would determine locations.
- After development, the area north of the intermodal spine would be paved with hardstands, and roads defined by striping.

Rail System

Phase II-A
- Demolish most buildings north of Fyffe Avenue.
- Install intermodal yard and upgrade/replace tracks.

Phase II-B
- Install/upgrade tracks to service auto loading facility.

Phase II-C
- Install/upgrade tracks to service container and break-bulk facilities to the east of auto loading facility.

Phase III
- Complete intermodal yard begun in Phase II-A.
- Install/upgrade tracks.

Wharf
- Dredging for the berths to 35 feet.
- Establishment of protocol for maintenance dredging at all berths.
- Establishment of protocol for upland placement of dredged materials.
- The fender system along the wharf will be replaced.
- 60 to 100-foot rail-mounted cranes may potentially be installed at container terminals only. Transit sheds near the wharf would have to be removed to accommodate this. If a rail-mounted crane is not used, a mobile harbor crane may be substituted.
- Upgrades to docks located west of Dock 20 to accommodate loading and unloading.

Utilities
- Upgrade/replace sanitary sewer, electrical, and fire protection systems as necessary.
- Install new stormwater drainage system.
- Install new water main.

Table 4.

Monthly Occurrences of Dissolved Oxygen Depressions below the 5mg/L Criteria in the Stockton Deepwater Ship Channel (Rough and Ready Island DO monitoring site)
Water Years 2000 to 2004

	Water Year					
Month	**2000-01**	**2001-02**	**2002-03**	**2003-04**	**2004-05**	**Monthly Sum**
September	0	26**	30**	16**	30**	102
October	0	0	7	0	4	11
November	0	0	12	0	3	15
December	6	4*	13	2	13	38
January	3	4	19	7	0	33
February	0	25	28	13	0	66
March	0	7	9	0	0	16
April	0	4	4	0	0	8
May	2*	0	2	4	0	8
Yearly Sum	11	70	124	42	50	**Total=297**

* = Suspect Data – potentially faulty DO meter readings

** = Wind driven and photosynthetic daily variations in DO level; very low night-time DO levels, high late afternoon levels

Table 5. Salmon and Steelhead monitoring programs in the Sacramento - San Joaquin River basins, and Suisun Marsh.

Geographic Region	**Species**	**Watershed**	**Methods**	**Geographic Area Covered**	**Monitoring Parameters**	**Monitoring Period**	**Implementing Agency**
Central Valley	***Chinook Salmon, Steelhead***	Sacramento River	Scale and otolith collection	Coleman National Hatchery, Sacramento River and tributaries	Scale and otolith microstructure analysis	Year-round	CDFG
		Sacramento River and San Joaquin River	Central Valley angler survey	Sacramento and San Joaquin rivers and tributaries downstream to Carquinez	In-river harvest	8 or 9 times per month, year round	CDFG
		Sacramento River	Rotary screw trap	Upper Sacramento River at Balls Ferry and Deschutes Road Bridge	Juvenile emigration timing and abundance	Year round	CDFG
		Sacramento River	Rotary screw trap	Upper Sacramento River at RBDD	Juvenile emigration timing and abundance	Year round	FWS
		Sacramento River	Ladder counts	Upper Sacramento River at RBDD	Escapement estimates, population size	Variable, May - Jul	FWS
		Sacramento River	Beach seining	Sacramento River, Caldwell Park to Delta	Spatial and temporal distribution	Bi-weekly or monthly, year-round	FWS
		Sacramento River	Beach seining, snorkel survey, habitat mapping	Upper Sacramento River from Battle Creek to Caldwell Park	Evaluate rearing habitat	Random, year-round	CDFG
		Sacramento River	Rotary screw trap	Lower Sacramento River at Knight's Landing	Juvenile emigration and post-spawner adult steelhead migration	Year-round	CDFG
		Sacramento-San Joaquin basin	Kodiak/Midwater trawling	Sacramento river at Sacramento, Chipps Island, San Joaquin River at Mossdale	Juvenile outmigration	Variable, year-round	FWS
		Sacramento-San Joaquin Delta	Kodiak trawling	Various locations in the Delta	Presence and movement of juvenile salmonids	Daily, Apr - Jun	IEP
		Sacramento-San Joaquin Delta	Kodiak trawling	Jersey Point	Mark and recapture studies on juvenile salmonids	Daily, Apr - Jun	Hanson Environmental Consultants

Geographic Region	**Species**	**Watershed**	**Methods**	**Geographic Area Covered**	**Monitoring Parameters**	**Monitoring Period**	**Implementing Agency**
Central Valley	*Chinook Salmon, Steelhead, Continued*	Sacramento-San Joaquin Delta	Salvage sampling	CVP and SWP south delta pumps	Estimate salvage and loss of juvenile salmonids	Daily	USBR/CDFG
		Battle Creek	Rotary screw trap	Above and below Coleman Hatchery barrier	Juvenile emigration	Daily, year-round	FWS
		Battle Creek	Weir trap, carcass counts, snorkel/ kayak survey	Battle Creek	Escapement, migration patterns, demographics	Variable, year-round	FWS
		Clear Creek	Rotary screw trap	Lower Clear Creek	Juvenile emigration	Daily, mid Dec- Jun	FWS
		Feather River	Rotary screw trap, Beach seining, Snorkel survey	Feather River	Juvenile emigration and rearing, population estimates	Daily, Dec - Jun	DWR
		Yuba River	Rotary screw trap	lower Yuba River	Life history evaluation, juvenile abundance, timing of emergence and migration, health index	Daily, Oct - Jun	CDFG
		Feather River	Ladder at hatchery	Feather River Hatchery	Survival and spawning success of hatchery fish (spring-run Chinook salmon), determine wild vs. hatchery adults (steelhead)	Variable, Apr - Jun	DWR, CDFG
		Mokelumne River	Habitat typing	Lower Mokelumne River between Camanche Dam and Cosumnes River confluence	Habitat use evaluation as part of limiting factors analysis	Various, when river conditions allow	EBMUD
		Mokelumne River	Redd surveys	Lower Mokelumne River between Camanche Dam and Hwy 26 bridge	Escapement estimate	Twice monthly, Oct 1- Jan 1	EBMUD
		Mokelumne River	Rotary screw trap, mark/recapture	Mokelumne River, below Woodbridge Dam	Juvenile emigration and survival	Daily, Dec- Jul	EBMUD
	Chinook Salmon, Steelhead, Continued	Mokelumne River	Angler survey	Lower Mokelumne River below Camanche Dam to Lake Lodi	In-river harvest rates	Various, year-round	EBMUD

Geographic Region	**Species**	**Watershed**	**Methods**	**Geographic Area Covered**	**Monitoring Parameters**	**Monitoring Period**	**Implementing Agency**
Central Valley		Mokelumne River	Beach seining, electrofishing	Lower Mokelumne	Distribution and habitat use	Various locations at various times throughout the year	EBMUD
		Mokelumne River	Video monitoring	Woodbridge Dam	Adult migration timing, population estimates	Daily, Aug - Mar	EBMUD
		Calaveras River	Adult weir, snorkel survey, electrofishing	Lower Calaveras River	Population estimate, migration timing, emigration timing	Variable, year-round	Fishery Foundation
		Stanislaus River	Rotary screw trap	lower Stanislaus River at Oakdale and Caswell State Park	Juvenile outmigration	Daily, Jan - Jun, dependent on flow	S.P. Cramer
		San Joaquin River basin	Fyke nets, snorkel surveys, hook and line survey, beach seining, electrofishing	Stanislaus, Tuolumne, Merced, and mainstem San Joaquin rivers	Presence and distribution, habitat use, and abundance	Variable, Mar- Jul	CDFG
	CV Steelhead	Sacramento River	Angler Survey	RBDD to Redding	In-river harvest	Random Days, Jul 15 - Mar 15	CDFG
		Battle Creek	Hatchery counts	Coleman National Fish Hatchery	Returns to hatchery	Daily, Jul 1 - Mar 31	FWS
		Clear Creek	Snorkel survey, redd counts	Clear Creek	Juvenile and spawning adult habitat use	Variable, dependent on river conditions	FWS
		Mill Creek, Antelope Creek, Beegum Creek	Spawning survey - snorkel and foot	Upper Mill, Antelope, and Beegum Creeks	Spawning habitat availability and use	Random days when conditions allow, Feb - Apr	CDFG
		Mill Creek, Deer Creek, Antelope Creek	Physical habitat survey	Upper Mill, Deer, and Antelope Creeks	Physical habitat conditions	Variable	USFS
		Dry Creek	Rotary screw trap	Miner and Secret Ravine's confluence	Downstream movement of emigrating juveniles and post-spawner adults	Daily, Nov- Apr	CDFG
		Dry Creek	Habitat survey, snorkel survey, PIT tagging study	Dry Creek, Miner and Secret Ravine's	Habitat availability and use	Variable	CDFG

Geographic Region	**Species**	**Watershed**	**Methods**	**Geographic Area Covered**	**Monitoring Parameters**	**Monitoring Period**	**Implementing Agency**
		Battle Creek	Otolith analysis	Coleman Hatchery	Determine anadromy or freshwater residency of fish returning to hatchery	Variable, dependent on return timing	FWS
		Feather River	Hatchery coded wire tagging	Feather River Hatchery	Return rate, straying rate, and survival	Daily, Jul - Apr	DWR
		Feather River	Snorkel survey	Feather River	Escapement estimates	Monthly, Mar to Aug (upper river), once annually (entire river)	DWR
		Yuba River	Adult trap	lower Yuba River	Life history, run composition, origin, age determination	Year-round	Jones and Stokes
		American River	Rotary screw trap	Lower American River, Watt Ave. Bridge	Juvenile emigration	Daily, Oct- Jun	CDFG
<u>**Central Valley**</u>	***CV Steelhead*** continued	American River	Beach seine, snorkel survey, electrofishing	American River, Nimbus Dam to Paradise Beach	Emergence timing, juvenile habitat use, population estimates	Variable	CDFG
		American River	Redd surveys	American River, Nimbus Dam to Paradise Beach	Escapement estimates	Once, Feb - Mar	CDFG, BOR
		Mokelumne River	Electrofishing, gastric lavage	Lower Mokelumne River	Diet analysis as part of limiting factor analysis	Variable	EBMUD
		Mokelumne River	Electrofishing, hatchery returns	Lower Mokelumne River, Mokelumne River hatchery	O. Mykiss genetic analysis to compare hatchery returning steelhead to residents	Variable	EBMUD
		Calaveras River	Rotary screw trap, pit tagging, beach seining, electrofishing	lower Calaveras River	Population estimate, migration patterns, life history	Variable, year-round	S.P. Cramer
		San Joaquin River basin	Fyke nets, snorkel survey, hook and line survey, beach seining, electrofishing, fish traps/weirs	Stanislaus, Tuolumne, Merced, and mainstem San Joaquin rivers	Presence, origin, distribution, habitat use, migration timing, and abundance	Variable, Jun - Apr	CDFG
		Merced River	Rotary screw trap	Lower Merced River	Juvenile oumigration	Variable, Jan-Jun	Natural Resource Scientists, Inc.

