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

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	United States Environmental Protection Agency, Region IX (USEPA)
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<u>Table of Contents</u>

I. STATUTORY AND REGULATORY INFORMATION 1
II. BACKGROUND AND CONSULTATION HISTORY 2
III. PROPOSED ACTION 3
  A. Overview of Programmatic Consultation 3
  B. Actions 4
    1. Dredging 4
    2. Knockdown 5
    3. Disposal 5
  C. LTMS Environmental Protection Measures 6
IV. ACTION AREA 7
  A. Geographic scope 7
  B. Habitat types 8
    1. Soft bottom habitat 8
    2. Wetland habitat 8
    3. Eelgrass habitat 10
V. EFFECTS OF THE ACTION 10
  A. Level of Effect 10
    1. Low 11
    2. Medium 11
    3. High 11
  B. Types of Effects 11
    1. Direct removal/burial of organisms 11
    2. Turbidity/siltation 12
    3. Contaminant release 12
    4. Release of oxygen consuming substances 13
    5. Entrainment 13
    6. Noise 13
    7. Adjacent habitat 14
    8. Invasive species 14
    9. Alteration to hydrodynamic regimes and physical habitat 15
  C. Effect by action 15
    1. Dredging 15
    2. Knockdown 17
    3. Disposal 17
  D. Effects Analysis 19
    1. Soft bottom habitat (prey loss) 19
    2. Wetland habitat (prey and refugia loss) 21
    3. Eelgrass habitat (refugia loss) 21
    4. Contaminants effects analysis 22
    5. Other effects 22
    6. Area outside San Francisco Bay 23
VI. EFH CONSERVATION RECOMMENDATIONS 23
  A. Soft bottom habitat permanent disturbance (prey loss) 23
  B. Eelgrass indirect effects (refugia loss) 24

C. Eelgrass direct effects (refugia loss) ... 26
D. Turbidity ... 29
E. Contaminants ... 30
F. Invasives ... 31
G. Other Submerged Aquatic Vegetation ... 31
H. Reporting requirements ... 32
VII. STATUTORY RESPONSE REQUIREMENT ... 32
VIII. SUPPLEMENTAL CONSULTATION ... 33
IX. LITERATURE CITED ... 33
Appendix 1. Contaminant Analysis ... 50
Appendix 2. Eelgrass Indirect Effects Flowchart ... 67
Appendix 3. Light Monitoring Protocol ... 68
Appendix 4. Southern California Eelgrass Mitigation Policy ... 71
Appendix 5. EFH Dredge Programmatic Report Form ... 78
Appendix 6. Comments provided by USACE and USEPA on draft consultation ... 79
Appendix 7. NMFS Responses ... 93

I. STATUTORY AND REGULATORY INFORMATION

The Magnuson-Stevens Fishery Conservation and Management Act (MSA), as amended by the Sustainable Fisheries Act of 1996, establishes a national program to manage and conserve the fisheries of the United States through the development of federal Fishery Management Plans (FMPs), and federal regulation of domestic fisheries under those FMPs, within the 200-mile U.S. Exclusive Economic Zone ("EEZ"). 16 U.S.C. §1801 *et seq*. To ensure habitat considerations receive increased attention for the conservation and management of fishery resources, the amended MSA required each existing, and any new, FMP to "describe and identify essential fish habitat for the fishery based on the guidelines established by the Secretary under section 1855(b)(1)(A) of this title, minimize to the extent practicable adverse effects on such habitat caused by fishing, and identify other actions to encourage the conservation and enhancement of such habitat." 16 U.S.C. §1853(a)(7). Essential Fish Habitat (EFH) is defined in the MSA as "those waters and substrate necessary to fish for spawning, breeding, feeding, or growth to maturity" 16 U.S.C. §1802(10). The components of this definition are interpreted at 50 C.F.R. §600.10 as follows: "Waters" include aquatic areas and their associated physical, chemical, and biological properties that are used by fish and may include aquatic areas historically used by fish where appropriate; "substrate" includes sediment, hard bottom, structures underlying the waters, and associated biological communities; "necessary" means the habitat required to support a sustainable fishery and the managed species' contribution to a healthy ecosystem; and "spawning, breeding, feeding, or growth to maturity" covers a species' full life cycle.

Pursuant to the MSA, each federal agency is mandated to consult with NMFS (as delegated by the Secretary of Commerce) with respect to any action authorized, funded, or undertaken, or proposed to be, by such agency that may adversely affect any EFH under this Act. 16 U.S.C. §1855(b)(2). The MSA further mandates that where NMFS receives information from a Fishery Management Council or federal or state agency or determines from other sources that an action authorized, funded, or undertaken, or proposed to be, by any federal or state agency would adversely effect any EFH identified under this Act, NMFS has an obligation to recommend to such agency measures that can be taken by such agency to conserve EFH. 16 U.S.C. §1855(4)(A). The term "adverse effect" is interpreted at 50 C.F.R. §600.810(a) as any impact that reduces quality and/or quantity of EFH and may include direct or indirect physical, chemical, or biological alterations of the waters or substrate and loss of, or injury to, benthic organisms, prey species and their habitat, and other ecosystem components, if such modifications reduce quantity and/or quality of EFH. In addition, adverse effects to EFH may result from actions occurring within EFH or outside EFH and may include site-specific or habitat-wide impacts, including individual, cumulative, or synergistic consequences of actions.

If NMFS determines that an action would adversely affect EFH and subsequently recommends measures to conserve such habitat, the MSA proscribes that the federal action agency that receives the EFH Conservation Recommendation must provide a detailed response in writing to NMFS within 30 days after receiving EFH Conservation Recommendations. The response must include a description of measures proposed by the agency for avoiding, mitigating, or offsetting the impact of the activity on EFH. In the case of a response that is inconsistent with NMFS EFH Conservation Recommendations, the federal agency must explain its reasons for not following the recommendations. 16 U.S.C. §1855(b)(4)(B).

II. BACKGROUND AND CONSULTATION HISTORY

The Long Term Management Strategy (LTMS) for the Placement of Dredged Material in the San Francisco Bay was organized in 1990 to evaluate and address the potential direct, indirect and cumulative effect of dredging and aquatic disposal of dredged material in the San Francisco Bay. The LTMS agencies include USACE, USEPA, San Francisco Bay Conservation and Development Commission (BCDC), and San Francisco Bay Regional Water Quality Control Board. The LTMS agencies issued a final Environmental Impact Statement (EIS)/Programmatic Environmental Impact Report (EIR) in 1998 with its recommended program to reduce in-Bay disposal and increase beneficial reuse of dredged material, and signed the Record of Decision in 1999. The LTMS is a 50-year plan that covers all federal and non-federal operations and maintenance dredging and dredged material placement in the region. The LTMS EIS/EIR and subsequent Management Plan did not explicitly include EFH consultation. Coordination with NMFS regarding EFH consultation began in 2004, with an official request for consultation on July 21, 2009. Because of the LTMS agency partnership and at the request of the USEPA and USACE this programmatic consultation has included the state agencies.

2004 – 2007	USACE, USEPA, and NMFS began discussions for Programmatic EFH consultation.
November 2007	USACE provided NMFS with Draft EFH Assessment
February 4, 2008	NMFS submitted comments on Draft EFH Assessment to USACE, USEPA, and BCDC including requests for additional information. Additional information requests included: • Specific reports referenced in the document • Electronic data files presented in the document • Data missing from tables in the document
February 19, 2008	USEPA provided NMFS with three of the requested reports.
February 23, 2009	NMFS requested status update from USACE on EFH Assessment based on comments provided and restated additional information request from 2008 not yet received.
July 21, 2009	USACE and USEPA issued request for Programmatic EFH consultation for operations and maintenance dredging activities in San Francisco Bay and associated placement of dredged material.
August 2009	NMFS requested additional information: • Electronic data files presented in the document • Data missing from tables in the document
November 2009 - January 2010	USACE and NMFS coordinated to fill data gaps needed for analysis of action effects on EFH.

February - May 2010	NMFS, USACE, USEPA, and BCDC met to discuss results of analyses and potential mitigation options.
May 1, 2010	NMFS provided a first draft of this document to USACE and USEPA for preliminary review.
May 21, 2010	USACE and USEPA comments received by NMFS (Appendix 6).
June 14, 2010	NMFS requested additional information from USACE and USEPA based on comments received.
June 17, 2010	Discussion regarding contaminant analysis and associated recommendations between USEPA and NMFS staff.
June 22, 2010	Additional information provided by USACE and USEPA.
July 13, 2010	Programmatic consultation concluded.

III. PROPOSED ACTION

A. Overview of Programmatic Consultation

This programmatic consultation applies to operations and maintenance dredging and dredged material placement/disposal projects within the defined geographic area (see section IV.A below) conducted by USACE (federally-authorized dredging projects) or by non-federal entities which USACE and USEPA review for authorization under section 10 of the Rivers and Harbors Act of 1899 (33 USC §403), section 404 of the Clean Water Act (33 USC §1344), and/or section 103 of the Marine Protection Research and Sanctuaries Act (33 USC §1401).

There are 7 in-water disposal sites and 123 maintenance dredging projects (15 generally maintained by USACE and 108 non-USACE) proposed for inclusion in this programmatic consultation (Table 1). Up to 10 additional non-federal maintenance dredging projects that have been previously authorized but are not explicitly named in Table 1 (referenced as "dummy" projects) may be covered by this programmatic consultation (see section V.D.1 for explanation of dummy projects). Some projects in Table 1 may not be covered if project-specific EFH Conservation Recommendations (*i.e.,* those recommendations related to eelgrass and contaminant levels, see section VII below) are not accepted.

Program activities are described in detail below, with certain limitations and restrictions. Specifically, this programmatic consultation will not cover the following: (1) any new or previously unauthorized dredging; (2) any deepening of areas below currently authorized depths plus allowable overdepth; (3) dredging for power plant maintenance; and (4) dredging for levee maintenance. Maintenance dredging of new or deepened areas following completion of initial work may be considered part of this consultation pending NMFS approval.

The time of coverage by this programmatic consultation matches the remaining duration of the LTMS Program. Originally a 50 year program, the LTMS has been in effect for 11 years, resulting in a 39 year lifetime for the current consultation. This programmatic consultation will cover the actions specified below until June, 2049. The USACE, USEPA, and NMFS will meet on the LTMS six year review cycle, or as needed, for the following purposes: (1) to evaluate and discuss the continued effectiveness of the programmatic consultation, (2) to ensure that activities authorized by the programmatic consultation continue to minimize adverse effects to EFH, and (3) to update procedures and project criteria, if necessary. The most recent LTMS six year review occurred in 2006, with the next review scheduled for 2012. An assessment of this programmatic consultation will occur in conjunction with the 2012 LTMS review, with subsequent assessments in 2018, 2024, 2030, 2036, 2042, and 2049.

At any time, NMFS may revoke or revise this programmatic consultation if it is determined that it is not being implemented as intended or if new information becomes available indicating a significant discrepancy in either the effects analysis or effectiveness of EFH Conservation Recommendations.

B. Actions

Below is a list of the actions currently employed for the purpose of maintaining previously dredged areas in San Francisco Bay:

1. Dredging

The dredging process involves the removal or excavation of bottom sediments from the aquatic environment in order to create or maintain waterways deep enough to support navigation, including access channels, turning basins, ports, and marinas. Dredging methods can be divided into two broad categories, mechanical and hydraulic (Gren 1976), differentiated primarily by the volume of water furnished with the dredged material. Mechanical dredges are commonly used for smaller, localized sites, and include clamshell, bucket, and excavator dredges. Hydraulic dredges remove and transport sediments by suction and pumping, which mixes large volumes of water with the sediment to form a slurry that is piped or barged to a disposal area. The most common hydraulic dredges include the cutterhead and the hopper dredge.

a. Mechanical dredging: Mechanical dredges remove bottom sediments by direct application of mechanical force to dislodge sediments, scooping the sediments from the bottom and placing them into a barge or scow for transport to a dredge disposal or reuse site.

i. Clamshell: A clamshell dredge employs a vertical loading grabber connected to wire rope which is lowered in the open position into the sediment, closed around the sediment load, and raised above the barge for deposit. Several diverse bucket configurations are available to be specifically tailored to the various sediment types.

ii. Environmental bucket: An environmental bucket is similar to a conventional clamshell dredge; however the environmental bucket generally has features that include some combination of covers, exterior pulleys, and sealed joints, intended to reduce the amount of sediments that can spill or flow out of the bucket during dredging activities (Wang *et al*. 2002).

iii. Excavator: Excavator dredging involves a backhoe excavator mounted to a barge. The excavator bucket is lowered to the seafloor where it scoops up sediment, brings the sediment up through the water column in the open bucket, where it is deposited on the barge.

b. Hydraulic dredging: Hydraulic dredges remove bottom sediments by suction force and those sediments are transported in the liquid slurry form for transport to a dredge disposal site.

i. Cutterhead: Cutterhead dredges are equipped with a rotating cutter apparatus surrounding the intake end of a suction pipe. The revolving cutterhead helps to break up bottom sediments and facilitates the pumping of the sediment up through the pipe.

ii. Suction/Hopper: Suction or hopper dredges are equipped with a drag arm, long suction pipes with drag heads attached to the end. During active dredging, the drag arm is slowly dragged across the seafloor using the forward motion of the vessel. The sediment and water slurry is drawn up through the drag head and drag arm by on-board pumps and deposited within the hopper bin. Once full, dredging ceases and the vessel moves directly to the disposal site where dredged material is disposed through large doors at the bottom of the dredge.

2. Knockdown

Knockdowns employ an I-beam or other similar equipment to redistribute shoaled sediment into deeper areas within the dredging site. These are generally used for smoothing the bottom following conventional mechanical or hydraulic dredging, and for managing localized mounds without the need to mobilize a full dredging episode. Typically knockdowns are used to alleviate shoaling in marinas, ports, and in some navigational channels.

3. Disposal

During the dredging process the sediment removed from the seafloor must be transported to and disposed of at an alternate location. Dredged material may be deposited in several different location types, including in-Bay, offshore, and nearshore unconfined locations, and upland disposal locations.

a. In-Bay: In-Bay disposal sites are open water locations within the San Francisco Bay action area (as defined in section IV below) but limited to the estuarine waters inside the Golden Gate Bridge. There are currently four in-Bay sites approved for disposal, including SF-9 and SF-10 in San Pablo Bay, SF-11 in the Central Bay, and SF-16 in Suisun Bay.

b. Offshore: Offshore disposal sites are open water locations within the San Francisco Bay action area (as defined in section IV below) located in the ocean waters outside of the Golden Gate Bridge, far from shore in deep water. There is currently one offshore, deep water site approved for placement of dredge material. SF-DODS (Deep Ocean Disposal Site) is located approximately 49 nautical miles offshore from the Golden Gate Bridge, encompassing an area of 4160 acres, at depths ranging from 2500 to 3000 meters.

c. Nearshore: Nearshore disposal sites are open water locations within the San Francisco Bay action area (as defined in Section IV below), located in the ocean waters outside the Golden Gate Bridge, but within 10 nautical miles of the Golden Gate Bridge. Currently there are two nearshore sites designated for placement of dredged material; these include SF-8 and SF-17 (under consideration) both located south of the Main Ship Channel.

d. Upland: Upland disposal includes any disposal site not located in the open waters of the San Francisco Bay action area (as defined in section IV below), and may include diked former baylands, wetlands surrounding the margins of the San Francisco Bay estuary, confined disposal facilities, rehandling facilities, levees requiring maintenance, sanitary landfills, construction sites, or sites suitable for habitat development (restoration, enhancement). Both mechanical and hydraulic equipment may be used to transport dredged material to an upland disposal site.

C. LTMS Environmental Protection Measures

Below is a list of the environmental protection measures implemented by the LTMS agencies to avoid or minimize adverse effects to EFH:

1. Reducing in-Bay disposal: Over the life of the San Francisco Bay LTMS, proposed 80 percent reductions in the volume of dredged material disposed of in the Bay will be achieved through the elimination of unnecessary dredging activities, and by maximizing reuse of dredged sediments. To date, in-Bay disposal has been reduced from 6.0 million cubic yards per year pre-1990 to less than 2.0 million cubic yards per year in 2009. The current level of annual in-Bay disposal is 1.64 million cubic yards.

2. Beneficial reuse of dredged material (habitat restoration): Dredged sediments that are determined to be suitable for reuse are used maximally to benefit the environment. The majority of beneficial reuse has been for restoring wetland ecosystems around San Francisco Bay (Table 2). Sediments are also being used to renourish eroded areas of coastline at Ocean Beach.

3. Dredged Material Management Office (DMMO) regulation on quality of sediments disposed in-Bay: Material to be dredged must be tested to determine wether it is suitable for the proposed disposal or reuse site.