Geographic Region	**Species**	**Watershed**	**Methods**	**Geographic Area Covered**	**Monitoring Parameters**	**Monitoring Period**	**Implementing Agency**
		Central Valley-wide	Carcass survey, hook and line survey, electrofishing, traps, nets	Upper Sacramento, Yuba, Mokelumne, Calaveras, Tuolumne, Feather, Cosumnes and Stanislaus Rivers, and Mill, Deer, Battle, and Clear Creeks	Occurrence and distribution of *O. Mykiss*	Variable, year-round	CDFG
		Central Valley - wide	Scale and otolith sampling	Coleman NFH, Feather, Nimbus, Mokelumne River hatcheries	Stock identification, juvenile residence time, adult age structure, hatchery contribution	Variable upon availability	CDFG
		Central Valley - wide	Hatchery marking	All Central Valley Hatcheries	Hatchery contribution	Variable	FWS, CDFG
	SR Winter-run Chinook salmon	Sacramento River	Aerial redd counts	Keswick Dam to Princeton	Number and proportion of reds above and below RBDD	Weekly, May 1-July 15	CDFG
		Sacramento River	Carcass survey	Keswick Dam to RBDD	In-river spawning escapement	Weekly, Apr 15-Aug 15	FWS, CDFG
Central Valley	***SR Winter-run Chinook salmon***	Battle Creek	Hatchery marking	Colemen National Fish Hatchery	Hatchery contribution	Variable	FWS, CDFG
		Sacramento River	Ladder counts	RBDD	Run-size above RBDD	Daily, Mar 30- Jun 30	FWS
		Pacific Ocean	Ocean Harvest	California ports south of Point Arena	Ocean landings	May 1- Sept 30 (commercial), Feb 15 - Nov 15 (sport)	CDFG
	CV Spring-run Chinook salmon	Mill, Deer, Antelope, Cottonwood, Butte, Big Chico Creeks	Rotary screw trap, snorkel survey, electrofishing, beach seining	upper Mill, Deer, Antelope, Cottonwood, Butte, and Big Chico creeks	Life history assessment, presence, adult escapement estimates	Variable, year-round	CDFG
		Feather River	Fyke trapping, angling, radio tagging	Feather River	Adult migration and holding behavior	Variable, Apr-June	DWR
		Yuba River	Fish trap	lower Yuba River, Daguerre Point Dam	Timing and duration of migration, population estimate	Daily, Jan - Dec	CDFG

Geographic Region	**Species**	**Watershed**	**Methods**	**Geographic Area Covered**	**Monitoring Parameters**	**Monitoring Period**	**Implementing Agency**
Suisun Marsh	***Chinook salmon***	Suisun Marsh	Otter trawling, beach seining	Suisun Marsh	Relative population estimates and habitat use	Monthly, year-round	UCDavis
		Suisun Marsh	Gill netting	Suisun Marsh Salinity Control Gates	Fish passage	Variable, Jun - Dec	CDFG

Table 6. Changes in Channel Bathymetry for the West Complex Dredging Phase

Channel Cross Section	Depth Feet	Surface Area in acres	Surface Area in Square Feet	Volume Cubic Feet (ft^3)
Total Channel	variable	102.047	4,445,167.32	
North Channel	8	35.35	1,539,846	12,318,768
South Channel				
Current Depth	24	32.927	1,434,300	34,423,203
Future Depth	35	32.927	1,434,300	50,200,504
Ship Channel	35	33.77	1,471,021	51,485,742
Percentage Change				
Current Volume	98,227,713			
Future Volume	114,005,014			
Percent Change	16.06			

Table 7(a). Quartile Statistics for Bathymetric Contour Trace Metals (mg/kg)

	Copper	Mercury	Lead	Zinc
Minimum	34.3	0.077	12.3	83
Lower Quartile	39.6	0.088	14.8	89.3
Median	49	0.14	23.2	107
Upper Quartile	55.1	0.19	24.7	121
Maximum	73.2	0.28	43.7	150
Mean	49.4	0.15	22.6	109

n=7

Table 7(b). Mean Statistics for random Sampled Cores (µg/kg)

Contaminant	Mean Concentration (ppb)
Cr (VI)	190
Benzo (b) fluoranthene	32
Benzo (a) pyrene	23
Benzo (k) fluoranthene	27
Benzo (a) anthracene	23
Benzo (ghi) perylene	25
Chrysene	38
Fluorathene	39
Phenanthrene	29
Aroclor 1242	51
DDE	16
1,2,3,4,6,7,8-HpCDD	0.079
OCDD	0.6
1,2,3,4,6,7,8-HpCDF	0.019
OCDF	0.048

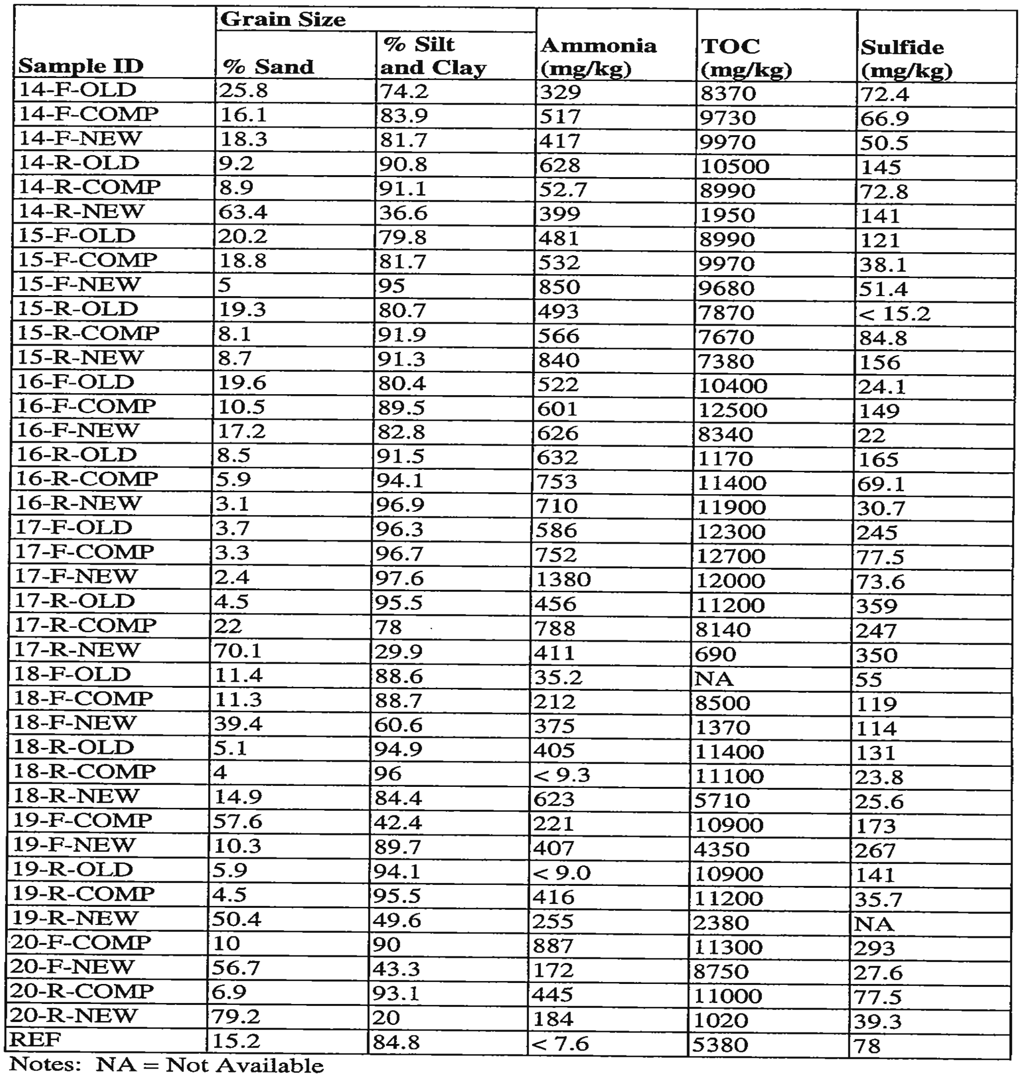
n=3

Table 8. Estimated Maximum Water Column Concentrations of Chemicals of Concern Released During Dredging Actions In the Deep Water Ship Channel (values in µg/L)

Chemicals Of Concern	June	July	Aug	Sept	Oct	Nov	Dec	Jan	Feb
Copper	4.5	4.5	4.6	4.4	3.7	3.6	4.6	4.5	4.2
Mercury	6.2E-3	6.0E-3	6.4E-3	5.8E-3	3.7E-3	3.4E-3	6.3E-3	6.1E-3	5.3E-3
Lead	1.1	1.1	1.2	1.1	0.75	0.71	1.1	1.1	1.0
Zinc	7.2	7.0	7.3	6.9	5.3	5.1	7.2	7.1	6.5
Chromium(VI)	0.26	0.26	0.26	0.26	0.25	0.25	0.26	0.26	0.26
Benzo (b) fluoranthene	8.0E-4	7.6E-4	8.4E-4	7.1E-4	2.7E-4	2.1E-4	8.2E-4	7.9E-4	6.1E-4
Benzo (a) pyrene	5.7E-4	5.4E-4	6.0E-4	5.1E-4	1.9E-4	1.5E-4	5.8E-4	5.6E-4	4.3E-4
Benzo (k) fluoranthene	6.8E-4	6.5E-4	7.2E-4	6.1E-4	2.3E-4	1.8E-4	7.0E-4	6.7E-4	5.2E-4
Benzo (a) anthracene	5.8E-4	5.6E-4	6.1E-4	5.2E-4	1.9E-4	1.5E-4	6.0E-4	5.7E-4	4.4E-4
Benzo (g,h,I,) perylene	6.4E-4	6.1E-4	6.8E-4	5.7E-4	2.1E-4	1.7E-4	6.6E-4	6.3E-4	4.9E-4
Chrysene	9.6E-4	9.2E-4	1.0E-3	8.5E-4	3.2E-4	2.5E-4	9.8E-4	9.4E-4	7.3E-4
fluoranthene	9.7E-4	9.3E-4	1.0E-3	8.7E-4	3.3E-4	2.5E-4	1.0E-3	9.6E-4	7.5E-3
Phenanthene	7.3E-4	7.0E-4	7.7E-4	6.5E-4	2.4E-4	1.9E-4	7.5E-4	7.2E-4	5.6E-4
Aroclor 1242	1.3E-3	1.2E-3	1.4E-3	1.1E-3	4.3E-4	3.3E-4	1.3E-4	1.3E-3	9.8E-4
DDE	3.9E-4	3.8E-4	4.2E-4	3.5E-4	1.3E-4	1.0E-4	4.1E-4	3.9E-4	3.0E-4
1,2,3,4,6,7,8,-HpCDD	2.0E-6	1.9E-6	2.1E-6	1.8E-6	6.7E-7	5.2E-7	2.1E-6	2.0E-6	1.5E-6
OCDD	1.5E-5	1.4E-5	1.6E-5	1.3E-5	5.1E-6	4.0E-6	1.6E-5	1.5E-5	1.2E-5
1,2,3,4,6,7,8-HpCDF	4.9E-7	4.7E-7	5.2E-7	4.3E-7	1.6E-7	1.3E-7	5.0E-7	4.8E-7	3.7E-7
OCDF	1.2E-6	1.2E-6	1.3E-6	1.1E-6	4.0E-7	3.2E-7	1.0E-6	1.2E-6	9.3E-7
TCDD-TEQ	2.6E-8	2.5E-8	2.8E-8	2.4E-8	8.9E-9	6.9E-9	2.7E-8	2.6E-8	2.0E-8

Data supplied by Jones and Stokes in a letter to NMFS dated November 17, 2004.