Funding of scientific studies to improve knowledge about potential impacts of dredging and dredged material placement: To date, the San Francisco Bay LTMS has provided over $7 million in funding to support studies to investigate effects of dredging and dredge disposal on sensitive fish species, mercury contamination at wetland reuse sites, assessments of sediment resuspension associated with dredging activities and effect of turbidity on sensitive fish species. Information on how dredging has been modified or fish habitat has been protected as a result of these LTMS-funded studies has not been compiled for the purpose of this programmatic consultation.

The environmental protection measures described here and in the consultation initiation package as parts of the proposed action reduce or avoid adverse effects to EFH. The NMFS regards these environmental protection measures as integral components of the proposed action and expects that all proposed activities will be completed consistent with those measures. Any deviation from these environmental protection measures will be beyond the scope of this consultation and may require supplemental consultation to determine what effect the modified action is likely to have on EFH.

IV. ACTION AREA

The proposed activities occur within areas identified as EFH for various life stages of fish species managed with the following Fishery Management Plans (FMP) under the MSA:

Pacific Groundfish FMP – various rockfish, sole and sharks
Pacific Salmon FMP – Chinook salmon
Coastal Pelagic FMP – northern anchovy, Pacific sardine, mackerel, squid

In addition, some activities will occur within areas designated as Habitat Areas of Particular Concern (HAPC) for various federally managed fish species within the Pacific Groundfish FMP. HAPC are described in the regulations as subsets of EFH that are rare, particularly susceptible to human-induced degradation, especially ecologically important, or located in an environmentally stressed area. Designated HAPC are not afforded any additional regulatory protection under MSA; however, federal projects with potential adverse impacts to HAPC are more carefully scrutinized during the consultation process. As defined in the Pacific Groundfish FMP San Francisco Bay is designated as estuary HAPC. Submerged aquatic vegetation (SAV), such as eelgrass and widgeon grass, which occurs within the project footprint, is also designated as HAPC.

A. Geographic scope

The action area spans 11 counties, including Marin, Sonoma, Napa, Solano, Sacramento, San Joaquin, Contra Costa, Alameda, Santa Clara, San Mateo, and San Francisco Counties. The geographic scope of potential impacts included in this consultation comprises the estuarine waters of the San Francisco Bay region and portions of the Sacramento-San Joaquin Delta (Delta) west of Sherman Island. It also includes the wetlands and shallow intertidal areas that form a margin around the estuary and the tidal portion of its tributaries. Outside of the Golden Gate bridge, the action area includes ocean waters that encompass the San Francisco Main Ship Channel, the San Francisco Deep Ocean Disposal Site (SF-DODs), the San Francisco Bar Disposal Site (SF-8), the Ocean Beach near shore dredged material beneficial reuse site (SF-17), and the waters that are used by vessels en route to these sites. It does not include the mountainous or inland areas far removed from navigable waters. The action area defines the region where navigational dredging covered by the San Francisco Bay LTMS program may occur, where dredged material disposal and beneficial use sites are located and where additional disposal or beneficial use sites may be feasible. See Figure 1 for detailed representation of the action area and the geographic scope covered by this programmatic.

B. Habitat types

For the purposes of this programmatic consultation, habitats within the geographic scope of the proposed project are categorized and described as follows:

1. Soft bottom habitat

Soft bottom substrates are the most common substrate types in San Francisco Bay. They are characterized by a lack of large stable surfaces for plant and animal attachment. Exposure to wave and current action, temperature, salinity, and light penetration determine the composition and distribution of organisms within the sediments (USGS 1998). Two types of soft bottom substrate comprise the majority of the Bay bottom where dredging and disposal activities occur: sand and fine grain sediment.

a Sand benthic habitat: Bottom sediments that contain greater than 80% sand (particles 0.062 to 2.0 mm in diameter) are considered sand benthic habitat for the purposes of this document. Sand habitat is more dynamic than fine grain habitat due to greater movements of larger grain sediment by wave and current action. This reduces the amount of productivity and invertebrate species diversity in this habitat type, making it less valuable as foraging habitat for fish. However, sand substrate does provide benthic habitat for fish to reproduce, rear, and grow (NMFS 2007).

b Fine grain benthic habitat: Fine grain sediments include mud, silts, and clay (particles 0.001 to 0.062 mm in diameter). Bottom sediments that contain less than 80% sand are considered fine grain benthic habitat for the purposes of this document. Fine grain sediment is considered good foraging habitat for fish because, when undisturbed, it provides a substrate for invertebrate epifauna and infauna, upon which fish prey. Fine grain benthic habitat also provides substrate for fish to reproduce, rear, and grow (NMFS 2007).

2. Wetland habitat

There are numerous definitions for the term “wetland” with 19 recently identified by the San Francisco Estuary Institute (SFEI 2009). At the federal level both the US Fish and Wildlife Service (USFWS) and the Army Corps of Engineers (USACE) have specified unique definitions. The USFWS definition includes the following language:

> Wetlands are lands transitional between terrestrial and aquatic systems where the water table is usually at or near the surface or the land is covered by shallow water. For purposes of this classification, wetlands must have one or more of the following three attributes: (1) at least periodically, the land supports hydrophytes, (2) the substrate is predominantly undrained hydric soil; and (3) the substrate is non-soil and is saturated with water or covered by shallow water at some time during the growing season of each year.

The USACE defines wetlands as follows:

> The term "wetlands" means those areas that are inundated or saturated by surface or ground water at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions. Wetlands generally include swamps, marshes, bogs, and similar areas.

The USACE has established identification and delineation procedures for wetlands, specifically the USACE 1987 Wetland Manual and subsequent regional supplements (USACE 2010). According to the USACE definition and delineation methodology, areas that are not dominated by hydrophytes but that provide wetland beneficial uses and ecological services, such as tidal flats, are not necessarily identified as wetlands. However, tidal flats are known to provide productive shallow water habitat for epibenthic fishes (Sogard and Able 1991).

While all areas of a properly functioning wetland benefit fish in some way, there are specific components that are directly considered fish habitat. For the purposes this document, the following wetland components are considered fish habitat: tidal marsh, tidal flats, and tidal sloughs. Given the varying definitions for the term “wetland”, these wetland components that are important for fish survival, reproduction, and growth to maturity will be collectively referred to as “marsh complex” in subsequent sections.

Tidal marshes, which include brackish and salt marshes, are vegetated wetlands subject to tidal action that occur throughout much of the Bay extending from approximately Mean Sea level to the maximum height of the tides. Established tidal marshes provide an essential and complex habitat for many species of fish, other aquatic organisms and wildlife. Tidal marshes provide foraging habitat and refugia for fish (Boesch and Turner 1984). In the early 1800s, tidal marshes covered some 190,000 acres on the fringes of the Bay. Tidal marsh bordering the Bay now totals approximately 40,000 acres, a loss of approximately 80 percent of the Bay's historic tidal marshes.

Tidal flats occur from the elevation of the lowest tides to approximately Mean Sea Level and include mudflats, sandflats and shellflats. Mudflats comprise the largest area of tidal flat areas and support an extensive community of invertebrate aquatic organisms, such as diatoms, worms and shellfish, as well as fish that feed during higher tides, and plants such as algae and eelgrass. Of the 50,000 acres of tidal flats that historically occurred around the margins of the Bay, approximately 30,000 acres remain, a reduction of approximately 40 percent (Goals Project 1999).

Sloughs/channels are the primary paths of moving water through wetlands, providing fish access to productive foraging habitat. Sloughs are subtidal, allowing fish permanent access and offering a haven between tidal inundations of salt marshes. Slough habitat is used for more than just transit to productive wetlands as demonstrated by observations of greater species diversity in sloughs than in associated shallow tidal creeks (Desmond *et al*. 2000). Sloughs occur throughout the San Francisco Bay for example, Montezuma and Suisun Sloughs in Suisun Bay, branches off the lower portions of the Napa and Petaluma Rivers in the North Bay, branches off Corte Madera

Creek in the Central Bay, and Redwood, Alviso, and Guadalupe Sloughs in the South Bay.

3. Eelgrass habitat

Eelgrass (*Zostera marina*) is a flowering vascular plant that grows both subtidally and intertidally in estuaries and in shallow coastal areas. Studies have shown that seagrasses, including eelgrass, are among the areas of highest primary productivity in the world (Herke and Rogers 1993, Hoss and Thayer 1993). In San Francisco Bay, eelgrass beds are considered to be a valuable shallow-water habitat, providing shelter, feeding, or breeding habitat for many species of invertebrates, fishes, and some waterfowl. Eelgrass beds supply organic material to nearshore environments, and their root systems stabilize area sediments. Intermittent eelgrass surveys suggest eelgrass abundance has varied greatly in San Francisco Bay in the last several decades. In the late 1920s, eelgrass was reported as an abundant species along the shores of San Francisco Bay (Setchell 1929). In 1987 a survey of the Bay found only 128 hectares of eelgrass, with much of the existing habitat exhibiting conditions of environmental stress (Wyllie-Echeverria and Rutten 1989, Wyllie-Echeverria 1990). In 2003 hydro acoustic surveys documented 1165.7 hectares of eelgrass, covering approximately 1 percent of San Francisco Bay (Merkel & Associates 2004).

As discussed above, eelgrass is designated as EFH for various federally-managed fish species within the Pacific Groundfish and Pacific Salmon Fisheries Management Plans (FMP) (PFMC 2008 and PFMC 1999). Eelgrass is also designated HAPC for various species within the Pacific Groundfish FMP. Eelgrass is also considered a special aquatic site under the 404 (b)(1) guidelines of the Clean Water Act (40 CFR Part 230.43). Under these guidelines, special aquatic sites are subject to greater protection than other waters of the United States, because of their significant contribution to the overall environment.

Other native submerged aquatic vegetation, such as widgeon grass (*Ruppia*) or sago pondweed (*Stuckenia* or *Potamogeton*) occurs within San Francisco Bay. While less is known about these species than is known about eelgrass, they likely provide primary productivity and organic material to nearshore environments and may provide shelter for invertebrates and fishes. Native submerged aquatic vegetation is designated as EFH for various federally-managed fish species within the Pacific Groundfish and Pacific Salmon FMPs and is designated HAPC for various species within the pacific Groundfish FMP (PFMC 2008 and PFMC 1999).

V. EFFECTS OF THE ACTION

A. Level of Effect

As described in Section I above, the term "adverse effect" is interpreted at 50 C.F.R. §600.810(a) as any impact that reduces quality and/or quantity of EFH. Impacts to marine habitats from dredging related activities can be placed into three categories: (1) permanent loss; (2) degradation; and (3) periodic disturbance. Generally, activities that lead to a permanent loss of habitat reduce the quantity of habitat, whereas habitat degradation and periodic disturbances result in a loss of habitat quality. The primary differences between the three categories are that recovery of habitat function can not occur from permanent loss, recovery may or may not occur from degradation, and recovery is possible from periodic disturbances (Deegan & Buchsbaum 2005).

These three categories are interpreted as a low, medium or high level of effect in the current analysis, as described below:

1. Low

A low level of effect arises from an action that is short term, infrequent, and small in area, and does not affect sensitive habitat types (*i.e.*, eelgrass). The effect is considered a *periodic disturbance*. While low level effects should be avoided or minimized when possible, compensation is generally not required.

2. Medium

A medium level of effect arises when an action occurs for a long time but in a small area or conversely when an action occurs for a short time but over a large area. A medium level of effect may also arise from an action that occurs for a moderate time over a medium area, or negatively affects sensitve habitat types (*i.e.*, eelgrass). The effect is usually considered *degradation of habitat*. Avoidance or minimization of medium level of effects is recommended. Mitigation for medium level effects may be required if effects can not be avoided or minimized.

3. High

A high level of effect arises from an action that occurs for a long time across a large area, or destroys a sensitive habitat type (*i.e.*, eelgrass). The effect is usually considered a *permanent loss*. Avoidance or minimization of high level of effects is recommended. Mitigation for high level effects will be required if effects can not be avoided or minimized.

B. Types of Effects

Types of effects that are expected to result from the proposed maintenance dredging and associated activities are described below. While there is overlap among some of the effects (for instance many of things affect the availability of prey) these are the generally accepted categories of the environmental effects of dredging on EFH (Hanson *et al.* 2003).

1. Direct removal/burial of organisms

a. Prey: Many EFH species forage on infaunal and bottom-dwelling organisms, such as polychaete worms, crustacean, and other EFH prey types. Dredging may adversely effect these prey species at the site by directly removing or burying these organisms (Newell *et al.* 1998, Van der Veer *et al.* 1985) and providing substrate for invasive species (see section V.B.8). Recolonization studies suggest that recovery (generally meaning the later phase of benthic community development after disturbance when species that inhabited the area prior to disturbance begin to re-establish) may not be quite as straightforward, and can be regulated by physical factors including particle size distribution, currents, and compaction/stabilization processes following disturbance. Rates of recovery listed in the literature range from several months to several years for estuarine muds (McCauley *et al.* 1976, Oliver *et al.* 1977, Currie & Parry 1996, Tuck *et al.*1998, Watling *et al.* 2001) to up to

2 to 3 years for sands and gravels (Reish 1961, Thrush *et al.* 1995, Watling *et al.* 2001, Gilkinson *et al.* 2005). Recolonization can also take up to 1 to 3 years in areas of strong current but up to 5 to 10 years in areas of low current (Oliver *et al.* 1977). Thus, forage resources for fish that feed on the benthos may be substantially reduced before recovery is achieved. Based on available literature, NMFS will assume recovery of prey resources will not occur within one year.

b. Refugia: Dredging activities and the activities of associated equipment may directly damage or destroy spawning nursery and other sensitive habitats such as emergent marshes and subaquatic vegetation, including eelgrass. Direct removal of eelgrass can occur when eelgrass is growing within the project footprint to be dredged (Sabol *et al.* 2005). Eelgrass may be directly damaged by the dredging vessels and barges themselves. Impacts may result from the dredging vessel grounding, direct damage from propellers, and anchor scour. Eelgrass is also susceptible to damage by burial resulting from the sediments re-suspended during dredging, dredge material disposal, and from the prop wash associated with dredging vessels.

2. Turbidity/siltation

Dredging and dredge disposal activities may result in greatly elevated levels of fine-grained mineral particles, or suspended sediment concentration (SSC), and organic particles in the water column. The finer grain sediments, silts and clays, are more readily suspended and settle out slower than course sediments, such as sand and gravel. Dredging in areas with fine sediments are likely to have greater turbidity impacts than dredging in areas with coarse sediments (Sabol *et al.* 2005).

Turbidity plumes of suspended particulates reduce light penetration through the water column. Limited light availability has been identified as the primary factor controlling depth distribution, density, and productivity of eelgrass (Dennison & Alberte 1982, Dennison & Alberte 1985, Dennison & Alberte 1986, Zimmerman *et al.* 1991). Reductions in light available at the eelgrass canopy due to dredging-related turbidity may result in eelgrass loss, especially where eelgrass is growing at or near its lower depth limit. Even slight reductions in light availability result in lower rates of photosynthesis for subaquatic vegetation (Dennison 1987). Furthermore, phytoplankton productivity in the water column may be reduced as a result of elevated turbidity and increased light attenuation (Cloern 1987).

While fish in San Francisco Bay are exposed to naturally elevated concentrations of suspended sediments resulting from storm flow runoff events, wind and wave action, and benthic foraging activities of other aquatic organisms (Schoellhammer 1996), dredging induced concentrations of suspended sediments may be significantly elevated to have direct effects on fish behavior. If suspended sediment loads remain high for an extended period of time, fish may suffer increased larval mortality (Wilber & Clarke 2001), reduced feeding ability (Benfield & Minello 1996) and be prone to fish gill injury (Nightingale & Simenstad 2001a). Additionally, the contents of the suspended material may react with the dissolved oxygen in the water and result in short-term oxygen depletion to aquatic resources (Nightingale & Simenstad 2001).

3. Contaminant release

Dredging can disturb aquatic habitats by resuspending bottom sediments and, thereby, recirculating toxic metals, hydrocarbons, hydrophobic organics, pesticides, pathogens, and nutrients into the water column (USEPA 2000, SFEI 2008). Any toxic metals and organics, pathogens, and viruses, absorbed or adsorbed to fine-grained particulates in the sediment, may become biologically available to organisms either in the water column or through food chain processes. Dredging can also expose sediments that are more highly contaminated than previous surface sediments causing degradation of benthic and water column habitat. For further discussion of contaminant effects see Appendix 1.

4. Release of oxygen consuming substances

The disposal of dredged material can change the chemistry and the physical characteristics of the receiving water at the disposal site by introducing chemical constituents in suspended or dissolved form. The introduction of nutrients or organic material to the water column as a result of the discharge can lead to a high biochemical oxygen demand (BOD), which in turn can lead to reduced dissolved oxygen, thereby potentially affecting the survival of many aquatic organisms. Increases in nutrients can favor one group of organisms such as polychaetes or algae to the detriment of other types.

5. Entrainment

Dredging may result in the direct uptake of aquatic species by the suction field generated at the draghead or cutterhead of a hydraulic dredge (Reine & Clarke 1998). Definitive information in the literature shows that elicit avoidance responses to the suction dredge entrainment occurs for both benthic and water column oriented species (Larson & Moehl 1990, McGraw & Armstrong 1990). However, demersal fish are more likely to become entrained because they reside on or in the bottom substrates (Reine & Clarke 1998). Entrainment of prey species is an adverse effect to EFH through the reduction in the quality of the habitat for managed species. Entrainment of demersal fish by mechanical dredges, though rare, has also been documented1. Disposal of dredged material may result in the direct uptake of aquatic species, both EFH species and their prey, when an offloader is used to transport material. Entrainment can occur when a pump intakes water to generate the slurry (typically an 80:20 mixture of water and dredged material) that an offloader requires for material transport.

6. Noise

Dredging equipment and dredging related activities can generate underwater sound pressure waves that may adversely affect the ecological functioning of EFH. Sources of these underwater sounds originate from vessel propellers, pumps, generators, and from dredge buckets and dragheads coming in contact with the substrate (Clarke *et al*. 2002, Dickerson *et al*. 2001). These pressure waves have been shown to injure and kill fish (*e.g.*,, CalTrans 2001, Longmuir & Lively 2001, Stotz & Colby 2001, Stadler, pers. obs. 2002). Injuries associated directly with dredging are poorly studied, but include rupture of the swimbladder and internal hemorrhaging (CalTrans 2001, Abbott & Bing-Sawyer 2002, Stadler, pers. obs. 2002). Sound pressure levels (SPL) 100 decibels (dB) above the threshold for hearing is thought to be sufficient to damage the auditory system in many fishes (Hastings 2002).

1 Personal communication from J. Crocker, National Marine Fisheries Service, Protected Resources Division, 55 Great Republic Drive, Gloucester, MA, 01930, February 2010.

7. Adjacent habitat

Though dredging or disposal activities may be confined to a localized area, tides and currents can have a significant influence on the dispersal of suspended sediments into the adjacent areas. Indirect impacts to adjacent undredged areas may occur as a result of increased turbidity and possibly siltation associated with dredging activities (Sabol *et al.* 2005).

8. Invasive species

The introduction of exotic species into estuarine and marine habitats has been well documented (Rosecchi *et al*. 1993, Kohler & Courtenay 1986, Spence *et al*. 1996). Exotic fish, shellfish, pathogens, and plants can enter the environment from industrial shipping (*e.g.*, as ballast), recreational boating, aquaculture, biotechnology, and aquariums. Dredging activities contribute to the establishment of invasive species in several ways. Barges and hydraulic dredges that travel into San Francisco Bay carrying ballast waters from other areas can directly transport and introduce invasive species. The maintainence of shipping channels via dredging may indirectly lead to transport of invasive species by allowing large vessels (able to travel from far distances) access to the Bay. Additionally, the act of removing soft-bottom sediments and their associated biotic assemblages during dredging creates an area of disturbance which is extremely susceptible to recolinization by invasive species, often resulting in the displacement of native species. As a result, dredging can increase both the number of new invasive species entering the bay and the distribution and abundance of existing invasive species in the bay. Finally, disposal of non-native species with dredged materials at dipsersive in-Bay sites also allows increased distribution and abundances of existing invasive species.

The transportation of nonindigenous organisms to new environments can have many severe impacts on habitat (Omori *et al.* 1994). Long-term impacts of the introduction of nonindigenous and reared species can change the natural community structure and dynamics, lower the overall fitness and genetic diversity of natural stocks, and pass and/or introduce exotic lethal disease. Overall, exotic species introductions create five types of negative impacts: 1) habitat alteration, 2) trophic alteration, 3) gene pool alteration, 4) spatial alteration, and 5) introduction of diseases. Habitat alteration includes the excessive colonization of exotic species which preclude the growth of endemic organisms. The introduction of exotic species may alter community structure by predation on native species or by population explosions of the introduced species. Spatial alteration occurs when territorial introduced species compete with and displace native species. Although hybridization is rare, it may occur between native and introduced species and can result in gene pool deterioration. Non-native plants and algae can degrade coastal and marine habitats by changing natural habitat qualities. Introduced organisms increase competition with indigenous species or forage on indigenous species, which can reduce fish and shellfish populations. Long-term impacts from the introduction of nonindigenous and reared species can change the natural community structure and dynamics, lower the overall fitness and genetic diversity of natural stocks, and pass and/or introduce exotic lethal diseases. The introduction of exotic organisms also threatens native biodiversity and could lead to changes in relative abundances of species and individuals that are of ecological and economic importance. The introduction of bacteria, viruses, and parasites is another severe threat to EFH as it may reduce habitat quality. New pathogens or higher concentrations of disease can be spread throughout the environment resulting in deleterious habitat conditions.

9. Alteration to hydrodynamic regimes and physical habitat

Dredging may modify current patterns and water circulation of the habitat by changing the direction or velocity of water flow, water circulation, or dimensions of the water body traditionally used by fish for food, shelter or reproductive purposes.

C. Effect by action

1. Dredging

Certain effects of dredging are ubiquitous and do not vary significantly in the level of intensity among the various equipment types. Acre-for-acre of bottom substrate disturbed, the effects of a hydraulic dredge are assumed equivalent to mechanical dredges in terms of the direct removal/burial of organisms, influencing invasive species abundance and distribution, and alteration of hydrodynamic regimes and physical habitat. However, for other effects, such as turbidity, noise, and entrainment, the nature of these direct and indirect effects, and the level of those effects vary by the types of equipment used, site specific conditions, and sediment type at the site.

a. Mechanical dredging: Mechanical dredges are moderately precise but typically generate more suspended sediments throughout the water column than hydraulic dredges. Sediments may become suspended due to the bucket's impact to the bottom, material washing from the top and side of the bucket as it passes through the water column, sediment spillage as it breaks the water surface, spillage of material during barge loading, and intentional overflow in an attempt to increase the barge's effective load (Nightingale & Simenstead 2001). A study characterizing the spatial extent of turbidity plumes during dredging operations in Oakland Harbor found the closed bucket dredge generated elevated concentration of suspended sediments. Ambient Total Suspended Sediment (TSS) concentrations were typicall less than 50 mg/l. While exact plume trajectories were dynamic, turbidity levels above ambient were detected up to 400 meters both up- and down-current from the source. But in general, significantly elevated TSS concentrations greater than 225 mg/l were detected up to 250 meters from the source (MEC Analytical Instruments, Inc. 2004).

In general, mechanical dredges produce a complex combination of several different types of repetitive sounds which may be intense enough to cause injury to fish, though the intensity, periodicity, and spectra of emitted sounds differ among the dredge types (Clarke *et al*. 2002, Dickerson *et al*. 2001). The most intense sound impacts are produced during the bucket's impact with the substrate, with peak sound pressure levels (SPL) of 124 dB measured 150 meters from the bucket strike location (Clarke *et al*. 2002). Entrainment is not an impact typically associated with mechanical dredges.

i. Clamshell: A clamshell dredge if properly maintained and operated may be effective in dredging sediments without resulting in excessive turbidity plumes. However, when not properly maintained or operated, clamshell dredges may generate significant concentrations of suspended sediment throughout the water column. Clamshell dredges have a repetitive sequence of sounds generated by the winches, bucket impact with the substrate, closing and opening the bucket, and sounds associated with dumping the dredged material into the barge. Although clamshell dredges generate less turbidity than excavator dredges, high turbidity is common during routine operations.

ii. Environmental bucket: Modifications to the traditional clamshell bucket design results in less sediment re-suspension than the traditional clamshell. The enclosed nature of this type of bucket is intended to reduce the amount of sediment that spills out of the bucket during digging, lifting through the water, or exiting the water surface. Hayes *et al*. (1984) found that environmental buckets provided up to 35 to 45 percent reduction of suspended sediment in the middle and upper water column compared to the conventional clamshell. Other than the reduction in suspended sediment, the effects of the environmental bucket are comparable to those of the traditional clamshell dredge.

iii. Excavator: Excavator dredges result in the highest suspended sediment concentrations throughout the water column, as much as 2.5 times higher than that of all other dredge equipment (LaSalle 1990). It is assumed that excavator dredges would produce sounds similar to those detailed for the clamshell dredge above.

b. Hydraulic dredging: Hydraulic dredges typically re-suspend less sediment than mechanical dredges. While overall turbidity may be lower, and tends to be lower through the water column, turbidity is still generated near the bottom. Sediments may be re-suspended as the cutter or the drag head moves across the bottom. Compared to mechanical dredges, hydraulic dredges are a source of continuous sounds, produced from a combination of vessel noise, *i.e.*, engine/propeller, pumps, generators, and the noise produced from the drag head's contact with the bottom (Clarke *et al*. 2002, Dickerson *et al*. 2001). While the sound produced by hydraulic dredges may not be severe enough to cause physiological damage to fish, it is likely significant enough to effect fish behavior. Entrainment of fish is a significant issue associated with hydraulic dredges. Entrainment can occur when a fish is trapped in the uptake of sediments and water being removed by the dredging machinery.

i. Cutterhead: Some hydraulic dredges use a revolving cutterhead to break up the sediment in order to facilitate removal. Cutterheads have the least precision of the various dredge equipment. There may be some re-suspension of bottom sediment by the movement of the cutterhead as it swings back and forth across the dredge site. These turbidity plumes are restricted to the lower water column closest to the bottom. In general the cutterhead dredge has the least affect on sediment re-suspension compared to other dredge equipment. The cutterhead itself does produce a continuous sound made by the cutter rotating through the substrate. Peak SPL for the cutterhead dredge were 100-110 dB in the frequency range of 70-1000 Hz approximately 500 meters from the source (Clarke *et al*. 2002).

ii. Suction/Hopper: Hopper dredges are considered the most precise compared with other dredge types. Under certain conditions, hopper dredges are prone to capturing high volumes of water when dredging fine grained materials. When a scow is loaded with overly liquidous dredge material it reduces the volume of material that may be carried within each scow load. The practice of "overflow", when the excess water is released from the scow during dredging to make room for more sediment material, results in the release of highly turbid water back into the water column. One of the hopper dredges used in San Francisco Bay, *The Essayons*, is fit with an anti-turbidity valve that may reduce turbidty during overflow.

Without overflow, hopper dredges follow cutterhead dredges as the second lowest turbidity generating dredge equipment. There is some sediment re-suspension due to the movement of the drag head as it moves across the dredge site, however, these turbidity plumes are restricted to the lower water column closest to the bottom. When hopper dredges overflow, unconfined sediments are returned to the water which results in a turbidity plume that extends down through the water column as these sediments settle out. According to Barnard (1978), turbidity resulting from the hopper dredge during overflow is comparable to that from a clamshell dredge.

Hopper dredges produce a combination of sounds from the engine/propeller, and from the sound of the draghead moving in contact with the substrate (Clarke *et al*. 2002, Dickerson *et al*. 2001). Peak SPL for the hopper dredge were 120-140 dB in the frequency range of 70-1000 Hz (Clarke *et al*. 2002, Dickerson *et al*. 2001).

2. Knockdown

The effects of knockdowns are somewhat different compared to other dredging techniques, as material is not removed completely but rather is redistributed within the area dredged. The burial of organisms, re-suspension of sediments and associated contaminants, and alteration to the hydrodynamic regime and physical habitat are the major effects associated with knockdowns. Based on the results of Clarke *et al*. (2004) the spatial and temporal extent and the magnitude of suspended sediment concentrations generated by knockdown dredges is site- and equipment-specific, but may generate high turbidity plumes. Though no reference was available on the subject, it is assumed that the noise resulting from a knockdown dredge would be similar to those produced by other dredge equipment while in contact with the sediment surface.

3. Disposal

The effects of in-water dredge material disposal can vary by location and type (*i.e.*,, in-Bay versus oceanic) of disposal site. In all cases, the unconsolidated particles discharged into the aquatic environment remain temporarily in suspension following discharge, creating a turbidity plume extending from the surface, through the water column, all the way to the bottom, and which may extend into adjacent habitats. The spatial and temporal extent of the turbidity plume resulting from disposal is specific to the sediment grain size of disposed material and the hydrodynamic regime of the site. Disposal sites differ in the nature of sediment dispersion due to differing current regimes among sites within the Bay and also between the Bay and the open ocean. Sediment dispersion will also vary with depth of the disposal site.

Disposing dredged material may adversely affect infaunal and bottom-dwelling organisms at the site by smothering immobile organisms, (*e.g.*,, invertebrate prey species) or forcing mobile animals (*e.g.*,, benthic oriented fish species) to migrate from the area. As discussed in section V.B.1 above, NMFS assumes recovery of prey resources will take 3 to 5 years, thus recovery of the benthic community is unlikely at disposal sites where disposal occurs with any frequency greater than annually. Based on records provided by USACE, all of the in-Bay and oceanic disposal sites are disposed at multiple times per year, indicating that these areas may be frequently disturbed.

In addition, erosion, slumping, or later displacement of sediment affects substrates in adjacent areas. The location, method, and timing of discharges may all influence the degree of impact on the substrate and receiving waters. The discharge of dredged material may change the chemistry and the physical characteristics at the disposal site by introducing chemical constituents in suspended or dissolved form. The level of contaminants approved for disposal varies among the different disposal sites.

a. <u>In-Bay:</u> In-Bay disposal sites are dispersive and located in areas where the dredged sediment is expected to be redistributed through the sediment transport system. These sites tend to be shallower than the offshore open-water disposal site and these shallower depths shorten the distance sediments travel in the currents before settling to the bottom. The exact nature of dispersal varies among the various in-Bay sites due to the bathymetry and hydrodynamic regime at each individual site. Disposal at in-Bay sites is limited to unconsolidated dredge materials that meet the standards for concentrations of contaminants proposed by the DMMO. Each of the in-Bay disposal sites are disturbed via disposal activities at least annually. Therefore in-Bay disposal sites are considered a permanently disturbed, or a high level effect.

b. <u>Offshore:</u> The one existing offshore disposal site is a deep water site. Because SF-DODs is located in the open ocean and in extremely deep water, sediments disposed there may disperse across a large area. SF-DODs is characterized by slow deposition with little to no sediment mass movement, making it a suitable location for dredge material disposal (Chin & Ota 2006). Studies have demonstrated that disposal of dredged material has had no regional impact or degradation of benthic infauna (Blake *et al*. 2009). Because SF-DODs is significantly deeper, and much more dispersive than the shallower in-Bay and nearshore disposal sites, bottom sediments are likely less disturbed. Therefore SF-DODs is not considered permanently disturbed. Sediments proposed for ocean disposal must also meet specific criteria for contaminants but in general the thresholds for offshore disposal are less conservative than those for in-Bay or nearshore disposal.

c. <u>Nearshore:</u> The two existing nearshore disposal sites are in deeper water than the in-Bay disposal sites, but not nearly as deep as the offshore site. The increased depth may result in sediments dispersing further than at in-Bay sites. However, both SF-8 and SF-17 were designated as disposal sites for clean sand only, therefore, these course sediments settle out of suspension faster than fine sediments disposed at other disposal sites. Furthermore, the location of SF-8 and SF-17 were chosen such that sediments would ultimately disperse towards an eroded area of the adjacent coastline. SF-8 and SF-17 are disposed at frequently enough to be considered permanently disturbed.

d. <u>Upland:</u> Upland disposal sites include a variety of disposal locations that each poses their own specific set of effects to EFH. Entrainment of aquatic species (fish, invertebrates, fish larvae, fish eggs) may occur if an offloader is used for upland disposal. Entrainment can occur when a pump intakes water to generate the slurry (typically an 80:20 mixture of water and dredged material) that an offloader requires for material transport. Offloaders may be equipped with screens to prevent entrainment of certain size fish, however entrainment of some prey species (*i.e.,* plankton) is unavoidable.

Typically, sediments with concentrations of contaminants deemed not suitable for in-Bay or offshore disposal are required to be disposed of at suitable upland sites, such as rehandling facilities or sanitary landfills. Sediments disposed of in upland beneficial reuse sites, such as wetland creation sites, must meet specific guidelines for contaminants.

D. Effects Analysis

1. <u>Soft bottom habitat (prey loss)</u>

In order to quantify the spatial extent of the effects of dredging and dredge disposal attributable to maintenance dredging in San Francisco Bay, an analysis was performed using GIS and project information provided by the USACE. Spatial data representing the shoreline of San Francisco Bay at Mean Sea Level was used to calculate the total two dimensional area of the Bay in acres. Polygons representing individual dredging projects and disposal locations (Figure 1, Table 1) were overlain onto spatial data to calculate the total two dimensional area of the Bay that is disturbed by dredging related activities in acres (Table 3). It must be acknowledged that calculated areas are estimates only and do not represent exact acreages disturbed. In some instances polygons representing specific projects may have covered a larger area than is actually dredged and in some instances a smaller area than is actually dredged. Calculated values were determined merely to provide a rough estimate of in-Bay disturbance caused by dredging related activities. Additionally, areas do not take into account volumes of sediment removed or disposed, nor movement of sediment into adjacent areas (*i.e.,*, turbidity).