Table 9. Sediment Composition Characteristics for West Complex Dredging Sites



Sample ID	Grain Size % Sand	 % Silt and Clay	Ammonia (mg/kg)	TOC (mg/kg)	Sulfide (mg/kg)
14-F-OLD	25.8	74.2	329	8370	72.4
14-F-COMP	16.1	83.9	517	9730	66.9
14-F-NEW	18.3	81.7	417	9970	50.5
14-R-OLD	9.2	90.8	628	10500	145
14-R-COMP	8.9	91.1	52.7	8990	72.8
14-R-NEW	63.4	36.6	399	1950	141
15-F-OLD	20.2	79.8	481	8990	121
15-F-COMP	18.8	81.7	532	9970	38.1
15-F-NEW	5	95	850	9680	51.4
15-R-OLD	19.3	80.7	493	7870	< 15.2
15-R-COMP	8.1	91.9	566	7670	84.8
15-R-NEW	8.7	91.3	840	7380	156
16-F-OLD	19.6	80.4	522	10400	24.1
16-F-COMP	10.5	89.5	601	12500	149
16-F-NEW	17.2	82.8	626	8340	22
16-R-OLD	8.5	91.5	632	1170	165
16-R-COMP	5.9	94.1	753	11400	69.1
16-R-NEW	3.1	96.9	710	11900	30.7
17-F-OLD	3.7	96.3	586	12300	245
17-F-COMP	3.3	96.7	752	12700	77.5
17-F-NEW	2.4	97.6	1380	12000	73.6
17-R-OLD	4.5	95.5	456	11200	359
17-R-COMP	22	78	788	8140	247
17-R-NEW	70.1	29.9	411	690	350
18-F-OLD	11.4	88.6	35.2	NA	55
18-F-COMP	11.3	88.7	212	8500	119
18-F-NEW	39.4	60.6	375	1370	114
18-R-OLD	5.1	94.9	405	11400	131
18-R-COMP	4	96	< 9.3	11100	23.8
18-R-NEW	14.9	84.4	623	5710	25.6
19-F-COMP	57.6	42.4	221	10900	173
19-F-NEW	10.3	89.7	407	4350	267
19-R-OLD	5.9	94.1	< 9.0	10900	141
19-R-COMP	4.5	95.5	416	11200	35.7
19-R-NEW	50.4	49.6	255	2380	NA
20-F-COMP	10	90	887	11300	293
20-F-NEW	56.7	43.3	172	8750	27.6
20-R-COMP	6.9	93.1	445	11000	77.5
20-R-NEW	79.2	20	184	1020	39.3
REF	15.2	84.8	< 7.6	5380	78

Notes: NA = Not Available

Data are from the Draft EIR for the West Complex Redevelopment Project (ESA 2003) Numbers in column one represent the dock number, *i.e.* Docks 14 - 20; "F" represents the fixed depth contour samples; "R" represents the random core sample; "old" represents the old sediment horizon layer; "new" represents the new sediment horizon layer after dredging to minus 35 feet; "comp" represents a composite sediment sample from the old to new depths in the core sample, "REF" represents sediment core samples taken from the reference site (French Camp Slough confluence with the San Joaquin River). "TOC" is total organic carbon in the sample.

Table 10. Chinook salmon Densities from Kodiak Trawls: Salmon/10,000 m^3 of trawled water (USFWS data)

Spring-run/ Fall-run Chinook salmon densities (1993-1999)

Year						Month						
	Aug	Sep	Oct	Nov	Dec	Jan	Feb	March	Apr	May	June	July
92-93	ns	ns	ns	ns	ns	ns	ns	ns	7.38	11.04	4.21	0.624
93-94	ns	ns	ns	0.331	0	0	0.003	0.017	4.439	3.74	0.195	ns
94-95	ns	ns	0.057	0.036	0	0.572	0.407	1.134	7.779	15.39	4.85	0.345
95-96	0.032	0.068	0.193	0.013	0.031	0.1	3.661	1.59	9.356	13.58	1.58	0
96-97	0.141	ns	0	0.011	0.017	0.817	0.004	0.123	3.912	2.358	0.358	0.103
97-98	0.047	0.013	0.003	0	0.002	0.336	0.678	2.735	10.71	16.28	3.62	ns
98-99	ns	0.053	0.028	0	0	0.041	1.171	0.207	4.676	9.923	2.211	0.127
Avg	0.073333	0.044667	0.0562	0.065167	0.008333	0.311	0.987333	0.967667	6.893143	10.33014	2.432	0.2398

Winter-run Chinook salmon densities (1993-1999)

Year						Month						
	Aug	Sep	Oct	Nov	Dec	Jan	Feb	March	Apr	May	June	July
93-94	ns	ns	ns	0	0	0.002		0.083		0.001	0	ns
94-95	ns	ns	0	0	0	0.011	0.325	0.437		0.004	0	0
95-96	0	0	0	0	0.064	0.065	0.112	0.595	0.085	0.001	0	0
96-97	0	ns	0	0	0.009	0.016	0.081	0.253	0.129	0.002	0	0
97-98	0	0	0	0	0.01	0.26	0.017	0.217	0.062	0.003	0	ns
98-99	ns	0	0	0	0.02	0.012	0.086	0.278	0.102	0	0	0
Avg	0	0	0	0	0.017167	0.061	0.1242	0.3105	0.0945	0.001833	0	0

Total Chinook salmon densities (1999-2003)

Station Code												
	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Marc	Apr	May	June	July
Mid-channel	0.04	0.05	0.14	0.07	0.22	0.47	0.42	0.9	8.94	8.87	1.2	0.13
North Channel	0.04	0.09	0.19	0.07	0.22	0.43	0.39	0.78	6.27	5.62	0.83	0.11
South Channel	0.03	0.05	0.14	0.06	0.3	0.36	0.27	1.1	10.27	8.97	1.3	0.09
Avg	0.036667	0.063333	0.156667	0.066667	0.246667	0.42	0.36	0.926667	8.493333	7.82	1.11	0.11

Total Chinook salmon densities at Jersey Point and Prisoners Point (1997-1998)

Station Code		estimates			From USFWS Data				estimates			
	Jan	Feb	Marc	Apr	May	June	July	Aug	Sep	Oct	Nov	Dec
Jersey Point	0.25	0.22	0.56	3.08	3.80	1.39	0.07	0.02	0.04	0.09	0.04	0.15
Prisoner's Point	0.07	0.06	0.15	0.37	3.66	0.24	0.02	0.01	0.01	0.03	0.01	0.04

Table 11(a).
Fall-run/Spring-run Chinook salmon Propeller Entrainment - one way
Chipps Island to Prisoners Point

Adjusted entrainment Rates for leg 1 Chipps Island to Blind Point /ship transit

5 mph, 4m, 0.5 PR	Aug	Sep	Oct	Nov	Dec	Jan	Feb	March	Apr	May	June	July	Annual Sum
	2	1	2	2	0	9	29	28	199	298	70	7	
Monthly	66	39	50	56	7	279	799	867	5,974	9,251	2,108	215	19,710
5mph, 4m, 1.0 PR	Aug	Sep	Oct	Nov	Dec	Jan	Feb	March	Apr	May	June	July	Annual Sum
	4	3	3	4	0	18	57	56	398	597	141	14	
Monthly	131	77	101	113	15	557	1,597	1,733	11,948	18,502	4,215	429	39,419
5 mph, 4m, 1.5 PR	Aug	Sep	Oct	Nov	Dec	Jan	Feb	March	Apr	May	June	July	Annual Sum
	6	4	5	6	1	27	86	84	597	895	211	21	
Monthly	197	116	151	169	22	836	2,396	2,600	17,922	27,753	6,323	644	59,129
5 mph, 5m, 1.0 PR	Aug	Sep	Oct	Nov	Dec	Jan	Feb	March	Apr	May	June	July	Annual Sum
	4	3	3	4	0	18	56	55	389	583	137	14	
Monthly	128	76	98	110	15	544	1,560	1,693	11,668	18,068	4,117	419	38,495
5 mph, 5m, 0.5 PR	Aug	Sep	Oct	Nov	Dec	Jan	Feb	March	Apr	May	June	July	Annual Sum
	8	5	6	7	1	35	111	109	778	1,166	274	27	
Monthly	257	151	197	221	29	1,088	3,120	3,385	23,335	36,136	8,233	839	76,990
5 mph, 5m, 1.5 PR	Aug	Sep	Oct	Nov	Dec	Jan	Feb	March	Apr	May	June	July	Annual Sum
	12	8	10	11	1	53	167	164	1,167	1,749	412	41	
Monthly	385	227	295	331	44	1,632	4,679	5,078	35,003	54,205	12,350	1,258	115,486
5 mph, 6m, 0.5 PR	Aug	Sep	Oct	Nov	Dec	Jan	Feb	March	Apr	May	June	July	Annual Sum
	7	4	5	6	1	30	96	94	672	1,007	237	23	
Monthly	222	131	170	191	25	940	2,695	2,925	20,162	31,222	7,113	725	66,520
5 mph, 6m, 1.0 PR													
	Aug	Sep	Oct	Nov	Dec	Jan	Feb	March	Apr	May	June	July	Annual Sum
Monthly	14	9	11	13	2	61	193	189	1,344	2,014	474	47	
	443	261	340	381	50	1,880	5,391	5,849	40,324	62,444	14,227	1,450	133,039
5 mph, 6m, 1.5 PR	Aug	Sep	Oct	Nov	Dec	Jan	Feb	March	Apr	May	June	July	Annual Sum
	21	13	16	19	2	91	289	283	2,016	3,021	711	70	
Monthly	665	392	510	572	76	2,820	8,086	8,774	60,485	93,665	21,340	2,174	199,559
8 mph, 4m, 0.5 PR	Aug	Sep	Oct	Nov	Dec	Jan	Feb	March	Apr	May	June	July	Annual Sum
	2	1	1	2	0	7	24	23	166	249	59	6	
Monthly	55	32	42	47	6	232	666	722	4,978	7,709	1,756	179	16,425
8 mph, 4m,1.0 PR	Aug	Sep	Oct	Nov	Dec	Jan	Feb	March	Apr	May	June	July	Annual Sum
	4	2	3	3	0	15	48	47	332	497	117	12	
Monthly	109	65	84	94	12	464	1,331	1,444	9,956	15,418	3,513	358	32,849
8 mph, 4m,1.5 PR	Aug	Sep	Oct	Nov	Dec	Jan	Feb	March	Apr	May	June	July	Annual Sum
	5	3	4	5	1	22	71	70	498	746	176	17	
Monthly	164	97	126	141	19	696	1,997	2,166	14,935	23,127	5,269	537	49,274

Table 11(b).
Winter-run Chinook salmon Propeller Entrainment - one way Chipps Island to Prisoners Point

Adjusted entrainment Rates for leg 1 Chipps Island to Blind Point /ship transit

5 mph, 4m, 0.5 PR	Aug	Sep	Oct	Nov	Dec	Jan	Feb	March	Apr	May	June	July	Annual Sum
	0	0	0	0	0	2	4	9	3	0	0	0	
Monthly	0	0	0	0	15	55	100	278	82	2	0	0	532
5mph, 4m, 1.0 PR	Aug	Sep	Oct	Nov	Dec	Jan	Feb	March	Apr	May	June	July	Annual Sum
	0	0	0	0	1	4	7	18	5	0	0	0	
Monthly	0	0	0	0	31	109	201	556	164	3	0	0	1,064
5 mph, 4m, 1.5 PR	Aug	Sep	Oct	Nov	Dec	Jan	Feb	March	Apr	May	June	July	Annual Sum
	0	0	0	0	1	5	11	27	8	0	0	0	
Monthly	0	0	0	0	46	164	301	834	246	5	0	0	1,596
5 mph, 5m, 1.0 PR	Aug	Sep	Oct	Nov	Dec	Jan	Feb	March	Apr	May	June	July	Annual Sum
	0	0	0	0	1	3	7	18	5	0	0	0	
Monthly	0	0	0	0	30	107	196	543	160	3	0	0	1,039
5 mph, 5m, 0.5 PR	Aug	Sep	Oct	Nov	Dec	Jan	Feb	March	Apr	May	June	July	Annual Sum
	0	0	0	0	2	7	14	35	11	0	0	0	
Monthly	0	0	0	0	60	213	392	1,086	320	6	0	0	2,078
5 mph, 5m, 1.5 PR	Aug	Sep	Oct	Nov	Dec	Jan	Feb	March	Apr	May	June	July	Annual Sum
	0	0	0	0	3	10	21	53	16	0	0	0	
Monthly	0	0	0	0	90	320	589	1,629	480	10	0	0	3,118
5 mph, 6m, 0.5 PR	Aug	Sep	Oct	Nov	Dec	Jan	Feb	March	Apr	May	June	July	Annual Sum
	0	0	0	0	2	6	12	30	9	0	0	0	
Monthly	0	0	0	0	52	184	339	938	276	6	0	0	1,796
5 mph, 6m, 1.0 PR													
	Aug	Sep	Oct	Nov	Dec	Jan	Feb	March	Apr	May	June	July	Annual Sum
Monthly	0	0	0	0	3	12	24	61	18	0	0	0	
	0	0	0	0	104	369	678	1,877	553	11	0	0	3,591
5 mph, 6m, 1.5 PR	Aug	Sep	Oct	Nov	Dec	Jan	Feb	March	Apr	May	June	July	Annual Sum
	0	0	0	0	5	18	36	91	28	1	0	0	
Monthly	0	0	0	0	156	553	1,017	2,815	829	17	0	0	5,387
8 mph, 4m, 0.5 PR	Aug	Sep	Oct	Nov	Dec	Jan	Feb	March	Apr	May	June	July	Annual Sum
	0	0	0	0	0	1	3	7	2	0	0	0	
Monthly	0	0	0	0	13	46	84	232	68	1	0	0	443
8 mph, 4m,1.0 PR	Aug	Sep	Oct	Nov	Dec	Jan	Feb	March	Apr	May	June	July	Annual Sum
	0	0	0	0	1	3	6	15	5	0	0	0	
Monthly	0	0	0	0	26	91	167	463	136	3	0	0	887
8 mph, 4m,1.5 PR	Aug	Sep	Oct	Nov	Dec	Jan	Feb	March	Apr	May	June	July	Annual Sum
	0	0	0	0	1	4	9	22	7	0	0	0	
Monthly	0	0	0	0	38	137	251	695	205	4	0	0	1,330