Data associated with each dredging project was used to further refine calculations. Project associated data included the following: dredger affiliation (USACE or non-USACE), sediment type (fines or sand), and frequency of dredging. Frequency of dredging was consolidated into three categories: dredging occurs at least once a year (high level effect), dredging occurs every 1-2 years (medium level effect), and dredging occurs every 3 years or greater (low level effect). Again, uncertainty in each of the associated data categories must be acknowledged. Data was provided by the USACE or extrapolated from information provided to the DMMO since 2003. In general, the USACE dredge projects include the federal navigation channels. Other projects, such as the Larkspur Ferry Channel, are sometimes dredged by the USACE though not always. The sediment type category is a rough estimate of the type of sediment dredged from each project area. It is acknowledged that the sand sediment area dredged may be an overestimate due to projects being listed with sand sediment even though sand may not be present in the entire project area. Similarly, the area that is dredged with a frequency of at least once per year may be an overestimate due to the fact that while dredging may occur at the project site every year, the entire area may not be dredged. However, the area in this most frequently dredged category may be an underestimate should a project in one of the other categories need to dredge more frequently.

Ten additional polygons were included in the spatial analysis as “dummy projects” to account for maintenance dredging projects that were not on the list of projects provided by the USACE. Data associated with the dummy projects was generated using average values from data associated with non-USACE projects.

From the spatial analysis, total area of the Bay was calculated to be 285,786.2 acres. Total area of the Bay where disposal of dredged material occurs was calculated to be 550.2 acres. Total area of the Bay dredged was calculated to be 9,444.2 acres. Thus, our best estimate of the total area of the Bay disturbed by dredging and disposal activities was calculated to be 9,994.4 acres (or 3.5% of the Bay, Table 3).

Recovery rates of soft bottom benthic habitat (see section V.B.1 above) indicate that annual disturbance is a high level effect (Table 4), from which recovery is unlikely. All in-Bay disposal sites (550.2 acres total) are considered to be annually disturbed. Total area of the Bay dredged annually was calculated to be 3,314.9 acres. Thus, the best estimate of the total area of the Bay disturbed annually by dredging and disposal activities was calculated to be 3,865.1 acres (1.4% of the Bay). As previously mentioned, the annual nature of these disturbances indicates these areas are permanently disturbed, and subject to high level effects.

a. <u>Sand benthic habitat:</u> The total area of sand habitat disturbed annually was calculated to be 988.5 acres (Table 5). Annual disturbance is considered a high level effect, particularly in areas with high productivity, due to the loss of foraging habitat. Sand habitat functions primarily as area in which fish can reproduce, rear, and grow. Productivity may be lower in sand than in fine grain substrate. So, although annual disturbance of sand sediment does reduce the function of this habitat, it is considered to be a medium level effect. With the application of LTMS Environmental Protective Measure #2 (section III.C.2), beneficial reuse of sand sediment for beach nourishment, the effect to sand habitat is partially compensated for.

b. <u>Fine grain benthic habitat:</u> The total area of fine grain habitat that is dredged annually was calculated to be 2,326.4 acres. Including the area of in-Bay disposal sites increases this number to 2,876.6 acres. Given the high productivity in fine grain sediment, the annual disturbance of 2,876.6 acres is considered a high level effect to foraging habitat. Via LTMS Environmental Protective Measure #2 (section III.C.2), beneficial reuse of dredged sediment for wetland restoration, approximately 4,567 acres of wetlands have been or will be created (Table 2). Table 2 shows the total acreage for each LTMS wetland restoration project currently in progress. Each project is broken down with estimates for acreage of soft bottom habitat anticipated to be created over both the short- and long-term as the resorations sites develop. Via LTMS Environmental Protective Measure #2, 2,876.6 acres of the wetlands created may be applied to compensate for the 2,876.6 acres of fine grain habitat disturbed annually. This is considered partial compensation for the dreding-related impacts to fine grain habitat because only 509.5 acres of the wetlands created will become soft bottom habitat. Although the 509.5 acres of soft bottom habitat created within these restored wetlands will be highly productive soft bottom habitat, this value will not be realized for some time. Due to the out-of-kind nature of the majority of the acreage applied to fine grain benthic habitat loss and the delayed functioning of the in-kind acreage, additional EFH Conservation Recommendations have been made.

2. Wetland habitat (prey and refugia loss)

Building on the analysis described above for soft bottom habitat, a further analysis was conducted to quantify the spatial extent of the effects of dredging to wetland habitat. In order to limit impacts to those affecting "marsh complex" habitat (defined in section IV.B.2 above) data layers representing tidal marsh, tidal flats (from figure 2.7, Goals Project 1999), and slough habitat[2] for San Francisco Bay were incorporated into the GIS developed for the soft bottom analysis. Acreage of "marsh complex" disturbed was calculated from the area of overlap of a dredge project footprint with tidal marsh, tidal flat, or slough habitat. Similar to the caveats described above, this analysis was conducted merely to provide a rough estimate of habitat disturbed and acreages should not be considered exact.

From the spatial analysis, the total area of wetland "marsh complex" that is dredged was calculated to be 525.5 acres. Of that, 143.2 acres are tidal marsh or tidal flat and 382.3 acres are slough habitat. Of the slough habitat, 101.7 acres are from Suisun Channel. Due to the valuable function of "marsh complex" as refugia and foraging habitat, disturbance of this habitat type is considered a high level effect. Via LTMS Environmental Protective Measure #2 (section III.C.2), beneficial reuse of dredged sediment for 4,567 acres wetland restoration, and after compensation for fine grain benthic habitat loss with 2,876.6 acres of that, approximately 1,690.4 acres of the wetland restoration may be applied to compensate for effects to wetland "marsh complex" habitat. Thus the effects to wetland "marsh complex" habitat are considered to be compensated for.

3. Eelgrass habitat (refugia loss)

Building on the analysis described above for soft bottom habitat, a further analysis was conducted to quantify the spatial extent of the effects of dredging to eelgrass habitat. Data layers representing known eelgrass locations identified in San Francisco Bay during surveys conducted in 2003 and 2009 were incorporated into the GIS developed for the soft bottom analysis (Merkel & Associates 2004; Merkel & Associates In preparation). As described in sections V.B.1 and 2 above, effects to eelgrass from dredging related activities may be indirect (via turbidity) or direct (via removal or burial).

a. Indirect eelgrass effects: Based on distances that significantly elevated concentrations of suspended seminents may travel (see section V.C.1.a above), and effects suspended sediments can have on eelgrass (see section V.B.2 above), a 250 meter buffer was placed around each dredge project footprint to determine which projects pose potential indirect effects to eelgrass. Any project with a 250 meter buffer that intersected with eelgrass was identified as having the potential to indirectly affect eelgrass through turbidity, the resulting increased shading, and consequently the loss of eelgrass from adjacent areas. A total of 40 projects (3 USACE and 37 non-USACE) were determined to have this potential (Table 6). Due to the valuable function of eelgrass habitat as refugia, foraging and nursery habitat, this is considered a high level effect.

[2] Personal communication from K. A. Schaeffer, National Marine Fisheries Service, Habitat Conservation Division, 777 Sonoma Ave., Santa Rosa, California, 95404, February 2010.

b. Direct eelgrass effects: Acreage of existing eelgrass that could potentially be removed by dredging was calculated from the area of overlap of a dredge project footprint with known eelgrass locations. A total of 11 projects were identified that overlapped with known eelgrass. The total acreage of eelgrass that could potentially be removed by dredging was calculated to be 2.2 acres (Table 6).

Eelgrass in San Francisco Bay exhibits natural variability in its spatial distribution. To be protective of existing eelgrass and account for fluctuations in distribution, a 45 meter buffer was placed around eelgrass3. This distance was determined by best professional judgement of scientists experienced with eelgrass in San Francisco Bay and is not based on specific scientific data. Inclusion of the 45 meter buffer should account for local fluctuations in eelgrass distribution for the duration of this programmatic consultation. The buffer was clipped to remove any areas where it is not feasible for eelgrass to grow (*i.e.*, depths greater than 4 meters4). Acreage of eelgrass that could potentially be directly affected by dredging was then recalculated from the area of overlap of a dredge project footprint with the clipped eelgrass 45 meter buffer. A total of 22 projects were identified with the potential to directly affect eelgrass (Table 6). Total acreage of eelgrass that could potentially be directly affected was calculated to be 21.5 acres. Due to the valuable function of eelgrass habitat as refugia, foraging and nursery habitat, this is considered a high level effect.

4. Contaminants effects analysis

Because of a lack of data provided in the EFH Assessment for contaminant distribution and dredging projects in San Francisco Bay, a spatial analysis of contaminants as related to dredging and dredging-related activities was not feasible. Nevertheless, a review of the major contaminants, how exposure to them is affected by dredging and dredge material disposal, and related effects on EFH has revealed that current procedures for handing contaminated materials may not be sufficient. The action agencies have significant reserved discretionary authority to address the avenues of exposure and impact in order meet their obligations under the Magnuson-Stevens Act while meeting their primary goal to restore and maintain the chemical, physical and biological integrity of the Nation's waters as mandated by the Clean Water Act (For analysis of contaminant issues see Appendix 1). In general, current LTMS Environmental Protective Measures do not adequately compensate for adverse effects of contaminants on EFH, therefore additional mitigation is required.

5. Other effects

The effects of dredging related activities to turbidity and adjacent habitat are considered medium level (Table 4A). With the application of LTMS Environmental Protective Measure #1, the reduction of in-Bay disposal, these effects are partially compensated (Table 4B). Suction dredges and upland disposal can both cause entrainment, which primarily results in a loss of prey or degradation of foraging habitat. Originally considered a medium level effect (Table 4A), with the application of LTMS Environmental Protective Measure #2, beneficial reuse for the restoration of wetlands, this effect is partially compensated (Table 4B). Invasive species that

3 Personal communication from K. W. Merkel, Merkel and Associates, Inc., 5434 Ruffin Rd., San Diego, California, 92123, April 2010.

4 4 meters was chosen based on maximum depth that eelgrass was found in Richardson Bay by Merkel & Associates (2008). This depth is protective of eelgrass throughout San Francisco Bay.

colonize the Bay as a result of dredging related activities are considered a medium level effect. No LTMS Environmental Protective Measures exist to reduce the level of this effect.

6. Area outside San Francisco Bay

Dredging of the Main Ship Channel by the USACE occurs annually outside of San Francisco Bay (Figure 1) with a footprint of approximately 1,203 acres. This area is considered highly dynamic sand benthic habitat, with limited function as foraging habitat. Dredging of the Main Ship Channel is considered a medium level effect (Table 4A). With the application of LTMS Environmental Protective Measure #2 (section III.C.2), beneficial reuse of sand sediment for beach nourishment, the effect to sand habitat is partially compensated (Table 4B).

Near shore disposal sites (SF-8 and SF-17) are annually disturbed outside of San Francisco Bay. The disposal of sand sediment at these sites is considered beneficial reuse for beach nourishment. Thus, disturbance at near shore disposal sites is considered a low level effect.

Offshore disposal (SF-DODS) occurs annually outside of San Francisco Bay. Studies conducted at the site have demonstrated a low effect level on the benthic community and water column (Blake *et al*. 2005; McGowan *et al*. 2003).

VI. EFH CONSERVATION RECOMMENDATIONS

As described in the above effects analysis, NMFS has determined that the proposed action would adversely affect EFH for various federally managed fish species within the Pacific Groundfish, Coastal Pelagic, and Pacific Salmonid FMPs. Therefore, pursuant to section 305(b)(4)(A) of the MSA, NMFS offers the following EFH Conservation Recommendations to avoid, minimize, mitigate, or otherwise offset the adverse effects to EFH.

A. Soft bottom habitat permanent disturbance (prey loss)

1. To minimize adverse effects to soft bottom benthic foraging habitat, NMFS recommends that the USACE and USEPA conduct a benthic recovery study. A benthic recovery study should be conducted in order to validate assumptions in the effects analysis that recovery of the benthic community occurs in areas that are dredged less frequently than once per year. The study should be conducted in representative areas within all regions of the Bay where dredging occurs, and should monitor benthic recovery for a minimum of 3 years. If the study indicates that benthic recovery takes 1-2 years, minimization or mitigation measures will be required to account for approximately 664 additional acres of soft bottom foraging habitat permanently disturbed. If the study indicates that benthic recovery takes longer than 3 years, minimization or mitigation measures will be required to account for up to 3,312.3 acres of soft bottom foraging habitat permanently disturbed. If the study indicates that benthic recovery takes one year or less, then effects may be considered accounted for by current LTMS Environmental Protective Measures and no further actions are required. Recovery of the benthic community will be considered to have occurred when species that inhabited the area prior to disturbance successfully re-establish. Study design subject to approval by NMFS. NMFS staff are available to assist with details of study design. A potential valid design has been developed by the USACE Waterways

Experiment Station, Vicksburg, MS:
http://oai.dtic.mil/oai/oai?verb=getRecord&metadataPrefix=html&identifier=ADP005482

2. To minimize adverse effects to soft bottom benthic foraging habitat, NMFS recommends that the USACE and USEPA encourage practices that reduce the frequency of dredging in an area when possible and when not in conflict with sensitive area (*i.e.*, eelgrass) recommendations. This may include:

a. Dredging areas to the authorized design depth (not including overdepth) in a single episode rather than dredging to lesser depths in multiple episodes.

b. Discouraging the initiation of dredging at times when it is unlikely that dredging will be completed in a single episode.

c. Rotating areas within a project footprint to be dredged when the entire area can not be dredged to the authorized design depth (not including overdepth) in a single episode. This would result in the dredging of one area to design depth in a single episode and dredging of another area to design depth in a subsequent episode rather than dredging smaller amounts from both areas simultaneously in multiple episodes.

3. To minimize or mitigate for uncompensated adverse effects to soft bottom benthic foraging habitat, NMFS recommends that the USACE and USEPA fund a single NMFS Fishery Biologist position to specialize in all dredge related activities. This position would help address loss of fish foraging habitat by allowing NMFS to actively participate in the LTMS Science Committee. With adequate NMFS representation on the LTMS Science Committee resources could be directed toward studies related to fish habitat and relevant habitat enhancement projects. This single NMFS position also compensates for outstanding adverse effects from contaminants and invasive species, and as such is also included in the EFH Conservation Recommendations for those effects. The funding of a single Fishery Biologist position would fufill all three recommendations (3, 9, and 11). The USACE, USEPA and NMFS are authorized to enter into an Interagency Reimburseable Agreement pursuant to the Economy Act (31 U.S.C. 1535) which provides that an agency may place an order with a major organizational unit within another agency for goods or services.

B. Eelgrass indirect effects (refugia loss)

4. To avoid and minimize adverse effects of turbidity on eelgrass, NMFS recommends that the following BMPs be implemented for any dredge project identified as having the potential to indirectly affect eelgrass (Table 6). To determine which BMP is appropriate for an individual project, a systematic approach has been developed as an easy to use flowchart (Appendix 2).

a. <u>Avoidance</u>: Under the following conditions, no turbidity effects are expected, therefore no additional minimization BMPs required:

i. Using a hydraulic dredge, no overflow,

ii. Dredging in sand (>80% sand) substrate,

iii. Physical barriers or site-specific hydrodynamics prevent turbidity plumes from dispersing to the adjacent eelgrass.

b. Minimization: Under the following conditions, turbidity effects are expected, therefore additional minimization BMPs5 are required:

i. Using a mechanical dredge,

ii. Dredging in fine sediment (<80% sand) substrate,

iii. Currents may disperse suspended sediments to adjacent eelgrass.

Examples of turbidity minimization measures include silt curtains, light monitoring, and any other operational control, subject to NMFS approval.

(a) Silt Curtain: A silt curtain is an impermeable barrier typically constructed of a flexible reinforced thermoplastic material. It is used to contain the suspended sediment plume generated during dredging so that the sediments will settle out of suspension within a controlled area. The upper hem has floatation material and the lower hem has ballast material. They are most effective when they are not open and closed to allow equipment access to the dredging area, and operationally are limited to areas where currents are less than 1-2 knot.

(b) Light Monitoring: If light monitoring is appropriate for a given project, monitoring should be conducted both within adjacent eelgrass as well as at an appropriate reference area outside not influenced by turbidity above ambient for the area. Location of appropriate reference area will depend on project-specific conditions, and should be determined on a project-by-project basis. Monitoring should be conducted to determine the average daily period of irradiance-saturated photosynthesis (H_{sat}) during dredging for comparison with H_{sat} levels determined from scientific literature that are necessary for the maintenance of whole plant carbon balance and growth (Zimmerman *et al.* 1991) or levels within a nearby reference eelgrass bed that would experience comparable ambient water quality conditions, absent influence of turbidity generating activities. If H_{sat} is reduced below 5 hours (Zimmerman *et al.* 1991), or ambient levels at the control site, dredging should cease until turbidity dissipates, and further operational controls should be considered prior to resuming.

See Appendix 3, the San Francisco Bay Light Monitoring Survey Protocol, for further guidance. This protocol may be subject to change if new information becomes available

5 In addition to the turbidity minimizing BMPs proposed here, direct mitigation may also be considered, see VI.C MITIGATION below for further details.

that supports modifications of protocol elements.

(c) Additional Operational Controls: The following list of operational BMPs should be employed maximally for all dredging projects. However, they should be applied more judiciously when indirect turbidity effects on eelgrass are possible. When implementation of any of the above avoidance and minimization BMPs is not feasible, then the following should be considered in combination with light monitoring to verify their effectiveness.

(i) Increased cycle time/ reduced bucket deployment: longer cycle times reduce the velocity of the ascending bucket through the water column, which reduces potential sediment wash from the bucket.

(ii) Consider alternate equipment: if all other avoidance and minimization measures have failed to effectively reduce turbidity effects on eelgrass, consider equipment with lower likelihood of generating turbidity, *e.g.,* use an environmental bucket instead of an excavator.

c. Exclusion: If USACE or USEPA determine that none of the above avoidance or minimization measures are implementable or provide sufficient turbidity reduction for a specific project, then that project is not covered by this programmatic consultation and must undergo individual consultation with NMFS.

C. Eelgrass direct effects (refugia loss)

5. In all cases where eelgrass is found directly in the dredge project area, NMFS recommends that every effort be made to avoid direct removal or burial. In cases where avoidance is not possible, impacts to eelgrass must be mitigated for to achieve no net loss of eelgrass or suitable eelgrass habitat. Populations of eelgrass are highly dynamic, and the exact location and extent of eelgrass beds can change across seasons and years. As discussed in V.D.3.b above, the 45 m buffer around the 2003/2009 mapped eelgrass extent accounts for areas between patches, temporal variation in bed extent, and area for potential bed expansion. Therefore, in all cases where the project area overlaps with the 45 m buffer around eelgrass (Table 6) NMFS recommends that the project must mitigate for those direct effects using one of the options described below.

Independent of which mitigation option is chosen, a mitigation plan shall be prepared in accordance with the U.S. Army Corps of Engineers' (USACE) 2004 Final Mitigation Guidelines and Monitoring Requirements, acknowledging that mitigation within subtidal and marine waters does not always fit well within all aspects of this guidance.

Mitigation Option #1
USACE and USEPA may establish an eelgrass mitigation bank to compensate for direct impacts to eelgrass within their project footprints that they are unable to avoid.

Mitigation Bank: Establishment of any "mitigation bank" must be consistent with the U.S.

Army Corps of Engineers and U.S. Environmental Protection Agency Final Rule for Compensatory Mitigation for Losses of Aquatic Resources (33 CFR Parts 325 and 332, 40 CFR Part 230), and the Memorandum of Understanding Concerning Mitigation and Conservation Banking in California Between the California Resources Agency, California Department of Fish and Game, Corps, US Fish &Wildlife Service, NMFS, USEPA, and USDA Natural Resources Conservation Service.

Upon conclusion of this programmatic consultation and acceptance of this EFH Conservation Recommendation (VI.C.5.a), the USACE and USEPA will initiate the creation of a Mitigation Bank. During the period of time that the Mitigation Bank is becoming established, and until the time that Mitigation Bank is determined to be successfully established, projects with direct eelgrass effects will be subject to individual mitigation requirements (see VI.C.5.b below). The provisions of this recommendation are not subject to change upon changes in NMFS' Eelgrass Mitigation Policy.

a. Bank Requirements:

i. Size: there is no exact size requirement for the bank, but target size should be slightly larger than anticipated acreage for potential withdrawals. Based on the results of the spatial analysis, NMFS recommends that a 20 acre bank would be sufficient to support the projects covered by this programmatic with direct eelgrass effects based on a mitigation ratio of 1:1 (section V.D.3.b, Table 6). A target for bank density will be determined by NMFS staff prior to bank intitiation and will be based on average eelgrass density for San Francisco Bay.

ii. Location: The specific location of the eelgrass mitigation bank(s) shall be based on factors such as depth, sediment type, salinity, water quality, and currents. NMFS staff and other appropriate resource agencies should be involved in evaluating suitable sites and in making an ultimate site selection for restoration.

iii. Technique: Techniques for eelgrass mitigation shall be consistent with the best available technology at the time of mitigation implementation and shall be tailored to the specific needs of the mitigation site. However, it is understood that whatever techniques are employed, they must comply with the stated requirements and criteria. Eelgrass transplants have been highly successful in southern and central California, but have had mixed results in San Francisco Bay and northern California. Bare-root bundles, seed buoys, and transplants using frames are techniques that have been utilized with some success in northern portions of the state.

iv. Monitoring: Monitoring the success of eelgrass mitigation shall be completed for a period of at least five years. Monitoring shall determine the area of eelgrass and density of plants at the mitigation sites and shall be conducted at 0, 6, 12, 24, 36, 48, and 60 months. All monitoring work must be conducted during the active vegetative growth period, April through October, and should avoid the recognized low growth season for San Francisco Bay. Additional monitoring beyond the 60-month period may be required in those instances where stability of the mitigation site is questionable or where other factors may influence the long-term success of mitigation. The need for extended monitoring shall be evaluated and discussed with NMFS and the applicable permitting agencies.

A monitoring schedule that indicates when each of the required monitoring events will be completed shall be provided to NMFS prior to or concurrent with the initiation of the mitigation. Monitoring reports shall be provided to NMFS within 30 days after the completion of each required monitoring period.

v. Success criteria: The bank will be deemed successful when the target area reaches a density representative of the average eelgrass density in San Francisco Bay (to be determined by NMFS staff based on best available information). If the mitigation area fails to achieve continuous success over the last three monitoring years, the monitoring period shall be extended and corrective measures will be recommended and undertaken to address shortfalls. In some instances, simply extending the monitoring period may be appropriate. However, in other cases, it may be necessary to perform supplemental mitigation efforts, or otherwise supplement mitigation actions to address mitigation needs.

b. Bank use and restrictions:

i. Prior to completion of successfully established Bank: Individual projects will mitigate for the area of direct project overlap with mapped eelgrass (Table 6, direct no buffer). These mitigation activities will be subject to existing NMFS Eelgrass Mitigation Policies (Southern California Eelgrass Mitigation Policy, Appendix 4). No pre- or post-dredge survey will be required.

ii. After Bank determined successfully established:

(a) Individual projects will withdraw from Bank an area-based ratio of 1 to 1 for the entire area of project overlap with mapped eelgrass, plus the area of overlap for the 45 m buffer (Table 6, direct with 45 m buffer). Upon Bank withdrawal, this project's eelgrass mitigation exists in perpetuity.

(b) Individual projects that mitigated for area of direct overlap during Bank establishment phase, will be credited for that individual mitigation. Upon that project's reinitiating of dredging activities, they will be accountable for mitigating the remaining area encompassed by the 45 m buffer. Following withdrawal from the Bank an area-based ratio of 1 to 1 for the 45 m buffer area (minus the area of mitigation completed during bank establishment phase), this project's mitigation exists in perpetuity.

(c) Any individual project that has mitigated for eelgrass during the 10 years proceeding this programmatic will be credited for the area established during that individual mitigation effort. Upon that project's reinitiating of dredging activities, they will be accountable for mitigating the entire area of project overlap with mapped eelgrass (2003-2009 maximum extent), plus the area of overlap for the 45 m buffer, minus the area previously mitigated. Following withdrawal from the Bank an area-based ratio of 1 to 1 for that area, this project's mitigation exists in perpetuity.

(d) If withdrawals exceed total Bank size and Bank balance goes to zero, return to project by project direct mitigation (Mitigation Option #1, b.i) until a net positive area of Bank can be re-established.

Mitigation Option #2
The USACE and USEPA may continue to mitigate on a project by project basis:

a. For individual projects with eelgrass occurring in the project footprint, prior to the start of dredging operations, eelgrass and potential eelgrass habitat directly within and adjacent to the dredge footprint will be mapped and measured for area and density. The extent of adjacent areas to be mapped should be determined on project-by-project basis depending on site specific conditions. An area and density survey report of the eelgrass will be submitted to NMFS for approval within 30 days of the start of dredging activities.

b. To protect eelgrass outside the project footprint, BMPs to avoid and minimize indirect affects of turbidity (section VI.B.4, Appendix 2) will be strictly employed as appropriate.

c. Eelgrass directly adjacent to the dredge footprint will be marked with buoys to ensure vessel traffic/barges avoid those areas. Dredging equipment will not be located to the maximum extent possible, temporarily or at anchor, in eelgrass areas outside the project footprint.

d. If NMFS determines dredging has adversely impacted eelgrass in the project area based on monitoring observations or comparison of pre- and post-dredging surveys, the applicant must provide NMFS with an eelgrass Mitigation Plan within 60 days of completing the post-dredge survey. All Mitigation Plans that have not been previously approved by NMFS will be subject to any existing or forthcoming NMFS Eelgrass Mitigation Policies (currently the Southern California Eelgrass Mitigation Policy, Appendix 4).

Mitigation Option #3
Alternative mitigation plan: The USACE and USEPA may develop an alternative in-kind mitigation plan for impacts to eelgrass from dredge related activities subject to NMFS approval. This programmatic consultation will not cover projects listed in Table 6 with direct impacts to eelgrass as determined by direct overlap with the 45 m buffer until the alternative mitigation plan is approved by NMFS and implementation is successful. Until the alternative plan is developed, approved, and implemented, mitigation will be done on a project by project basis as described in Mitigation Option #2.

D. Turbidity

6. Reduce in-Bay disposal: To avoid or minimize adverse effects from disposal related turbidity, NMFS recommends the USACE and USEPA further reduce in-Bay disposal. This may include:

a. Outfitting the USACE hopper dredges to be compatible with and to use offloader equipment for out-of-Bay placement of sediment.

b. Encouraging or facilitating non-federal dredge projects to use available offloaders for out-of-Bay placement of sediment.

E. Contaminants

7. Bioaccumulation testing: The action agencies have reserved discretionary authority to require bioaccumulation evaluations and/or alternatives to in-Bay disposal. This authority should be more clearly defined in the San Francisco Bay district with clear triggers in testing requirements and subsequent permitting decisions. If bioaccumulative contaminants (PCBs, PAHs, DDTs, dieldrin, chlordane, dioxins/furans, and mercury) are present in dredged material above ambient sediment levels in the vicinity of the proposed in-Bay disposal site or bioaccumulation triggers used elsewhere in the Northern Pacific, bioaccumulation testing needs to be required if the project proponent wishes to dispose of the material in-Bay. If testing confirms bioaccumulation of contaminants, then the dredged materials must be declared not suitable for unconfined in-Bay disposal and disposed of in an appropriate manner. This procedure is to remain in place until an acceptable protocol of sediment bioaccumulation triggers, or other tool, are developed and implemented following appropriate consultations.

8. Residuals: If dredging results in the exposure of new surface material having higher chemical concentrations than the sediment that was dredged or which exceeds the ambient concentration of surrounding areas for the contaminants of concern listed in EFH Conservation Recommendation #7 (above), then the parcel must be managed to prevent exposure to the contamination and further degradation of EFH if testing of the new sediments exposed shows toxicity or bioaccumulation of contaminants. This may warrant over-dredging and subsequent backfill to the planned project depth. The exact details will need to be determined on a case-by-case basis.

9. To minimize or mitigate for adverse effects to EFH from contaminants, NMFS recommends that the USACE and USEPA fund a single NMFS Fishery Biologist position to specialize in dredge related activities. This position would minimize adverse effects from contaminants by allowing NMFS to actively participate in the DMMO. With adequate NMFS representation in the DMMO, constituents of concerns and associated levels relevant to fish would be addressed. This single NMFS position also compensates for outstanding adverse effects to soft bottom benthic habitat and from invasive species, and as such is also included in the EFH Conservation Recommendations for those effects. The funding of a single Fishery Biologist position would fufill all three recommendations (3, 9, and 11). The USACE, USEPA and NMFS are authorized to enter into an Interagency Reimburseable Agreement pursuant to the Economy Act (31 U.S.C. 1535), which provides that an agency may place an order with a major organizational unit within another agency for goods or services.

F. Invasives

10. To minimize adverse effects to EFH from invasive species, NMFS recommends that the USACE and USEPA establish a working group tasked with evaluating the feasibility of enhancing native benthic invertebrate species in the San Francisco estuary. The workgroup should assess methodology, enhancement sites, suitable species, and appropriate monitoring. Based on the outcome of the workgroup, a pilot project should be designed to determine if reintroduction of the native benthic invertebrate species into the estuary is feasible. If the results of the pilot determine that this is feasible, then a program should be implemented that will fully compensate for the annual impact to benthic habitat from dredging activities. If determined infeasible, or the scope does not fully compensate for impacts, then the USACE and USEPA will develop alternative measures to compensate for impacts to EFH.

11. To minimize or mitigate for adverse effects to EFH from invasive species, NMFS recommends that the USACE and USEPA fund a single NMFS Fishery Biologist position to specialize in dredge related activities. This position would account for adverse effects from invasive species by allowing NMFS to actively participate in the LTMS Science Committee. With adequate NMFS representation on the LTMS Science Committee resources could be directed toward studies related to fish habitat and relevant habitat enhancement projects. This single NMFS position also compensates for outstanding adverse effects to soft bottom benthic habitat and from contaminants, and as such is also included in the EFH Conservation Recommendations for those effects. The funding of a single Fishery Biologist position would fufill all three recommendations (3, 9, and 11). The USACE, USEPA and NMFS are authorized to enter into an Interagency Reimburseable Agreement pursuant to the Economy Act (31 U.S.C. 1535) which provides that an agency may place an order with a major organizational unit within another agency for goods or services.

G. Other Submerged Aquatic Vegetation

12. To avoid adverse effects to EFH and HAPC, in all cases where native submerged aquatic vegetation, other than eelgrass, (e.g., *Ruppia*, *Stuckenia/Potamogetan*), is found directly in the dredge project area, NMFS recommends that every effort be made to avoid direct removal or burial. In cases where avoidance is not possible, mitigation should occur to compensate for adverse effects:

a. For individual projects with native submerged aquatic vegetation occurring in the project footprint, prior to the start of dredging operations, native submerged aquatic habitat directly within and adjacent to the dredge footprint will be mapped and measured for area and density. The extent of adjacent areas to be mapped should be determined on project-by-project basis depending on site specific conditions. An area and density survey report of the native submerged aquatic vegetation will be submitted to NMFS for approval within 30 days of the start of dredging activities.

b. If NMFS determines dredging has adversely impacted native submerged aquatic vegetation in the project area based on monitoring observations or comparison of preand post-dredging surveys, the applicant must provide NMFS with a Mitigation Plan within 60 days of completing the post-dredge survey. The mitigation plan should be prepared in accordance with the U.S. Army Corps of Engineers' (USACE) 2004 Final Mitigation Guidelines and Monitoring Requirements, acknowledging that mitigation within subtidal and marine waters does not always fit well within all aspects of this guidance.

H. Reporting requirements

13. To avoid adverse effects to EFH that may occur from improper utilization of this programmatic consultation, NMFS recommends that the USACE provide annual reports to NMFS on all activities conducted under this programmatic consultation. Reports should be submitted to NMFS within 90 days of the end of each calendar year. Reports should include a summary of annual dredging activities (total number of projects dredged, total volumes of sediment disposed in Bay) and an EFH Dredge Programmatic Report Form (Appendix 5) for each project where active dredging occurred. Reports should also track the number of dummy projects used to ensure the allotted amount (10) is not exceeded.

14. To avoid adverse effects to EFH that may occur from improper utilization of this programmatic consultation, NMFS recommends that the USACE notify NMFS of the following:

a. When a project will indirectly impact eelgrass and which BMP is being used (inclusion of BMP in Public Notice and submission of notice to NMFS is satisfactory).

b. When a project will directly impact eelgrass and what mitigation is proposed.

c. When a project has contaminant loads above those indicated in EFH Conservation Recommendation 7, and how material will be disposed.

VII. STATUTORY RESPONSE REQUIREMENT

Please be advised that regulations (50 CFR 600.920(k)) to implement the EFH provisions of the MSA require your office to provide a written response to this letter within 30 days of its receipt and prior to the final action. A preliminary response is acceptable if final response cannot be completed within 30 days. Your final response must include a description of how the EFH Conservation Recommendations will be implemented and any other measures that will be required to avoid, mitigate, or offset the adverse impacts of the activity. If your response is inconsistent with our EFH Conservation Recommendations, you must provide an explanation for not implementing this recommendation at least 10 days prior to final approval of the action. This explanation must include scientific justification for any disagreements with NMFS over the anticipated effects of the action and the measures needed to avoid, minimize, mitigate, or offset such effects. If the final response is inconsistent with our project-specific EFH Conservation Recommendations (4, 5, 7, and 8), projects to which these recommendations apply will not be covered by the programmatic consultation and must be consulted on individually. However, the USACE and USEPA may propose and develop alternative EFH Conservation Recommendations subject to NMFS approval, to compensate for outstanding adverse effects.