Table 11(c).
Total Chinook salmon Propeller Entrainment - one way
Jersey Point to the Port of Stockton

Adjusted Entrainment Numbers For slippage and Mortality percentage

5 mph, 4m, 0.5 PR	Jan	Feb	Mar	Apr	May	June	July	Aug	Sep	Oct	Nov	Dec	Sum
JP	6	6	14	79	97	36	2	1	1	2	1	4	
PP	3	2	6	14	140	9	1	0	0	1	0	2	
Monthly	283	235	624	2,789	7,353	1,387	67	25	41	106	43	166	13,119
5mph, 4m, 1.0 PR	Jan	Feb	Mar	Apr	May	June	July	Aug	Sep	Oct	Nov	Dec	
JP	13	11	29	158	194	71	3	1	2	5	2	8	
PP	5	5	12	28	280	18	1	0	1	2	1	3	
Monthly	566	469	1,249	5,577	14,706	2,774	134	49	83	211	87	332	26,238
5 mph, 4m, 1.5 PR	Jan	Feb	Mar	Apr	May	June	July	Aug	Sep	Oct	Nov	Dec	
JP	19	17	43	236	292	107	5	2	3	7	3	11	
PP	8	7	17	42	420	28	2	1	1	3	1	5	
Monthly	849	704	1,873	8,366	22,059	4,161	201	74	124	317	130	499	39,356
5 mph, 5m, 1.0 PR	Jan	Feb	Mar	Apr	May	June	July	Aug	Sep	Oct	Nov	Dec	
JP	13	11	28	154	190	69	3	1	2	5	2	7	
PP	5	4	11	28	273	18	1	0	1	2	1	3	
Monthly	553	458	1,219	5,447	14,361	2,709	131	48	81	206	85	325	25,623
5 mph, 5m, 0.5 PR	Jan	Feb	Mar	Apr	May	June	July	Aug	Sep	Oct	Nov	Dec	
JP	25	22	56	308	380	139	7	2	4	9	4	15	
PP	10	9	23	55	547	36	3	1	2	4	2	6	
Monthly	1,105	917	2,439	10,893	28,723	5,418	261	96	161	412	170	649	51,245
5 mph, 5m, 1.5 PR	Jan	Feb	Mar	Apr	May	June	July	Aug	Sep	Oct	Nov	Dec	
JP	38	33	84	462	570	208	10	3	6	14	6	22	
PP	15	13	34	83	820	54	4	1	2	6	2	9	
Monthly	1,658	1,375	3,658	16,340	43,084	8,127	392	145	242	618	255	974	76,868
5 mph, 6m, 0.5 PR	Jan	Feb	Mar	Apr	May	June	July	Aug	Sep	Oct	Nov	Dec	
JP	22	19	48	266	328	120	6	2	3	8	3	13	
PP	9	8	20	48	472	31	2	1	1	3	1	5	
Monthly	955	792	2,107	9,412	24,817	4,681	226	83	139	356	147	561	44,276
5 mph, 6m, 1.0 PR	Jan	Feb	Mar	Apr	May	June	July	Aug	Sep	Oct	Nov	Dec	
JP	44	38	97	532	656	240	11	4	7	16	7	26	
PP	18	15	39	96	945	62	5	2	3	7	3	10	
Monthly	1,910	1,584	4,214	18,824	49,633	9,363	452	167	279	712	293	1,122	88,552
5 mph, 6m, 1.5 PR	Jan	Feb	Mar	Apr	May	June	July	Aug	Sep	Oct	Nov	Dec	
JP	66	56	145	798	984	360	17	6	10	25	10	39	
PP	27	23	59	143	1417	93	7	2	4	10	4	16	
Monthly	2,865	2,376	6,321	28,235	74,450	14,044	678	250	418	1,069	440	1,683	132,828
8 mph, 4m, 0.5 PR	Jan	Feb	Mar	Apr	May	June	July	Aug	Sep	Oct	Nov	Dec	
JP	5	5	12	66	81	30	1	0	1	2	1	3	
PP	2	2	5	12	117	8	1	0	0	1	0	1	
Monthly	236	196	520	2,324	6,128	1,156	56	21	34	88	36	138	10,932
8 mph, 4m,1.0 PR	Jan	Feb	Mar	Apr	May	June	July	Aug	Sep	Oct	Nov	Dec	
JP	11	9	24	131	162	59	3	1	2	4	2	6	
PP	4	4	10	24	233	15	1	0	1	2	1	3	
Monthly	472	391	1,040	4,648	12,255	2,312	112	41	69	176	72	277	21,865
8 mph, 4m,1.5 PR	Jan	Feb	Mar	Apr	May	June	July	Aug	Sep	Oct	Nov	Dec	
JP	16	14	36	197	243	89	4	1	2	6	3	10	

Table 11(d).
Fall-run/Spring-run Propeller Entrainment-Round trip
Chipps Island to Port of Stockton

	Jan	Feb	Mar	Apr	May	June	July	Aug	Sep	Oct	Nov	Dec	Sum
5 mph, 4m, 0.5 PR	45	40	92	702	987	159	12	4	6	15	7	23	
Monthly Total	1,408	1,118	2,861	21,073	30,593	4,765	381	121	169	462	208	726	63,884
26,131													
	Jan	Feb	Mar	Apr	May	June	July	Aug	Sep	Oct	Nov	Dec	Sum
5mph, 4m, 1.0 PR	91	80	185	1,405	1,974	318	25	8	11	30	14	47	
Monthly Total	2,815	2,235	5,721	42,146	61,185	9,529	762	242	338	924	417	1,453	127,767
	Jan	Feb	Mar	Apr	May	June	July	Aug	Sep	Oct	Nov	Dec	Sum
5 mph, 4m, 1.5 PR	136	120	277	2,107	2,961	476	37	12	17	45	21	70	
Monthly Total	4,223	3,353	8,582	63,219	91,778	14,294	1,143	363	508	1,386	625	2,179	191,651
5 mph, 5m, 0.5 PR	Jan	Feb	Mar	Apr	May	June	July	Aug	Sep	Oct	Nov	Dec	Sum
	89	78	180	1,372	1,927	310	24	8	11	29	14	46	
Monthly Total	2,749	2,183	5,587	41,158	59,751	9,306	744	236	331	902	407	1,419	124,773
	Jan	Feb	Mar	Apr	May	June	July	Aug	Sep	Oct	Nov	Dec	Sum
5 mph, 5m, 1.0 PR	177	156	360	2,744	3,855	620	48	15	22	58	27	92	
Monthly Total	5,499	4,365	11,174	82,316	119,503	18,611	1,488	473	661	1,804	814	2,837	249,546
	Jan	Feb	Mar	Apr	May	June	July	Aug	Sep	Oct	Nov	Dec	Sum
5 mph, 5m, 1.5 PR	266	234	541	4,116	5,782	931	72	23	33	87	41	137	
Monthly Total	8,248	6,548	16,761	123,474	179,254	27,917	2,233	709	992	2,706	1,220	4,256	374,319
	Jan	Feb	Mar	Apr	May	June	July	Aug	Sep	Oct	Nov	Dec	Sum
5 mph, 6m, 0.5 PR	153	135	311	2,371	3,331	536	41	13	19	50	23	79	
Monthly Total	4,751	3,772	9,654	71,121	103,250	16,080	1,286	409	571	1,559	703	2,452	215,608
	Jan	Feb	Mar	Apr	May	June	July	Aug	Sep	Oct	Nov	Dec	Sum
5 mph, 6m, 1.0 PR	307	269	623	4,741	6,661	1,072	83	26	38	101	47	158	
Monthly Total	9,502	7,544	19,309	142,242	206,501	32,161	2,572	817	1,142	3,117	1,406	4,903	431,215
	Jan	Feb	Mar	Apr	May	June	July	Aug	Sep	Oct	Nov	Dec	Sum
5 mph, 6m, 1.5 PR	460	404	934	7,112	9,992	1,608	124	40	57	151	70	237	
Monthly Total	14,253	11,315	28,963	213,363	309,751	48,241	3,858	1,226	1,714	4,676	2,109	7,355	646,823
	Jan	Feb	Mar	Apr	May	June	July	Aug	Sep	Oct	Nov	Dec	Sum
8 mph, 4m, 0.5 PR	38	33	77	585	822	132	10	3	5	12	6	20	
Monthly Total	1,173	931	2,384	17,561	25,494	3,970	318	101	141	385	174	605	53,236
	Jan	Feb	Mar	Apr	May	June	July	Aug	Sep	Oct	Nov	Dec	Sum
8 mph, 4m,1.0 PR	76	67	154	1,171	1,645	265	20	7	9	25	12	39	
Monthly Total	2,346	1,863	4,768	35,121	50,988	7,941	635	202	282	770	347	1,211	106,473
	Jan	Feb	Mar	Apr	May	June	July	Aug	Sep	Oct	Nov	Dec	Sum
8 mph, 4m,1.5 PR	114	100	231	1,756	2,467	397	31	10	14	37	17	59	
Monthly Total	3,519	2,794	7,151	52,682	76,482	11,911	953	303	423	1,155	521	1,816	159,709

Table 12. Stormwater Contamination Concentrations from Various Land Uses. Values are in mg/l (ppm)

Source: http://www.Stormwatercenter.net/monitoring

Pollutant	New Surburban	Older Suburban	Hardwood Forest	National Urban
Phosphorus				
Total	0.26	1.08	0.15	-
Ortho	0.12	0.26	0.02	-
Soluble	0.16	-	0.04	0.59
Organic	0.1	0.82	0.11	-
Nitrogen				
Total	2	13.6	0.78	-
Nitrate	0.48	8.99	0.17	-
Ammonia	0.26	1.1	0.07	-
Organic	1.25	-	0.54	-
TKN	1.51	7.2	0.61	2.72
COD	35.6	163.0	> 40.0	124.0
BOD(5 day)	5.1	-	-	-
Metals				
Zinc	0.037	0.397	-	0.380
Lead	0.018	0.389	-	0.350
Copper	-	0.105	-	-

Abbreviations:

TKN	Total Kjeldahl Nitrogen
COD	Chemical Oxygen Demand
BOD	Biological Oxygen demand

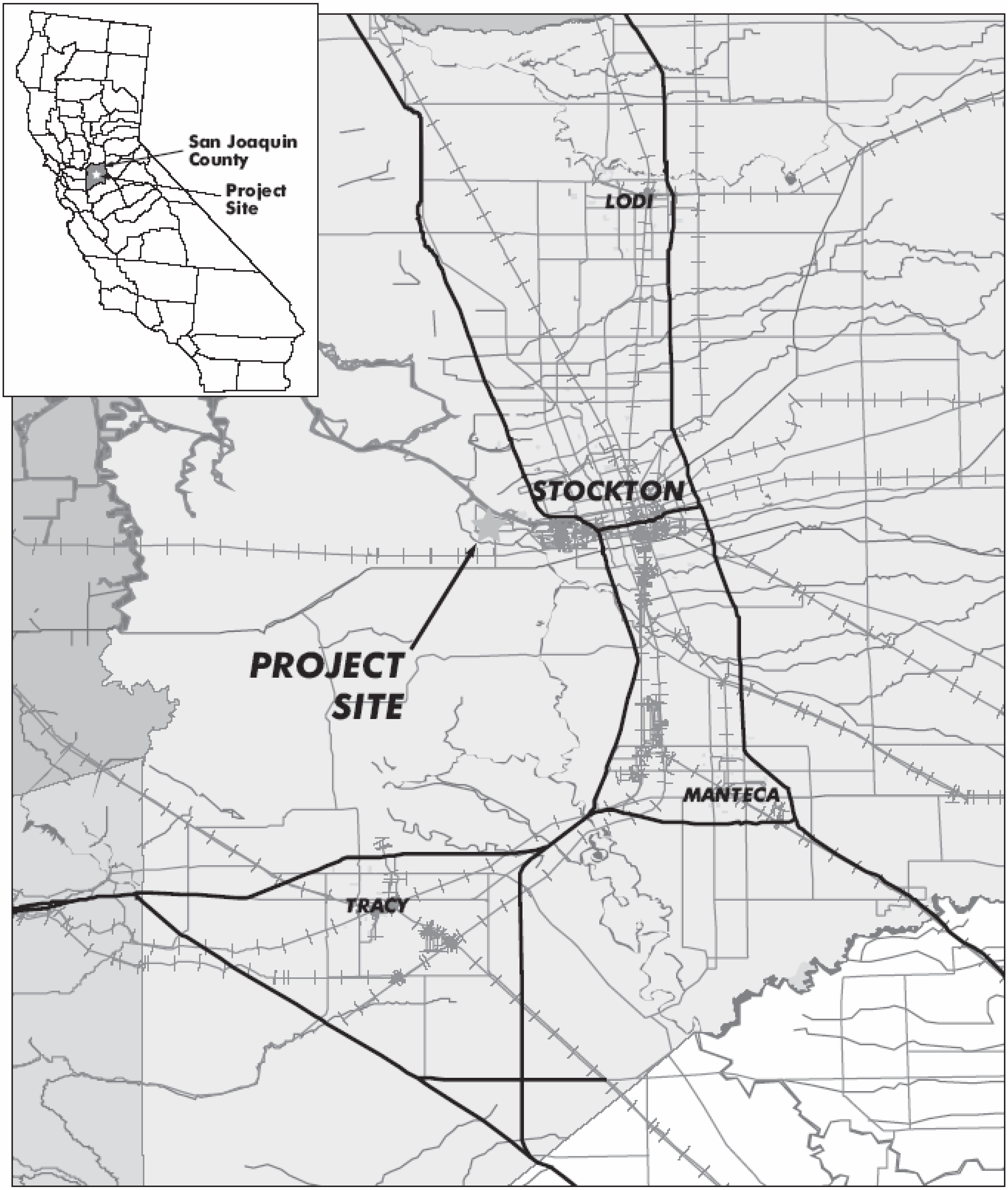
Table 13.

Highway Runoff Constituents and Their Primary Sources
Source: EPA (1993)

Constituent	Primary Sources
Particulates	Pavement wear, vehicles, atmospheric deposition
Nitrogen, Phosphorus	Atmospheric deposition, roadside fertilizer application
Lead	Tire wear, automobile exhaust
Zinc	Tire wear, motor oil, grease
Iron	Auto body rust, steel highway structures, moving engine parts
Copper	Metal plating, brake lining wear, moving engine parts, bearing and bushing wear, fungicides and insecticides
Cadmium	Tire wear, roadside insecticide application
Chromium	Metal plating, moving engine parts, brake lining wear
Nickel	Diesel fuel and gasoline, lubricating oils, metal plating, brake lining wear, asphalt paving
Manganese	Moving engine parts
Sulphate	Roadway beds
Petroleum	Spills, leaks, or blow-by of motor lubricants, antifreeze and hydraulic fluids, asphalt surface leachate

Appendix B: Figures 1-9

Figure 1: Regional Map



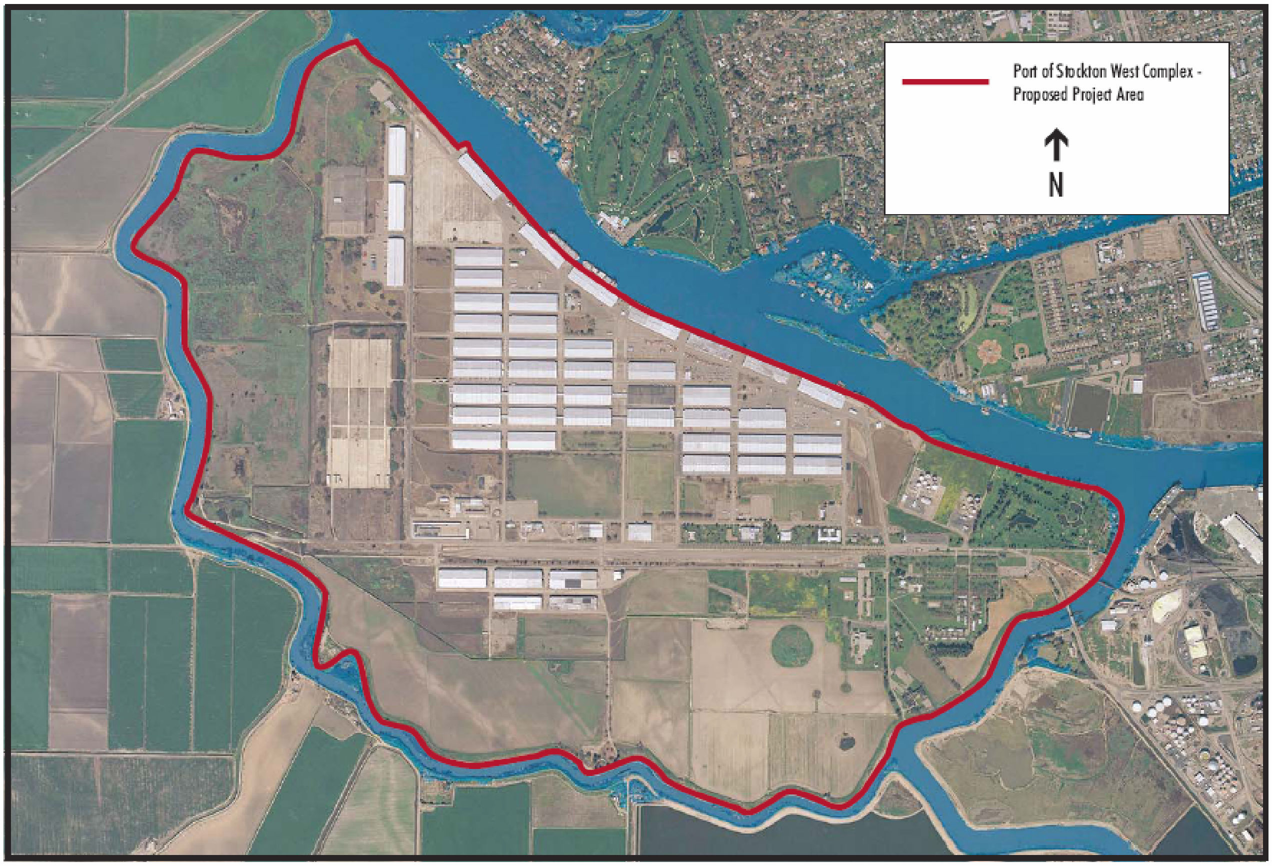


Figure 2: Project Site- Former Rough and Ready Island Naval Communications Base.

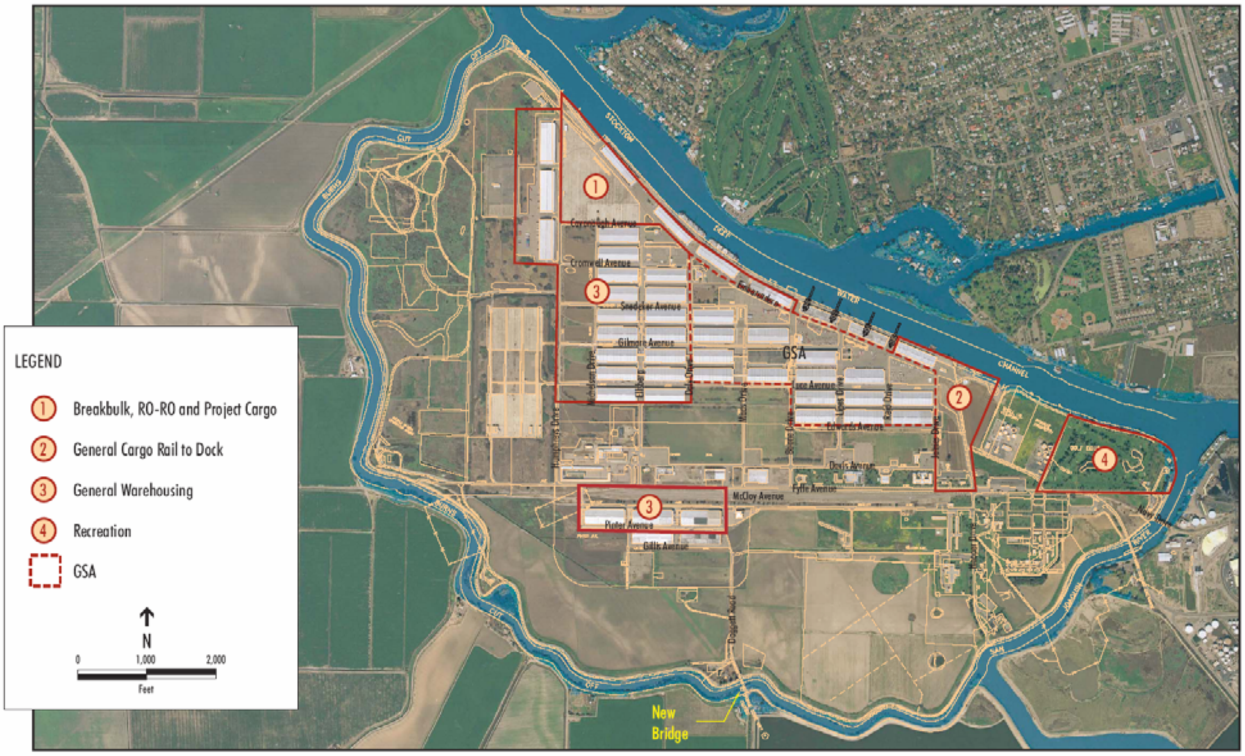
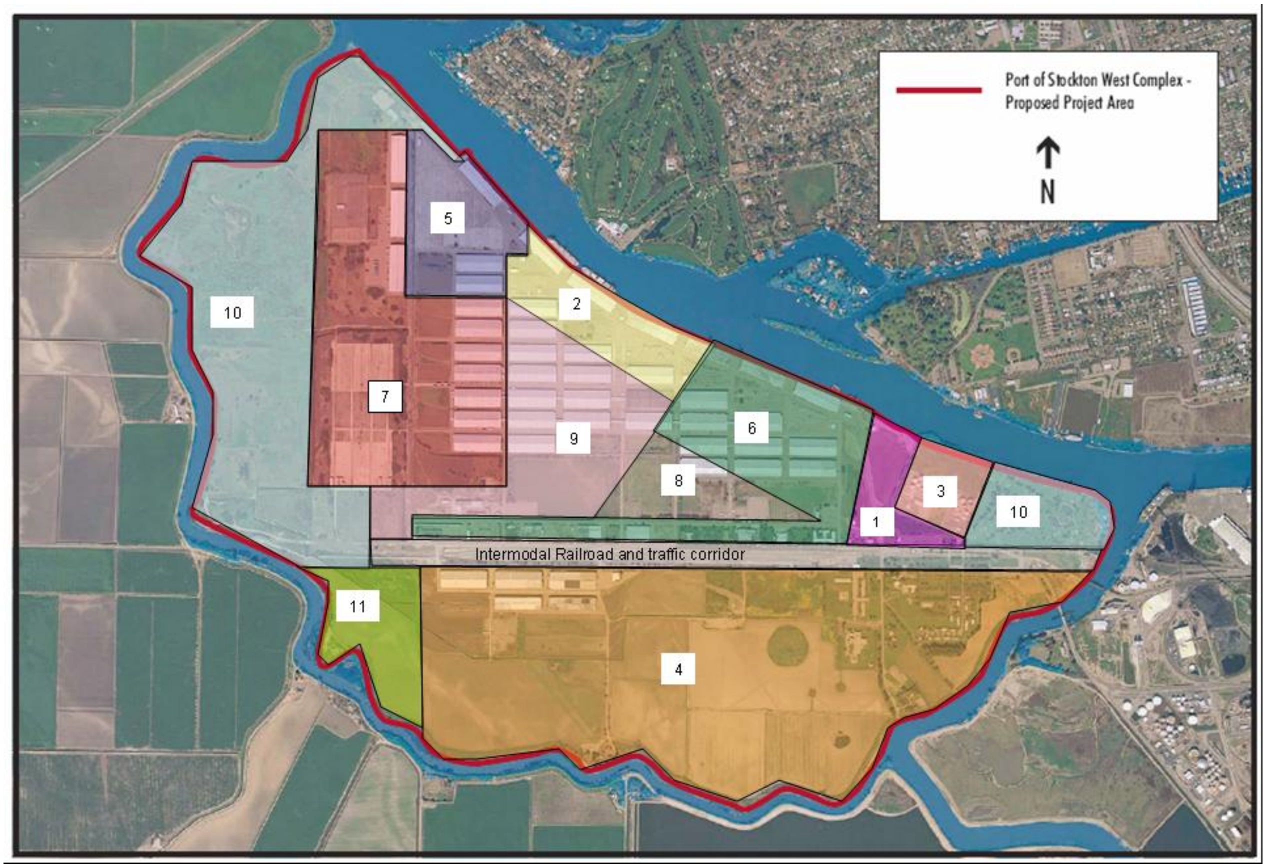