VIII. SUPPLEMENTAL CONSULTATION

This concludes programmatic EFH consultation for operations and maintenance dredging in the San Francisco Bay area and associated dredged material placement. Pursuant to 50 CFR 600.920(l) of the EFH regulations, the USACE and USEPA must reinitiate EFH consultation with NMFS if the proposed action is substantially revised in a way that may adversely affect EFH, or if new information becomes available that affects the basis for NMFS' EFH Conservation Recommendations.

IX. LITERATURE CITED

Abbott, R., & E. Bing-Sawyer. 2002. Assessment of pile driving impacts on the Sacramento blackfish (*Othodon microlepidotus*). Draft report prepared for Caltrans District 4.

Army Corps of Engineers. 2010. Regional Supplement to the Corps of Engineers Wetland Delineation Manual: Western Mountains, Valleys, and Coast Region (Version 2.0). J. S. Wakeley, R. W. Lichvar, and C. V. Noble (eds.). ERDC/EL TR-10-3. Vicksburg, MS: U.S. Army Engineer Research and Development Center.
http://www.usace.army.mil/CECW/Pages/reg_supp.aspx

Barnard, W.D. 1978. Prediction and control of dredged material dispersion around dredging and open-water pipeline disposal operations. Technical report DS-78-13, U.S. Army Corps of Engineers Waterways Experiment Station, Vicksburg, MS.

Benfield, M.C. & T.J. Minello. 1996. Relative effects of turbidity and light intensity on reactive distance and feeding of an estuarine fish. Environmental Biology of Fishes, 46: 211-216.

Blake J.A., N.J. Maciolek, & I.P. Williams. 2005. Long-term benthic infaunal monitoring at the San Francisco Deep-Ocean Disposal Site (SF-DODS). Woods Hole, MA: Prepared for US Environmental Protection Agency Region IX by ENSR Marine and Coastal Center. p 83.

Blake, J.A., N.J. Maciolek, A.Y. Ota, & I.P. Williams. 2009. Long-term benthic infaunal monitoring at a deep-ocean dredged material disposal site off Northern California. Deep-Sea Research, 56: 1775-1803.

Boesch D.F., & R.E. Turner. 1984. Dependence of fishery species on salt marshes: the role of food and refuge. Estuaries, 7: 460-468.

Caltrans. 2001. Fisheries Impact Assessment, Pile Installation Demonstration Project for the San Francisco - Oakland Bay Bridge, East Span Seismic Safety Project. 59 p.

Chin, J.A., & A. Ota. 2006. Disposal of dredged material and other waste on the continental shelf and slope. USGS report. (http://pubs.usgs.gov/circ/c1198/chapters/193-206_Disposal.pdf)

Clarke, D., C. Dickerson, & K. Reine. 2002. Characterization of underwater sounds produced by dredges. Proceedings of the Third Specialty Conference on Dredging and Dredged Material Disposal, American Society of Civil Engineers, Orlando, FL.

Clarke, D., A. Martin, C. Dickerson, & D. Moore. 2004. Characterization of suspended sediment plumes associated with knockdown operations at Redwood City, California. Technical report, U.S. Army Corps of Engineers Research and Development Center, Vicksburg, MS.

Cloern, J.E. 1987. Turbidity as a Control on Phytoplankton Biomass and Productivity in Estuaries. Continental Shelf Research, 7: 1367-1381.

Cowardin, L.M., V. Carter, F.C. Golet, & E.T. LaRoe. 1979. Classification of wetlands and deepwater habitats of the United States. FWS/OBS-79/31. U.S. Fish and Wildlife Service, Office of Biological Services. Washington D.C.

Currie, D. & G. Parry. 1996. Effects of scallop dredging on soft sediment community: a large-scale experimental study. Marine Ecology Progress Series 134: 131-150.

Deegan L.A., & R.N. Buchsbaum. 2005. The effect of habitat loss and degradation on fisheries. In: Buchsbaur R.N., J. Pederson, & W.E. Robinson (eds.) The decline on fisheries resources in New England: evaluating the impact of overfishing, contamination, and habitat degradation. Cambridge, MA: MIT Sea Grant Collegs Program; Publication No. MITSG 05-5. p 67-96.

Dennison, W.C. & R.S. Alberte. 1982. Photosynthetic Responses of Zostera-Marina L (Eelgrass) to *In situ* Manipulations of Light-Intensity. Oecologia, 55: 137-144.

Dennison, W.C. & R.S. Alberte. 1985. Role of Daily Light Period in the Depth Distribution of Zostera-Marina (Eelgrass). Marine Ecology-Progress Series, 25: 51-61.

Dennison, W.C. & R.S. Alberte. 1986. Photoadaptation and Growth of Zostera-Marina L (Eelgrass) Transplants Along a Depth Gradient. Journal of Experimental Marine Biology and Ecology, 98: 265-282.

Dennison, W.C. 1987. Effects of Light on Seagrass Photosynthesis, Growth and Depth Distribution. Aquatic Botany, 27: 15-26.

Desmond J.S., G.D. Williams, & J.B. Zedler. 2000. Fish use of tidal creek habitats in tow southern Claifornia salt marshes. Ecological engineering, 14:233-252.

Dickerson, C., K.J. Reine, & D.G. Clarke. 2001. Characterization of underwater sounds produced by bucket dredging operations. ERDC TN-DOER-E14

EPA, SFB BCDC, USACE, SFBRWQCB, and CSLC, 2001. Guidelines for Implementing the Inland Testing Manual in the San Francisco Bay Region, September 21, 2001. 21 pages. Available at: http://www.spn.usace.army.mil/conops/sfitm092101.pdf

Environmental Protection Agency (USEPA). 2000. Environmental screening checklist and workbook for the water transportation industry. http://www.epa.gov/compliance/resources/publications/monitoring/selfevaluation/wtr_fnl.pdf

Gilkinson K.D., D.C. Gordon, K.G. MacIsaac, D.L. McKeown, E.L.R. Kenchington, C. Bourbonnais, & W.P. Vass. 2005. Immediate impacts and recovery trajectories of macrofaunal communities following hydraulic clam dredging on Banquereau, eastern Canada. Ices Journal of Marine Science 62 (5): 925-947.

Goals Project. 1999. Baylands ecosystem habitat goals. A report of habitat recommendations prepared by the San Francisco Bay Area Wetlands Ecosystem Goals Project. U.S. Environmental Protection Agency, San Francisco, CA/San Francisco Bay Regional Water Quality Control Board, Oakland, CA.

Gren, G.G. 1976. Hydraulic dredges, including boosters. In: P.A. Krenkal, J. Harrison, & J.C. Burdick III (eds.) Proceedings of the specialty conference on dredging and its environmental effects. p.115-124. American Society of Civil Engineers, New York, NY.

Hanson, J., M. Helvey, & R. Strach (eds.) 2003. Non-fishing impacts to essential fish habitat and recommended conservation measures. National Marine Fisheries Service (NOAA Fisheries), version 1. Southwest Region, Long Beach, CA.

Hastings, M.C. 2002. Clarification of the meaning of sound pressure levels and the known effects of sound on fish. Document in support of Biological Assessment for San Francisco-Oakland Bay Bridge East Span Seismic Safety Project. 8 p.

Hayes, D.F, G.L. Raymond, & T.N. McLellan. 1984. Sediment re-suspension from dredging activities. *Dredging and dredge material disposal*. American Society of Civil Engineers, New York, NY.

Herke, W.H., & B.D. Rogers. 1993. Maintenance of the estuarine environment. In: C.C.Kohler, W.A Hubert.(eds.) Inland fisheries management in North America, p. 263-286. American Fisheries Society. Bethesda, MD.

Hoss, D.E., & G.W. Thayer. 1993. The importance of habitat to the early life history of estuarine dependent fishes. American Fisheries Society Symposium 14:147-158.

Kohler, C.C., & W.R. Courtenay, Jr. 1986. American Fisheries Society Position on Introductions of Aquatic Species. Fisheries 11(2):39-42. (http://www.afsifs.vt.edu/afspos.html)

Larson, K.W., & C.E. Moehl. 1990. Entrainment of anadromous fish by hopper dredge at the mouth of the Columbia River. In: C.A. Simenstad, Jr. (ed.) Effects of dredging on anadromous pacific coast fishes. p.113-131. University of Washington Sea Grant. University of Washington, Seattle, WA.

LaSalle, W.M. 1990. Physical and chemical alterations associated with dredging: an overview. In: C.A. Simenstad, Jr. (ed.) Effects of dredging on anadromous pacific coast fishes. p.1-12. University of Washington Sea Grant. University of Washington, Seattle, WA.

Longmuir, C., & T. Lively. 2001. Bubble curtain systems for use during marine pile driving. Report by Fraser River Pile and Dredge Ltd. New Westminister, British Columbia. 9 p.

McCauley, J.E., R.A. Parr, & D.T. Hancock. 1976. Benthic infauna and maintenance dredging: a case study. Water Research 11:233-242.

McGowan M.F., C. McCandlish, A. Good, A. Marchi, J. Tustin, & R. Dugdale. 2003. SF DODS upper water column monitoring in 2000 and 2001. Prepared for U.S. Army Corps of Engineers, San Francisco District, San Francisco, California.

McGraw, K., & D. Armstrong. 1990. Fish entrainment by dredges in Grays Harbor, Washington. In: C.A. Simenstad, Jr. (ed.), Effects of dredging on anadromous Pacific coast fishes. p.102-112. University of Washington Sea Grant. University of Washington, Seattle, WA

MEC Analytical Systems, Inc. & U.S. Army Engineer Research and Development Center. 2004. Spatial characterization of suspended sediment plumes during dredging operations through acoustic monitoring. Technical report to the U.S. Army Corps of Engineers, San Francisco District, San Francisco, CA.

Merkel & Associates. 2004. Baywide eelgrass (*Zostera marina* L.) inventory of San Francisco Bay. Prepared for Parsons Brinkerhoff Quade & Douglas, California Department of Transportation, and National Marine Fisheries Service.

Merkel & Associates. 2008. Baseline eelgrass survey in Richardson Bay, San Francisco Bay. Prepared for Marin Bayland Advocates and Audobon Society.

Merkel & Associates. In preparation. San Francisco Bay eelgrass atlas. California Department of Transporation, Oakland, California/National Marine Fisheries Service, Santa Rosa, California.

National Marine Fisheries Service. 2007. Report on the subtidal habitats and associated biological taxa in San Francisco Bay. Schaeffer K, McGourty K, and Cosentino-Manning N, editors. Santa Rosa, CA. p 86.

Newell, R.C., L.J. Seiderer, & D.R. Hitchcock. 1998. The impact of dredging on biological resources of the sea bed. Oceanography and Marine Biology Annual Review 336:127-178.

Nightingale, B., & C.A. Simenstad, Jr. 2001. Dredging activities: Marine issues. Seattle, WA

98105: Washing ton State Transportation Center, University of Seattle. (http://depts.washington.edu/trac/reports/reports.html)

Oliver, J. S., P. N. Slattery, L. W. Hulberg & J. W. Nybakken 1977. Patterns of succession in benthic infaunal communities following dredging and dredged material disposal in Monterey Bay. U.S. Army Corps of Engineers. Technical Report D-77-27.

Omori M., S. VanderSpoel, & CP Norman. 1994. Impact of human activities on pelagic biogeography. Progress in Oceanography 34(2-3): 211-219.

Pacific Fishery Management Council (PFMC). 1999. Description and Identification of Essential Fish Habitat, Adverse Impacts and Recommended Conservation Measures for Salmon; Amendment 14 to the Pacific Coast Salmon Plan. (http://pcouncil.org/wp-content/uploads/fmpthrua14.pdf)

Pacific Fishery Management Council (PFMC). 2008. Pacific coast Groundfish Fishery Management Plan for the California, Oregon, and Washington Groundfish Fishery as Amended through Amendment 19. (http://www.pcouncil.org/wp-content/uploads/fmpthru19.pdf)

Reine, K., & D.G. Clarke. 1998. Entrainment by hydraulic dredges- a review of potential impacts. Technical Note DOER-E1. U.S. Army Corps of Engineers Research and Development Center, Vicksburg, MS.

Reish, D.J. 1961. A study of the benthic fauna in a recently constructed boat harbor in southern California. Ecology, 42: 84-91.

Rosecchi, E., A.J. Crivelli & G. Catsadorakis. 1993. The Establishment and Impact of Pseudorasbora-Parva, an Exotic Fish Species Introduced into Lake Mikri Prespa (North-Western Greece). Aquatic Conservation-Marine and Freshwater Ecosystems, 3: 223-231.

Sabol, B., D. Shafer, & E. Lord. 2005. Dredging effects on Eelgrass (Zostera marina) distribution in a New England small boat harbor. Final Report ERDC/EL TR-05-8. U.S. Army Corps of Engineers Research and Development Center, Vicksburg, MS.

San Francisco Estuary Institute. 2008. Effects of short-term water quality impacts due to dredging and disposal on sensitive fish species in San Francisco Bay. Prepared for the U.S. Army Corps of Engineers, San Francisco District. Contribution No. 560. http://www.spn.usace.army.mil/ltms/Water%20Quality.pdf

San Francisco Estuary Institute. 2009. California wetland and riparian area protection policy, Technical memorandum No. 2: wetland definition. Oakland, CA.

Schoellhammer, D.H. 1996. Factors affecting suspended-solid concentrations in South San Francisco Bay, California. Journal of Geophysical Research, 101: 12087-12095.

Setchell, W.A. 1929. Morphological and phenological notes on *Zostera marina* L. University of California Publications in Botany, 14: 389-452.

Sogard S.M., & Able K.W. 1991. A comparison of eelgrass, sea lettuce macroalgae and marsh creeks as habitats for epibenthic fishes and decapods. Estuarine, Coastal and Shelf Science, 33: 501-519.

Spence, B.C., G.A. Lomnicky, R.M. Hughes, & R.P. Novitzki. 1996. An ecosystem approach to salmonid conservation. Corvallis, OR: ManTech Environmental Research Services Corp. TR-4501-96-6057.

Stadler, J.H. 2002. Personal communication. October 7, 2002. Fish Biologist, DOC/NOAA/National Marine Fisheries Service/HCD, Lacey, WA. Winslow, WA.

Stotz, T., & J. Colby. 2001. January 2001 dive report for Mukilteo wingwall replacement project. Washington State Ferries Memorandum. 5 pp. + appendices.

Thrush S.F., J.E. Hewitt, V.J. Cummings, & P.K. Dayton. 1995. The impact of habitat disturbance by scallop dredging on marin benthic communities: What can be predicted from the results of experiments? Marine Ecology Progress Series, 129(1-3): 131-150.

Tuck, I.D., S.J. Hall, & M.R. Robertson. 1998. Effects of physical trawling disturbance in a previously unfished sheltered sheltered Scottish sea loch. Marine Ecology-Progress Series, 162: 227-242.

U.S. Geological Survey. 1998. Classification of wetlands and deepwater habitats of the Unites States unconsolidated bottom.

Van der Veer, H., M.J.N. Bergman, & J.J. Beukema. 1985. Dredging activities in the Dutch Wadden Sea effects on macrobenthic infauna. Netherlands Journal for Sea Research 19:183-190.

Wang, T., K. Larm, & D. Hotchkiss. 2002. Evaluation of closed buckets for remedial dredging and case histories. Proceedings Third Speciality Conference on Dredging and Dredged Material Disposal, ASCE Dredging, Orlando, FL.

Watling, L., R.H. Findlay, L.M. Lawrence & D.F. Schick. 2001. Impact of a scallop drag on the sediment chemistry, microbiota, and faunal assemblages of a shallow subtidal marine benthic community. Journal of Sea Research, 46: 309-324.

Wilber, D.H. & D.G. Clarke. 2001. Biological effects of suspended sediments: A review of suspended sediment impacts on fish and shellfish with relation to dredging activities in estuaries. North American Journal of Fisheries Management, 21: 855-875.

Wyllie-Escheverria, S. 1990. Geographic range and distribution of *Zostera marina*, eelgrass in San Francisco Bay. In: K. Merkel and R. Hoffman (eds.), Proceedings of the California

Eelgrass Symposium, 99. p. 65-69. Sweetwater River Press, National City, CA.

Wyllie-Echeverria, S. & P.J. Rutten. 1989. Inventory of eelgrass (Zostera marina L.) in San Francisco/San Pablo Bay. NMFS/SWR. SWR-89-05, 18 pp.

Zimmerman, R.C., J.L. Reguzzoni, S. Wyllie-Echeverria, M. Josselyn, & R.S. Alberte. 1991. Assessment of environmental suitability for growth of Zostera marina L. (eelgrass) in San Francisco Bay. Aquatic Botany, 39: 353-366.

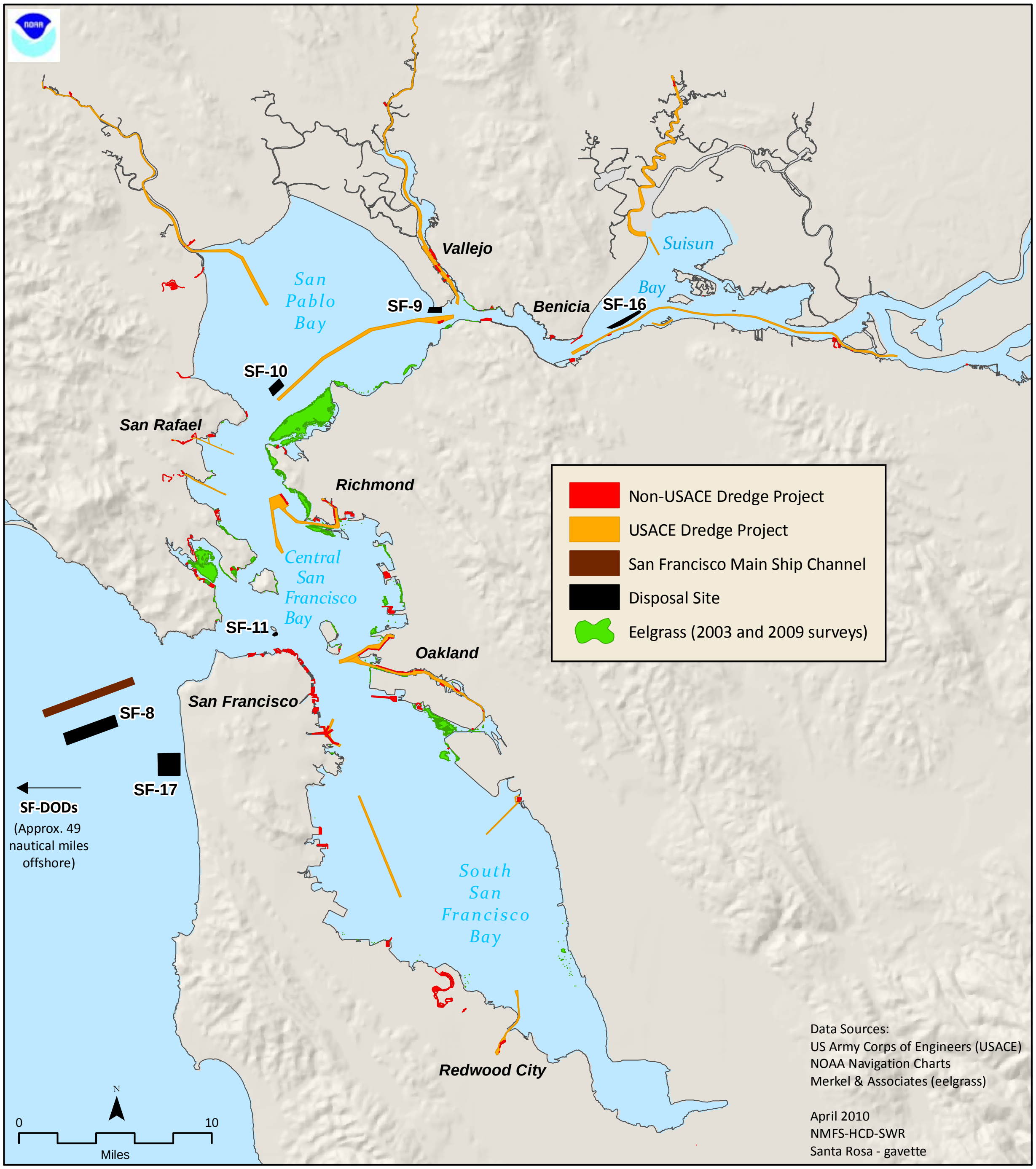


Figure 1. Action area covered by the EFH Programmatic Consultation for maintenance dredging in San Francisco Bay.

Table 1. In-water disposal sites and dredge projects covered by this programmatic consultation. Latidudes and longitudes are provided for reference only and do not represent spatial extent of sites.

Name	Type	Latitude	Longitude
SF-DODS	Disposal (offshore)	37° 39.000' N	123° 29.000' W
SF-08	Disposal (nearshore)	37° 45.000' N	122° 36.000' W
SF-09	Disposal (in-Bay)	38° 03.667' N	122° 16.000' W
SF-10	Disposal (in-Bay)	38° 00.333' N	122° 25.000' W
SF-11	Disposal (in-Bay)	37° 49.333' N	122° 25.333' W
SF-16	Disposal (in-Bay)	38° 03.133' N	122° 05.700' W
SF-17	Disposal (nearshore)	37° 43.833' N	122° 31.000' W
Larkspur Ferry Channel	Dredge (USACE)	37° 56.156' N	122° 29.326' W
Napa River Channel	Dredge (USACE)	38° 8.882' N	122° 16.859' W
Oakland Harbor	Dredge (USACE)	37° 47.538' N	122° 17.848' W
Petaluma River Channel	Dredge (USACE)	38° 8.022' N	122° 30.056' W
Pinole Shoal - Mare Island Strait	Dredge (USACE)	38° 2.549' N	122° 19.732' W
Redwood City Harbor	Dredge (USACE)	37° 32.148' N	122° 11.806' W
Richmond Harbor	Dredge (USACE)	37° 55.297' N	122° 22.278' W
San Bruno Shoals	Dredge (USACE)	37° 39.745' N	122° 19.432' W
San Francisco Harbor, Islais Creek Shoal	Dredge (USACE)	37° 44.842' N	122° 22.209' W
San Leandro Marina	Dredge (USACE)	37° 41.085' N	122° 12.327' W
San Rafael Creek	Dredge (USACE)	37° 57.930' N	122° 29.172' W
Sausalito Bay Model	Dredge (USACE)	37° 51.920' N	122° 29.633' W
SF Main Ship Channel	Dredge (USACE)	37° 46.443' N	122° 36.249' W
Suisun Bay Channel	Dredge (USACE)	38° 3.699' N	122° 1.814' W
Suisun Slough Channel	Dredge (USACE)	38° 6.749' N	122° 3.493' W
Aeolian Yacht Club	Dredge (non-USACE)	37° 45.003' N	122° 14.079' W
Alameda Point Channel	Dredge (non-USACE)	37° 46.441' N	122° 18.907' W
Arques Shipyard and Marina	Dredge (non-USACE)	37° 52.064' N	122° 29.769' W
Ballena Isla Marina	Dredge (non-USACE)	37° 45.978' N	122° 17.109' W
Ballena Isla Townhomes	Dredge (non-USACE)	37° 46.149' N	122° 17.240' W
Bel Marin Keys Community Services District	Dredge (non-USACE)	38° 5.686' N	122° 29.445' W
Bellevue Channel (Belvedere Cove)	Dredge (non-USACE)	37° 52.337' N	122° 27.575' W
Belvedere Land Company	Dredge (non-USACE)	37° 52.363' N	122° 27.584' W
Benicia Marina	Dredge (non-USACE)	38° 2.597' N	122° 9.444' W
Benicia Port Terminal (Amport)	Dredge (non-USACE)	38° 2.488' N	122° 8.087' W
Berkeley Marina	Dredge (non-USACE)	37° 52.122' N	122° 18.972' W
Black Point Boat Launch Ramp	Dredge (non-USACE)	38° 6.880' N	122° 30.356' W
BP, Richmond Terminal	Dredge (non-USACE)	37° 54.439' N	122° 21.817' W
Brickyard Cove Homeowners Association	Dredge (non-USACE)	37° 54.497' N	122° 22.799' W
Brisbane Marina at Sierra Point	Dredge (non-USACE)	37° 40.462' N	122° 22.797' W
C&H Sugar Company	Dredge (non-USACE)	38° 3.494' N	122° 13.083' W
CA Maritime Academy	Dredge (non-USACE)	38° 3.976' N	122° 13.835' W
Castrol North American Consumer's Berth	Dredge (non-USACE)	37° 55.342' N	122° 22.367' W
Chevron Rod and Gun	Dredge (non-USACE)	37° 57.617' N	122° 24.658' W
Chevron, Richmond Longwharf	Dredge (non-USACE)	37° 55.492' N	122° 24.766' W
City of Emeryville Marina	Dredge (non-USACE)	37° 50.430' N	122° 18.750' W
City of Suisun Pierce Island Boat Ramp	Dredge (non-USACE)	38° 13.980' N	122° 2.249' W
City of Sunnydale Boat Ramp	Dredge (non-USACE)	37° 26.131' N	122° 1.622' W
Clipper Yacht Harbor	Dredge (non-USACE)	37° 51.858' N	122° 29.543' W
Coast Guard Station, Golden Gate	Dredge (non-USACE)	37° 49.968' N	122° 28.633' W

Coast Guard Station, Yerba Buena Island	Dredge (non-USACE)	37° 48.685' N	122° 21.637' W
Coast Guard, Alameda Station	Dredge (non-USACE)	37° 46.780' N	122° 14.963' W
Conoco Philips, Richmond	Dredge (non-USACE)	37° 54.754' N	122° 21.875' W
Conoco Philips, Rodeo Terminal	Dredge (non-USACE)	38° 3.421' N	122° 15.711' W
Corinthian Yacht Club	Dredge (non-USACE)	37° 52.359' N	122° 27.406' W
Corona Del Mar Homeowners Association	Dredge (non-USACE)	37° 45.832' N	122° 13.513' W
Coyote Point Marina	Dredge (non-USACE)	37° 35.339' N	122° 19.012' W
Emery Access Chanel	Dredge (non-USACE)	37° 50.563' N	122° 18.867' W
Emery Cove Marina	Dredge (non-USACE)	37° 50.312' N	122° 18.628' W
Exploratorium	Dredge (non-USACE)	37° 48.160' N	122° 23.902' W
Foster City Lagoon	Dredge (non-USACE)	37° 32.647' N	122° 15.829' W
Galilee Harbor	Dredge (non-USACE)	37° 51.759' N	122° 29.329' W
Gallinas Creek	Dredge (non-USACE)	38° 1.023' N	122° 30.472' W
Glen Cove Marina	Dredge (non-USACE)	38° 4.023' N	122° 12.790' W
Greenbrae Marina Neighborhood	Dredge (non-USACE)	37° 56.540' N	122° 30.627' W
Hanson Aggregates	Dredge (non-USACE)	37° 45.799' N	122° 13.439' W
Harbor Bay Ferry Channel	Dredge (non-USACE)	37° 44.143' N	122° 15.479' W
High Tide Boat Sales	Dredge (non-USACE)	37° 58.080' N	122° 30.718' W
Jackson Property	Dredge (non-USACE)	37° 45.862' N	122° 13.526' W
Johnson Property	Dredge (non-USACE)	37° 52.405' N	122° 27.644' W
Kappas Marina	Dredge (non-USACE)	37° 52.580' N	122° 30.262' W
Kiewit Pacific Company	Dredge (non-USACE)	38° 5.477' N	122° 15.294' W
Larkspur Landing Ferry Terminal	Dredge (non-USACE)	37° 56.744' N	122° 30.551' W
Larkspur Marina	Dredge (non-USACE)	37° 56.417' N	122° 31.391' W
Larkspur Sea Scout Base	Dredge (non-USACE)	37° 56.587' N	122° 30.699' W
Levin-Richmond Terminal Corporation	Dredge (non-USACE)	37° 55.269' N	122° 22.017' W
Loch Lomond Marina	Dredge (non-USACE)	37° 58.343' N	122° 28.867' W
Lowrie Yacht Harbor	Dredge (non-USACE)	37° 58.037' N	122° 30.469' W
Mare Island Shipyard	Dredge (non-USACE)	38° 5.796' N	122° 15.869' W
Marin Rowing Association	Dredge (non-USACE)	37° 56.557' N	122° 31.026' W
Marin Yacht Club	Dredge (non-USACE)	37° 58.315' N	122° 29.922' W
Marina Bay Yacht Harbor	Dredge (non-USACE)	37° 54.804' N	122° 20.960' W
Marina Plaza Harbor	Dredge (non-USACE)	37° 52.008' N	122° 29.706' W
Marina Vista Canal and Homeowners Assoc.	Dredge (non-USACE)	37° 58.385' N	122° 29.754' W
Martinez Marina	Dredge (non-USACE)	38° 1.629' N	122° 8.230' W
Martinez Shore Terminal	Dredge (non-USACE)	38° 2.748' N	122° 6.082' W
Montezuma Harbor	Dredge (non-USACE)	38° 11.229' N	121° 58.230' W
Napa Valley Marina	Dredge (non-USACE)	38° 13.245' N	122° 18.783' W
Oakland Yacht Club	Dredge (non-USACE)	37° 47.021' N	122° 15.818' W
Oyster Cove Marina	Dredge (non-USACE)	37° 39.821' N	122° 22.709' W
Oyster Point Marina	Dredge (non-USACE)	37° 39.820' N	122° 22.682' W
Paradise Cay Homeowners Assoc.	Dredge (non-USACE)	37° 54.825' N	122° 28.659' W
Paradise Cay Yacht Club	Dredge (non-USACE)	37° 54.930' N	122° 28.590' W
Petaluma Marina	Dredge (non-USACE)	38° 13.797' N	122° 36.811' W
Petaluma River Turning Basin	Dredge (non-USACE)	38° 14.106' N	122° 38.262' W
Pittsburg Marina	Dredge (non-USACE)	38° 2.157' N	121° 52.964' W
Point San Pablo Yacht Club	Dredge (non-USACE)	37° 57.818' N	122° 25.103' W
Port of Oakland	Dredge (non-USACE)	37° 48.646' N	122° 19.715' W
Port of Redwood City	Dredge (non-USACE)	37° 30.808' N	122° 12.576' W
Port of Richmond	Dredge (non-USACE)	37° 54.729' N	122° 21.876' W
Port of San Francisco	Dredge (non-USACE)	37° 48.022' N	122° 23.770' W
Port Sonoma Marina	Dredge (non-USACE)	38° 7.060' N	122° 29.949' W
Redwood City Marina	Dredge (non-USACE)	37° 30.421' N	122° 12.727' W

Redwood Shores Lagoon	Dredge (non-USACE)	37° 32.315' N	122° 14.691' W
Richmond Yacht Club	Dredge (non-USACE)	37° 54.510' N	122° 23.015' W
RMC Lonestar Cement Marina Terminal	Dredge (non-USACE)	37° 30.850' N	122° 12.522' W
Ron Valantine Boat Dock	Dredge (non-USACE)	37° 46.160' N	122° 17.255' W
Ryer Island Boat Harbor (Veneco)	Dredge (non-USACE)	38° 4.467' N	122° 0.713' W
San Francisco Dry Dock	Dredge (non-USACE)	37° 45.801' N	122° 22.984' W
San Francisco Marina (Golden Gate & St. Francis Yacht Clubs)	Dredge (non-USACE)	37° 48.410' N	122° 26.661' W
San Francisco Yacht Club	Dredge (non-USACE)	37° 52.308' N	122° 27.735' W
San Leandro Marina	Dredge (non-USACE)	37° 41.820' N	122° 11.485' W
San Rafael Creek, Residential Berths	Dredge (non-USACE)	37° 58.068' N	122° 30.680' W
San Rafael Rock Quarry	Dredge (non-USACE)	37° 59.302' N	122° 26.838' W
San Rafael Yacht Harbor	Dredge (non-USACE)	37° 58.134' N	122° 31.062' W
Sausalito Marina Properties	Dredge (non-USACE)	37° 51.603' N	122° 29.044' W
Sausalito Yacht Club	Dredge (non-USACE)	37° 51.581' N	122° 28.877' W
Schnitzer Steel	Dredge (non-USACE)	37° 47.628' N	122° 17.538' W
Schoonmaker Point Marina	Dredge (non-USACE)	37° 51.859' N	122° 29.479' W
Shamrock Materials	Dredge (non-USACE)	38° 13.515' N	122° 36.478' W
Shell Terminal	Dredge (non-USACE)	38° 2.002' N	122° 7.380' W
South Beach Yacht club	Dredge (non-USACE)	37° 46.804' N	122° 23.158' W
Strawberry Recreation District	Dredge (non-USACE)	37° 53.311' N	122° 30.001' W
Suisun City Marina	Dredge (non-USACE)	38° 14.056' N	122° 2.247' W
Time Oil Terminal	Dredge (non-USACE)	37° 55.079' N	122° 21.856' W
Timmers Landing	Dredge (non-USACE)	37° 54.554' N	122° 28.481' W
Tosco Refinery	Dredge (non-USACE)	37° 54.926' N	122° 21.900' W
US Army Reserve Center, Mare Island	Dredge (non-USACE)	38° 5.277' N	122° 15.468' W
USS Posco	Dredge (non-USACE)	38° 1.915' N	121° 52.250' W
Valero Refinery Co. - Benicia Crude Dock	Dredge (non-USACE)	38° 2.676' N	122° 7.741' W
Vallejo Ferry Terminal	Dredge (non-USACE)	38° 5.982' N	122° 15.808' W
Vallejo Marina	Dredge (non-USACE)	38° 6.424' N	122° 16.096' W
Vallejo Yacht Club	Dredge (non-USACE)	38° 6.283' N	122° 16.063' W
Dummy01—used for Napa Yacht Club	Dredge	NA	NA
Dummy02	Dredge	NA	NA
Dummy03	Dredge	NA	NA
Dummy04	Dredge	NA	NA
Dummy05	Dredge	NA	NA
Dummy06	Dredge	NA	NA
Dummy07	Dredge	NA	NA
Dummy08	Dredge	NA	NA
Dummy09	Dredge	NA	NA
Dummy10	Dredge	NA	NA

Table 2. Wetland restoration projects that LTMS has created or contributed to. Wetland acres are the total estimated acres for the project. Short-term soft bottom acres are the estimated areas of the projects that will provide soft bottom benthic habitat for fish in the short-term future. Long-term soft bottom acres are the estimated areas of the projects that will provide soft bottom benthic habitat for fish in the long-term future as wetlands evolve.