Figure 3: Existing West Complex Uses



1. Rail to Dock
2. Break Bulk Facility
3. Private Petroleum Plant (existing)
4. Commercial and Industrial Park
5. Auto Facility and 900’ wharf upgrade
6. Container Facility
7. Expanded break-bulk, Ro-Ro, & project cargo
8. Container expansion/intermodal transfer
9. Water related future development
10. Diversified land use
11. Proposed Immigration and Naturalization Service facility

Figure 4: Future West Complex Use

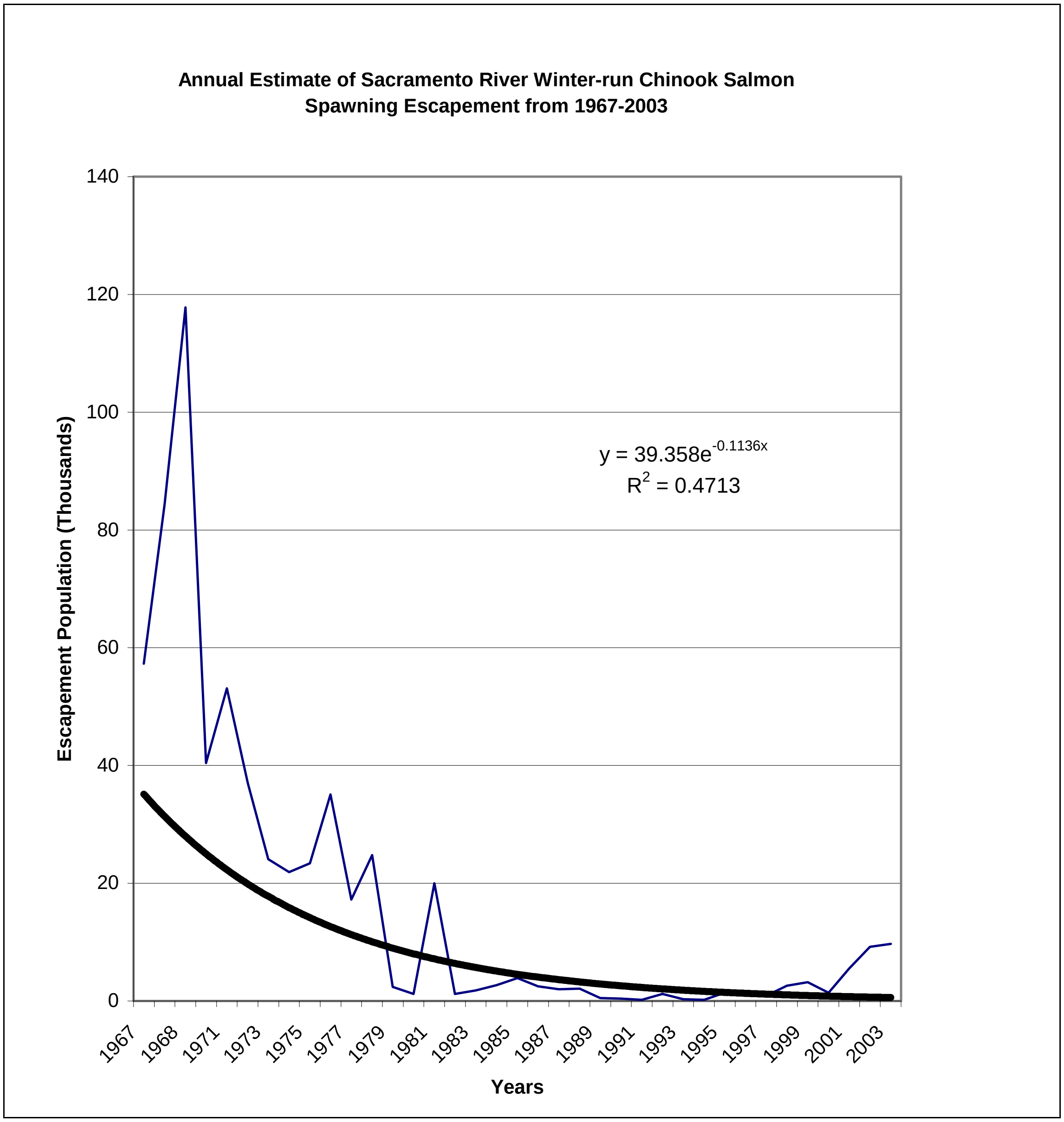


Figure 5:
Annual estimated Sacramento River winter-run Chinook salmon escapement population.
Sources: PFMC 2002, DFG 2004, NOAA Fisheries 1997
Trendline for figure 5 is an exponential function: $Y=39.358\ e^{-0.1136x}$, $R^2=0.4713$.

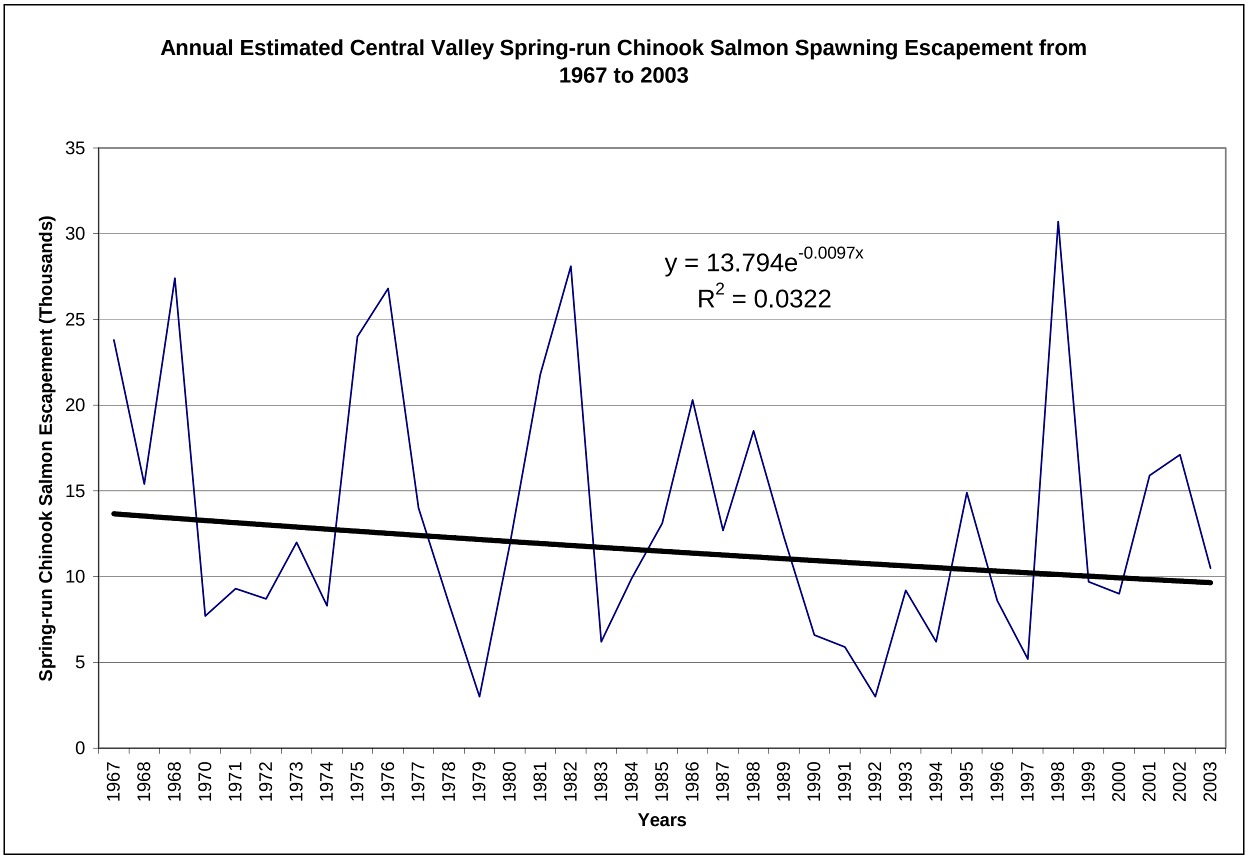
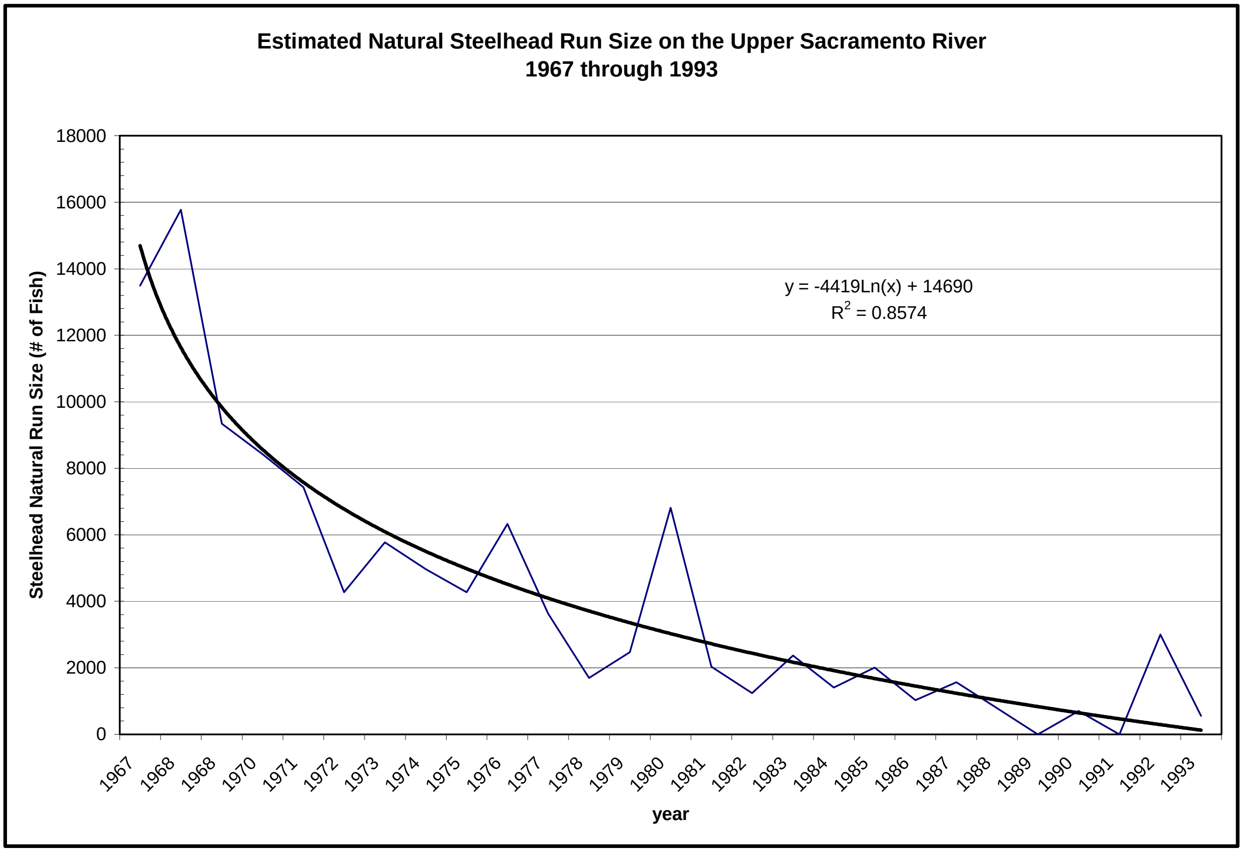


Figure 6:
Annual estimated Central Valley spring-run Chinook salmon escapement population for the Sacramento River watershed for years 1967 through 2003.
Sources: PFMC 2002, DFG 2004, Yoshiyama 1998.
Trendline for figure 6 is an exponential function: $Y=13.794\ e^{-0.0097}$, $R^2 = 0.0322$.



Note: Steelhead escapement surveys at RBDD ended in 1993

Figure 7:
Estimated Central Valley natural steelhead escapement population in the upper SacramentoRiver based on RBDD counts.
Source: McEwan and Jackson 1996.
Trendline for Figure 7 is a logarithmic function: Y= -4419 Ln(x) + 14690 R^2= 0.8574

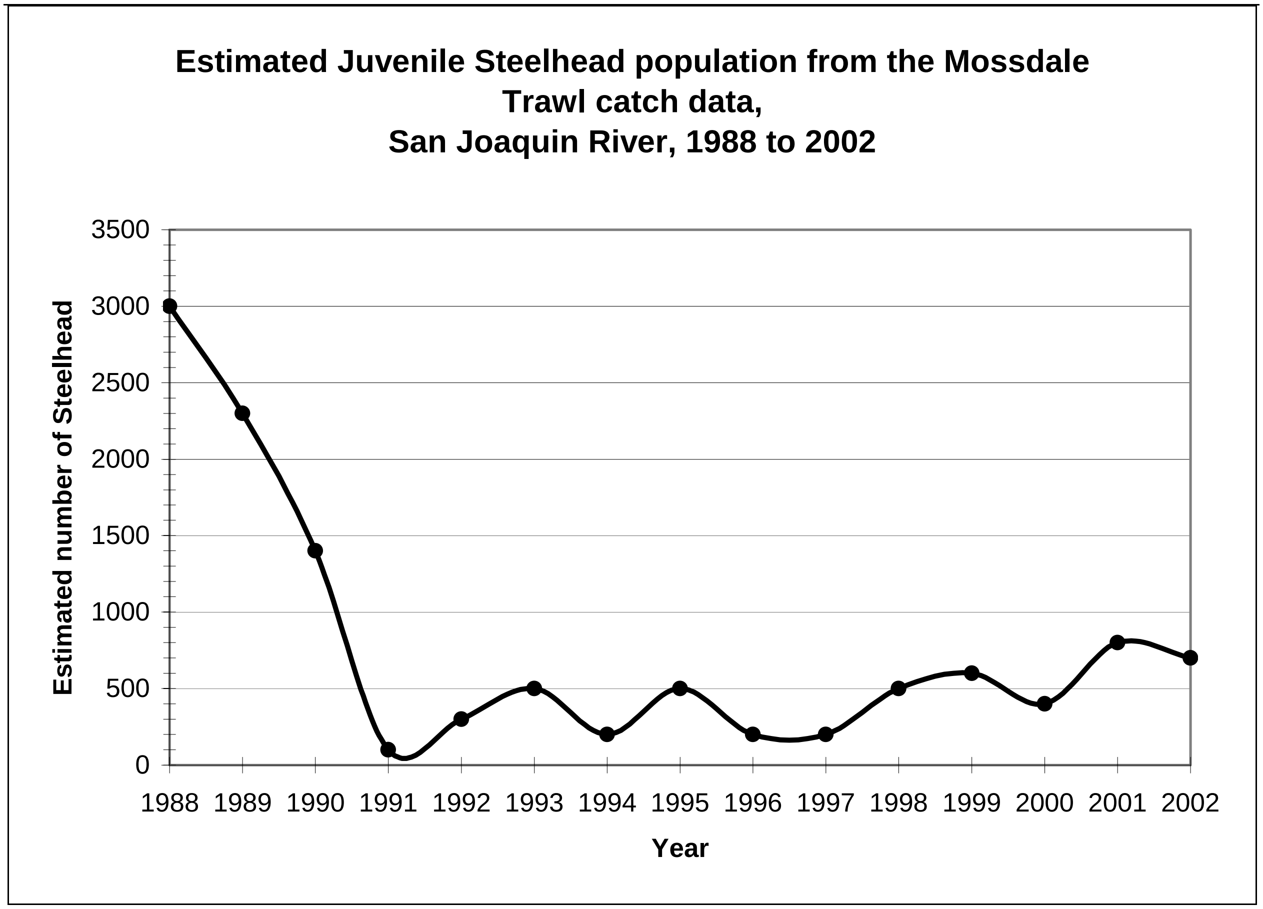


Figure 8:
Estimated number of juvenile Central Valley steelhead derived from the Mossdale trawl surveys on the San Joaquin River from 1988 to 2002.
Source: Marston (DFG), 2003.

Figure 9: Transformation and Transport of a Chemical in an Aquatic Environment
(Figure based on illustration in Rand [1995], page 450)

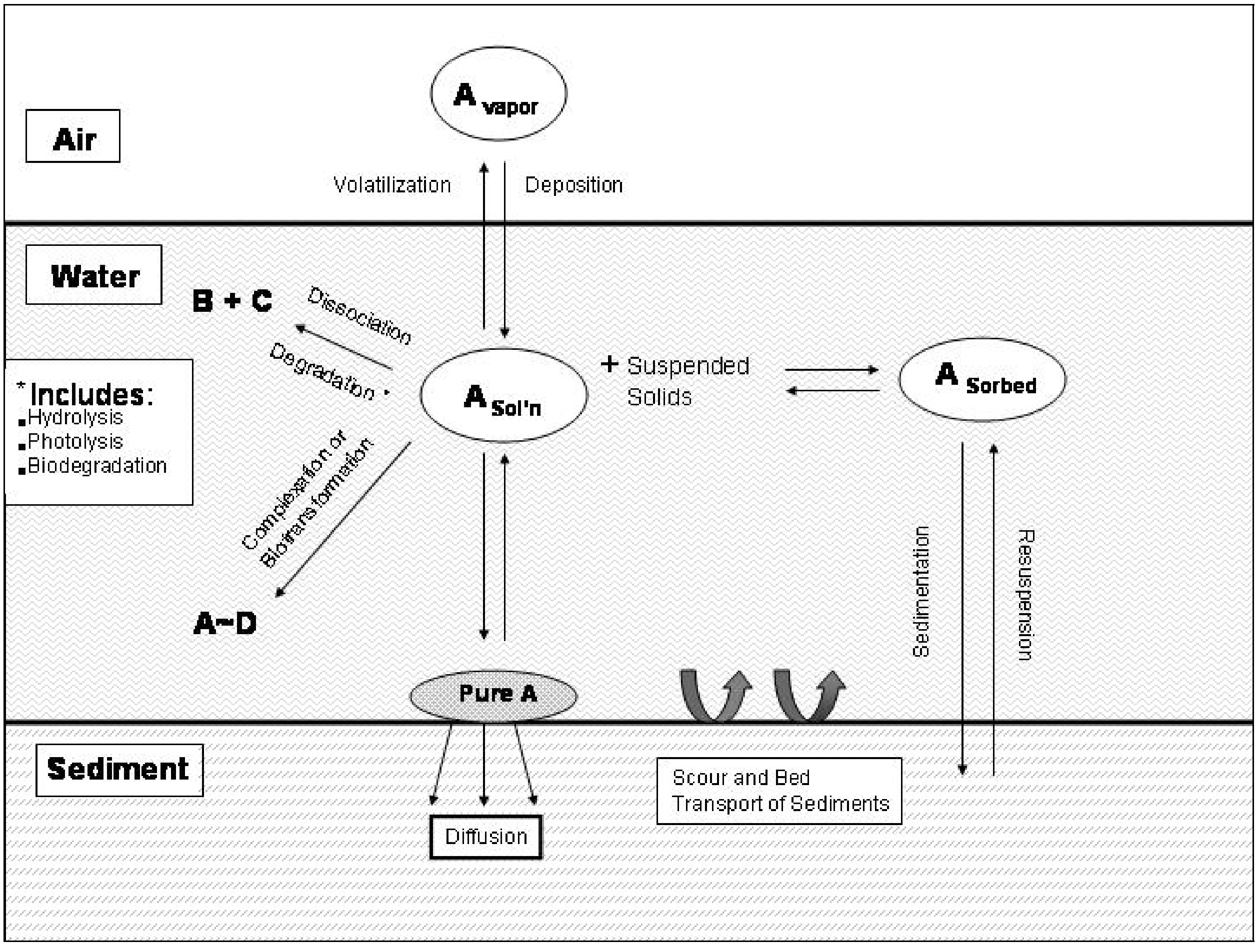


Figure 9 represents a cartoon of the generalized transformation and transportation processes of a chemical in an aquatic environment. Symbols "B" and "C" represent degradation products of chemical "A" and symbol "D" represents a ligand that complexes with or joins to compound A. For example, a proportion of the NH_3 present in the water column in solution would form NH_4^+ via hydrolysis under the influence of the ambient pH in the water column. The ammonium ion (NH_4^+) could then be transformed by microbial action into nitrite (NO_2^-) and then nitrate (NO_3^{-2}) ions. Likewise, the element copper could enter the aquatic environment from the sediment through resuspension and proceed through different pathways to affect aquatic organisms as a free or complexed metal ion.

Enclosure 2

Magnuson-Stevens Fishery Conservation and Management Act

ESSENTIAL FISH HABITAT CONSERVATION RECOMMENDATIONS

I. IDENTIFICATION OF ESSENTIAL FISH HABITAT

The Magnuson-Stevens Fishery Conservation and Management Act (MSA), as amended (U.S.C. 180 *et seq.*), requires that Essential Fish Habitat (EFH) be identified and described in Federal fishery management plans (FMPs). Federal action agencies must consult with the NOAA's National Marine Fisheries Service (NMFS) on any activity which they fund, permit, or carry out that may adversely affect EFH. NMFS is required to provide EFH conservation and enhancement recommendations to the Federal action agencies.

EFH is defined as those waters and substrates necessary to fish for spawning, breeding, feeding, or growth to maturity. For the purposes of interpreting the definition of EFH, "waters" includes aquatic areas and their associated physical, chemical, and biological properties that are used by fish, and may include areas historically used by fish where appropriate; "substrate" includes sediment, hard bottom, structures underlying the waters, and associated biological communities; "necessary" means habitat required to support a sustainable fishery and a healthy ecosystem; and "spawning, breeding, feeding, or growth to maturity" covers all habitat types used by a species throughout its life cycle. The proposed project site is within the region identified as EFH for Pacific salmon in Amendment 14 of the Pacific Salmon FMP and for starry flounder (*Platichthys stellatus*) and English sole (*Parophrys vetulus*) in Amendment 11 to the Pacific Coast Groundfish FMP.

The Pacific Fishery Management Council (PFMC) has identified and described EFH, Adverse Impacts and Recommended Conservation Measures for salmon in Amendment 14 to the Pacific Coast Salmon FMP (PFMC 1999). Freshwater EFH for Pacific salmon in the California Central Valley includes waters currently or historically accessible to salmon within the Central Valley ecosystem as described in Myers *et al.* (1998), and includes the San Joaquin Delta (Delta) hydrologic unit (*i.e.*, number 18040003), Suisun Bay hydrologic unit (18050001) and the Lower Sacramento hydrologic unit (18020109). Sacramento River winter-run Chinook salmon (*Oncorhynchus tshawytscha*), Central Valley spring-run Chinook salmon (*O. tshawytscha*), and Central Valley fall-/late fall-run Chinook salmon (*O. tshawytscha*) are species managed under the Salmon Plan that occur in the Delta, Suisun Bay and Lower Sacramento units.

Factors limiting salmon populations in the Delta include periodic reversed flows due to high water exports (drawing juveniles into large diversion pumps), loss of fish into unscreened agricultural diversions, predation by introduced species, and reduction in the quality and quantity of rearing habitat due to channelization, pollution, rip-rapping, *etc*. (Dettman *et al.* 1987; California Advisory Committee on Salmon and Steelhead Trout 1988, Kondolf *et al.* 1996a, 1996b). Factors affecting salmon populations in Suisun Bay include heavy industrialization within its watershed and discharge of waste water effluents into the bay. Loss of vital wetland habitat along the fringes of the bay reduce rearing habitat and diminish the functional processes that wetlands provide for the bay ecosystem.

A. Life History and Habitat Requirements

1. Pacific Salmon

General life history information for Central Valley Chinook salmon is summarized below. Information on Sacramento River winter-run and Central Valley spring-run Chinook salmon life histories is summarized in the preceding biological opinion for the proposed project (Enclosure 1). Further detailed information on Chinook salmon Evolutionarily Significant Units (ESUs) are available in the NMFS status review of Chinook salmon from Washington, Idaho, Oregon, and California (Myers *et al.* 1998), and the NMFS proposed rule for listing several ESUs of Chinook salmon (63 FR 11482).

Adult Central Valley fall-run Chinook salmon enter the Sacramento and San Joaquin Rivers from July through April and spawn from October through December (U.S. Fish and Wildlife Service [FWS] 1998). Chinook salmon spawning generally occurs in clean loose gravel in swift, relatively shallow riffles or along the edges of fast runs (NMFS 1997).

Egg incubation occurs from October through March (Reynolds *et al.* 1993). Shortly after emergence from their gravel nests, most fry disperse downstream towards the Delta and into the San Francisco Bay and its estuarine waters (Kjelson *et al.* 1982). The remaining fry hide in the gravel or station in calm, shallow waters with bank cover such as tree roots, logs, and submerged or overhead vegetation. These juveniles feed and grow from January through mid-May, and emigrate to the Delta and estuary from mid-March through mid-June (Lister and Genoe 1970). As they grow, the juveniles associate with coarser substrates along the stream margin or farther from shore (Healey 1991). Along the emigration route, submerged and overhead cover in the form of rocks, aquatic and riparian vegetation, logs, and undercut banks provide habitat for food organisms, shade, and protect juveniles and smolts from predation. These smolts generally spend a very short time in the Delta and estuary before entry into the ocean. Whether entering the Delta or estuary as fry or juveniles, Central Valley Chinook salmon depend on passage through the Sacramento-San Joaquin Delta for access to the ocean.

2. Starry Flounder

The starry flounder is a flatfish found throughout the eastern Pacific Ocean, from the Santa Ynez River in California to the Bering and Chukchi Seas in Alaska, and eastwards to Bathurst inlet in Arctic Canada. Adults are found in marine waters to a depth of 375 meters. Spawning takes place during the fall and winter months in marine to polyhaline waters. The adults spawn in shallow coastal waters near river mouths and sloughs, and the juveniles are found almost exclusively in estuaries. The juveniles often migrate up freshwater rivers, but are estuarine dependent. Eggs are broadcast spawned and the buoyant eggs drift with wind and tidal currents. Juveniles gradually settle to the bottom after undergoing metamorphosis from a pelagic larva to a demersal juvenile by the end of April. Juveniles feed mainly on small crustaceans, barnacle larvae, cladocerans, clams and dipteran larvae. Juveniles are extremely dependent on the condition of the estuary for their health. Polluted estuaries and wetlands decrease the survival rate for juvenile starry flounder. Juvenile starry flounder also have a tendency to accumulate many of the anthropogenic contaminants found in the environment.

3. English Sole

The English sole is a flatfish found from Mexico to Alaska. It is the most abundant flatfish in Puget Sound, Washington and is abundant in the San Francisco Bay estuary system. Adults are found in nearshore environments. English sole generally spawn during late fall to early spring at depths of 50 to 70 meters over soft mud bottoms. Eggs are initially buoyant, then begin to sink just prior to hatching. Incubation may last only a couple of days to a week depending on temperature. Newly hatched larvae are bilaterally symmetrical and float near the surface. Wind and tidal currents carry the larvae into bays and estuaries where the larvae undergo metamorphosis into the demersal juvenile. The young depend heavily on the intertidal areas, estuaries, and shallow near-shore waters for food and shelter. Juvenile English sole primarily feed on small crustaceans (*i.e.* copepods and amphipods) and on polychaete worms in these rearing areas. Polluted estuaries and wetlands decrease the survival rate for juvenile English soles. The juveniles also have a tendency to accumulate many of the contaminants found in their environment and this exposure manifests itself as tumors, sores, and reproductive failures.

II. PROPOSED ACTION

The proposed action is described in section II (*Description of the Proposed Action*) of the preceding biological opinion for endangered Sacramento River winter-run Chinook salmon, threatened Central Valley spring-run Chinook salmon and Central Valley steelhead (*O. mykiss*), critical habitat for winter-run Chinook salmon and proposed critical habitat for spring-run Chinook salmon and Central Valley steelhead (Enclosure 1).

III. EFFECTS OF THE PROJECT ACTION

The effects of the proposed action on salmonid habitat (*i.e.* for fall-run Chinook salmon) are described at length in section V (*Effects of the Action*) of the preceding biological opinion, and generally are expected to apply to Pacific salmon EFH. The general contaminant effects on the quality of EFH for the two species of flatfish are expected to be similar to those for salmon but will result in a greater magnitude of exposure to the two flatfish species due to their benthic life history. Benthic dwelling flatfish will have direct contact with contaminated sediment and will ingest sediment as well as benthic invertebrates during their foraging activities. Both the starry flounder and the English sole will spend more time as juveniles rearing in the action area than the Chinook salmon smolts. Therefore, these fish species will have a greater duration of exposure to the contaminants of concern than the juvenile Chinook salmon, leading to greater levels of adverse effects to the individual organisms. Furthermore, as indicated by the reports by CDFG staff of sturgeon propeller entrainment following large vessel passage, the two species of flatfish are expected to encounter conditions leading to propeller entrainment and are assumed to have some level of mortality and morbidity associated with this encounter.

IV. CONCLUSION

Based on the best available information, NMFS believes that the proposed Port of Stockton West Complex Dredging project and its associated upland development and Port activities may adversely affect EFH for Pacific salmon and groundfish during its initial and normal long-term operations.

V. EFH CONSERVATION RECOMMENDATIONS

NMFS recommends that the reasonable and prudent measures from the biological opinion be adopted as EFH Conservation Recommendations for EFH in the action area. In addition, certain other conservation measures need to be implemented in the project area, as addressed in Appendix A of Amendment 14 to the Pacific Coast Salmon Plan (PFMC 1999). NMFS anticipates that implementing those conservation measures intended to minimize disturbance and sediment and pollutant inputs to waterways would benefit groundfish as well.

Riparian Habitat Management–In order to prevent adverse effects to riparian corridors, the U.S. Army Corps of Engineers (Corps) and The Port (applicant) should:

- Maintain riparian management zones of appropriate width in the San Joaquin River and Calaveras River watersheds that influence EFH;
- Reduce erosion and runoff into waterways within the project area; and
- Minimize the use of chemical treatments within the riparian management zone to manage nuisance vegetation along the levee banks and reclamation district's irrigation drain.

Bank Stabilization–The installation of riprap or other streambank stabilization devices can reduce or eliminate the development of side channels, functioning riparian and floodplain areas and off channel sloughs. In order to minimize these impacts, the Corps and the applicant should:

- Use vegetative methods of bank erosion control whenever feasible. Hard bank protection should be a last resort when all other options have been explored and deemed unacceptable;
- Determine the cumulative effects of existing and proposed bio-engineered or bank hardening projects on salmon EFH, including prey species before planning new bank stabilization projects; and
- Develop plans that minimize alterations or disturbance of the bank and existing riparian vegetation.

Conservation Measures for Construction/Urbanization–Activities associated with urbanization (*e.g.*, building construction, utility installation, road and bridge building, and storm water discharge) can significantly alter the land surface, soil, vegetation, and hydrology and subsequently adversely impact salmon EFH through habitat loss or modification. In order to minimize these impacts, the Corps and the applicant should:

- Plan development sites to minimize clearing and grading;

- Use Best Management Practices in building as well as road construction and maintenance operations such as avoiding ground disturbing activities during the wet season, minimizing the time disturbed lands are left exposed, using erosion prevention and sediment control methods, minimizing vegetation disturbance, maintaining buffers of vegetation around wetlands, streams and drainage ways, and avoid building activities in areas of steep slopes with highly erodible soils. Use methods such as sediment ponds, sediment traps, or other facilities designed to slow water runoff and trap sediment and nutrients; and

- Where feasible, reduce impervious surfaces.

Wastewater/Pollutant Discharges–Water quality essential to salmon and their habitat can be altered when pollutants are introduced through surface runoff, through direct discharges of pollutants into the water, when deposited pollutants are resuspended (*e.g.*, from dredging or ship traffic), and when flow is altered. Indirect sources of water pollution in salmon habitat includes run-off from streets, yards, and construction sites. In order to minimize these impacts, the Corps and the applicant should:

- Monitor water quality discharge following National Pollution Discharge Elimination System requirements from all discharge points;

- For those waters that are listed under Clean Water Act section 303 (d) criteria (*e.g.*, the Delta), work with State and Federal agencies to establish total maximum daily loads and develop appropriate management plans to attain management goals; and

- Establish and update, as necessary, pollution prevention plans, spill control practices, and spill control equipment for the handling and transport of toxic substances in salmon EFH (*e.g.*, oil and fuel, organic solvents, raw cement residue, sanitary wastes, *etc*.). Consider bonds or other damage compensation mechanisms to cover clean-up, restoration, and mitigation costs.

VI. STATUTORY REQUIREMENTS

Section 305 (b) 4(B) of the MSA requires that the Federal lead agency provide NMFS with a detailed written response within 30 days, and 10 days in advance of any action, to the EFH conservation recommendations, including a description of measures adopted by the lead agency for avoiding, minimizing, or mitigating the impact of the project on EFH (50 CFR §600.920[j]). In the case of a response that is inconsistent with our recommendations, the Corps must explain its reasons for not following the recommendations, including the scientific justification for any disagreement with NMFS over the anticipated effects of the proposed action and the measures needed to avoid, minimize, or mitigate such effects.

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