Project	**Wetlands (acres)**	**Short-term soft bottom (acres)**	**Long-term soft bottom (acres)**
Hamilton Wetlands	570	14	383
Inner Bair Island	248	10	10
Montezuma Wetlands	1829	79.5	79.5
Sonoma Baylands	320	7	7
Bel Marin Keys V	1600	30	30
TOTAL	4567	140.5	509.5

Table 3A. Area and percent of San Francisco Bay disturbed by dredging related activities.

Disturbance	Acres	Percent of Bay
Disposal	550.2	0.2%
USACE dredging	7636.1	2.7%
Non-USACE dredging	1808.1	0.6%
TOTAL	9994.4	3.5%

Table 3B. Area and percent of San Francisco Bay disturbed annually by dredging related activities.

Annual Disturbance	Acres	Percent of Bay
Disposal	550.2	0.2%
USACE dredging	2806.6	1.0%
Non-USACE dredging	508.3	0.2%
TOTAL	3865.1	1.4%

Table 4A. Type (section V.B) and level (section V.A) of effect by action prior to application of LTMS Environmental Protective Measures. L = low, M = medium, H = high level of effect. A slash (*i.e.*,, L/H) indicates that a range of level of effects is possible, dependant on the area in which the action occurs. Red, yellow and blue colors highlight effects that will require avoidance, minimization, or mitigation measures.

	Frequency	Prey loss (foraging)	Refugia loss (area avoidance)	Turbidity (foraging, injury, area avoidance)	Contaminants (reproduction)	O_2 loss (injury, area avoidance)	Entrainment (foraging, area avoidance)	Noise (area avoidance)	Adjacent habitat (foraging, area avoidance)	Invasives (foraging)	Physical habitat (area avoidance)
Clamshell dredge	**0-1 yr**	**H**	**L/H**	**L/M**	**L/H**	**L**	**L**	**L**	**L**	**M**	**L**
	1-2 yr	**M**	**L/H**	**L/M**	**L/H**	**L**	**L**	**L**	**L**	**L**	**L**
	> 2 yr	**L**	**L/H**	**L/M**	**L/H**	**L**	**L**	**L**	**L**	**L**	**L**
Environmental bucket	**0-1 yr**	**H**	**L/H**	**L/M**	**L**	**L**	**L**	**L**	**L**	**M**	**L**
	1-2 yr	**M**	**L/H**	**L/M**	**L**	**L**	**L**	**L**	**L**	**L**	**L**
	> 2 yr	**L**	**L/H**	**L/M**	**L**	**L**	**L**	**L**	**L**	**L**	**L**
Excavator dredge	**0-1 yr**	**H**	**L/H**	**M**	**L/H**	**L**	**L**	**L**	**L**	**M**	**L**
	1-2 yr	**M**	**L/H**	**M**	**L/H**	**L**	**L**	**L**	**L**	**L**	**L**
	> 2 yr	**L**	**L/H**	**M**	**L/H**	**L**	**L**	**L**	**L**	**L**	**L**
Cutterhead dredge	**0-1 yr**	**H**	**L/H**	**L**	**L/M**	**L**	**L**	**L**	**L**	**M**	**L**
	1-2 yr	**M**	**L/H**	**L**	**L/M**	**L**	**L**	**L**	**L**	**L**	**L**
	> 2 yr	**L**	**L/H**	**L**	**L/M**	**L**	**L**	**L**	**L**	**L**	**L**
Suction dredge	**0-1 yr**	**H**	**L/H**	**L**	**L/M**	**L**	**M**	**L**	**L**	**M**	**L**
	1-2 yr	**M**	**L/H**	**L**	**L/M**	**L**	**M**	**L**	**L**	**L**	**L**
	> 2 yr	**L**	**L/H**	**L**	**L/M**	**L**	**M**	**L**	**L**	**L**	**L**
Knockdown	**0-1 yr**	**H**	**L/H**	**L**	**L**	**L**	**L**	**L**	**L**	**L**	**L**
	1-2 yr	**M**	**L/H**	**L**	**L**	**L**	**L**	**L**	**L**	**L**	**L**
	> 2 yr	**L**	**L/H**	**L**	**L**	**L**	**L**	**L**	**L**	**L**	**L**
In-Bay disposal	**annual**	**H**	**L/M**	**H**	**H**	**L**	**L**	**L**	**M**	**L**	**L**
Offshore disposal	**annual**	**L**	**L**	**L**	**L**	**L**	**L**	**L**	**L**	**L**	**L**
Upland disposal	**annual**	**L**	**L**	**L**	**L**	**L**	**M**	**L**	**L**	**L**	**L**

Table 4B. Type and level of effect by action after application of appropriate LTMS Environmental Protective Measures. L = low, M = medium, H = high level of effect. A slash (*i.e.*,, L/H) indicates that a range of level of effects is possible, dependant on the area in which the action occurs. 1 = reduce in-Bay disposal, 2 = wetland restoration, 3 = remove contaminants from Bay. Green color indicates effects that have been fully compensated by LTMS Environmental Protective Measures. Yellow and blue colors highlight effects with outstanding levels that will require avoidance, minimization, or mitigation measures (see conservation recommendations (CRs)).

	Frequency	Prey loss (foraging) CRs 1-3	Refugia loss (area avoidance) CRs 4-5	Turbidity (foraging, injury, area avoidance) CR 6	Contaminants (reproduction) CRs 7-9	O_2 loss (injury, area avoidance)	Entrainment (foraging, area avoidance)	Noise (area avoidance)	Adjacent habitat (foraging, area avoidance)	Invasives (foraging) CRs 10-11	Physical habitat (area avoidance)
Clamshell dredge	**0-1 yr**	**H-2**	**L/H**	**L/M-1***	**L/H-3**	**L**	**L**	**L**	**L**	**M**	**L**
	1-2 yr	**M-2**	**L/H**	**L/M-1***	**L/H-3**	**L**	**L**	**L**	**L**	**L**	**L**
	> 2 yr	**L**	**L/H**	**L/M-1***	**L/H-3**	**L**	**L**	**L**	**L**	**L**	**L**
Environmental bucket	**0-1 yr**	**H-2**	**L/H**	**L/M-1***	**L**	**L**	**L**	**L**	**L**	**M**	**L**
	1-2 yr	**M-2**	**L/H**	**L/M-1***	**L**	**L**	**L**	**L**	**L**	**L**	**L**
	> 2 yr	**L**	**L/H**	**L/M-1***	**L**	**L**	**L**	**L**	**L**	**L**	**L**
Excavator dredge	**0-1 yr**	**H-2**	**L/H**	**M-1***	**L/H-3**	**L**	**L**	**L**	**L**	**M**	**L**
	1-2 yr	**M-2**	**L/H**	**M-1***	**L/H-3**	**L**	**L**	**L**	**L**	**L**	**L**
	> 2 yr	**L**	**L/H**	**M-1***	**L/H-3**	**L**	**L**	**L**	**L**	**L**	**L**
Cutterhead dredge	**0-1 yr**	**H-2**	**L/H**	**L**	**L/M-3**	**L**	**L**	**L**	**L**	**M**	**L**
	1-2 yr	**M-2**	**L/H**	**L**	**L/M-3**	**L**	**L**	**L**	**L**	**L**	**L**
	> 2 yr	**L**	**L/H**	**L**	**L/M-3**	**L**	**L**	**L**	**L**	**L**	**L**
Suction dredge	**0-1 yr**	**H-2**	**L/H**	**L**	**L/M-3**	**L**	**M-2**	**L**	**L**	**M**	**L**
	1-2 yr	**M-2**	**L/H**	**L**	**L/M-3**	**L**	**M-2**	**L**	**L**	**L**	**L**
	> 2 yr	**L**	**L/H**	**L**	**L/M-3**	**L**	**M-2**	**L**	**L**	**L**	**L**
Knockdown	**0-1 yr**	**H-2**	**L/H**	**L**	**L**	**L**	**L**	**L**	**L**	**L**	**L**
	1-2 yr	**M-2**	**L/H**	**L**	**L**	**L**	**L**	**L**	**L**	**L**	**L**
	> 2 yr	**L**	**L/H**	**L**	**L**	**L**	**L**	**L**	**L**	**L**	**L**
In-Bay disposal	**annual**	**H-2**	**L/M**	**H-1**	**H-3**	**L**	**L**	**L**	**M-1**	**L**	**L**
Offshore disposal	**annual**	**L**	**L**	**L**	**L**	**L**	**L**	**L**	**L**	**L**	**L**
Upland disposal	**annual**	**L**	**L**	**L**	**L**	**L**	**M-2**	**L**	**L**	**L**	**L**

*****Turbidity from these actions may still cause indirect impacts to eelgrass which must be avoided or mitigated for.

Table 5. Acres of dredging in San Francisco Bay by sediment type and frequency of dredging.

Dredge entity	Sediment type	Frequency of dredging (level of disturbance) 0-1 year (high)	1-2 years (medium)	3+ years (low)	Total (all frequencies)	TOTAL
USACE	Fines	1818.1	187.9	2512.0	4518.0	7636.1
	Sand+	988.5	1140.7	988.9	3118.1	
Non-USACE	Fines	508.3	475.8	800.3	1784.4	1788.4
	Sand	0.0	0.0	4.0	4.0	
Total (USACE & non-USACE)	Fines	**2326.4**	663.7	3312.3	6302.4	9424.5
	Sand	988.5	1140.7	992.9	3122.1	
TOTAL	Fines & sand	3314.9	1804.4	4305.2	9424.5	**9444.2∗**

+ This category does not include dredging of the Main Ship Channel as this area was not considered within San Francisco Bay for the spatial analysis.

∗ A third sediment type termed "shell-hash" is dredged by non-USACE every 3+ years adding 19.7 acres to the total acres dredged by non-USACE entities. To avoid confusion, this value is only included in the final total.

Table 6. List of projects with potential direct and indirect impacts to eelgrass, and estimated acreage of eelgrass impacted for direct effects. Data presented here were derived from NMFS spatial analysis (V.D.3).

		Potential direct effects		**Potential indirect effects**
Name	**Type**	**Acres of direct overlap with eelgrass**	**Acres of direct overlap with 45m buffer**	**Eelgrass within 250m of project**
Richmond Harbor	Dredge (USACE)	0	0.003	yes
San Francisco Harbor	Dredge (USACE)	0	0	yes
Oakland Harbor	Dredge (USACE)	0	0	yes
Glen Cove Marina	Dredge (non-USACE)	0.01	2.94	yes
C&H Sugar Company	Dredge (non-USACE)	0	0	yes
San Rafael Rock Quarry	Dredge (non-USACE)	0	0	yes
Coast Guard Station, Golden Gate	Dredge (non-USACE)	0	0.51	yes
Sausalito Yacht Club	Dredge (non-USACE)	0	1.44	yes
Schoonmaker Point Marina	Dredge (non-USACE)	0	0.83	yes
Galilee Harbor	Dredge (non-USACE)	0	0.38	yes
Kappas Marina	Dredge (non-USACE)	0.01	1.66	yes
Strawberry Recreation District	Dredge (non-USACE)	0.29	1.03	yes
Clipper Yacht Harbor	Dredge (non-USACE)	0	0.35	yes
Paradise Cay Yacht Club	Dredge (non-USACE)	0	0	yes
Paradise Cay Homeowners Assoc	Dredge (non-USACE)	0	0	yes
Timmers Landing	Dredge (non-USACE)	0	0	yes
Corinthian Yacht Club	Dredge (non-USACE)	0	0	yes
San Francisco Yacht Club	Dredge (non-USACE)	0.01	4.32	yes
Belvedere Land Company	Dredge (non-USACE)	0.25	0.88	yes
Port of San Francisco	Dredge (non-USACE)	0	0	yes
CG Station, Yerba Buena Island	Dredge (non-USACE)	0.47	1.85	yes
Point San Pablo Yacht Club	Dredge (non-USACE)	0	0.39	yes
Berkeley Marina	Dredge (non-USACE)	0	0	yes
Richmond Yacht Club	Dredge (non-USACE)	0	0.18	yes
Aeolian Yacht Club	Dredge (non-USACE)	0	0.12	yes
Emery Cove Marina	Dredge (non-USACE)	0	0	yes
Port of Oakland	Dredge (non-USACE)	0	0	yes
Ballena Isla Townhomes	Dredge (non-USACE)	0.01	1.36	yes
Ron Valantine Boat Dock	Dredge (non-USACE)	0	0	yes
Redwood City Marina	Dredge (non-USACE)	0	0	yes
Coyote Point Marina	Dredge (non-USACE)	0	0	yes
Ballena Isla Marina	Dredge (non-USACE)	0	0	yes
Harbor Bay Ferry Channel	Dredge (non-USACE)	0	0.18	yes
Bellevue Channel	Dredge (non-USACE)	0.36	0.68	yes
Johnson Property	Dredge (non-USACE)	0.66	0.66	yes
Sausalito Marina Properties	Dredge (non-USACE)	0.08	0.83	yes
CA Maritime Academy	Dredge (non-USACE)	0.03	0.9	yes
Marina Bay Yacht Harbor	Dredge (non-USACE)	0	0.01	yes
Emery Access Chanel	Dredge (non-USACE)	0	0	yes
Chevron Rod and Gun	Dredge (non-USACE)	0	0	yes

Appendix 1. Contaminant Analysis

Analysis of contaminant effects to species listed under the Endangered Species Act (ESA) and to Essential Fish Habitat (EFH) for species managed under the Magnuson-Stevens Act (MSA).

The action agencies for this project are the U.S. Army Corps of Engineers (USACE) and the U.S. Environmental Protection Agency (EPA) Region IX. The USACE issues permits for maintenance dredging while the EPA sets sediment and water quality objectives, in conjunction with the State of California, to protect the beneficial uses of San Francisco Bay. The State must certify any dredging and disposal actions authorized by the USACE. EPA is integral in this process as a co-manager of the Long Term Management Strategy for dredging (LTMS) that was put in place to reduce the amount of dredged material disposed in-Bay and maximize the amount which is beneficially reused. The volumes sent to the ocean disposal site (SFDODs) were also expected to increase from previous levels (but remain within authorized volumes) with the adoption of the LTMS. Most of the beneficial reuse projects to date have involved the restoration or recreation of wetland habitat.

At question here are the potential effects of the USACE maintenance dredging program to ESA listed species (particularly green sturgeon) and EFH. The LTMS program sets a "40-40-20" goal as well as an overarching annual volume of allowable dredge material disposal within the Bay. Up to forty percent of the dredged materials may be disposed of in-Bay, another forty percent (minimum) is to be disposed of at an upland location and the final twenty percent (minimum) may go to SFDODs. A secondary goal of the LTMS is to maximize reuse over other disposal options. At this time, the overall volume goal (1.2 million cubic yards maximum disposed of in-Bay after 2012) of the LTMS program is nearly met while the percentage goals of the program have not been achieved. In general, a large percentage of dredged materials are still disposed of in-Bay while the ocean disposal site remains under utilized. Specific percentages can be pulled from the annual reports that the USACE has posted on their DMMO website.

One of NMFS' main concerns with the maintenance dredging program as proposed by the action agencies relates to contaminant levels in San Francisco Bay sediments and how the levels of contaminants in those sediments are considered in disposal decisions. The basic structure of the decision process is put forth in the Inland Testing Manual (EPA and USACE 1998). This national level guidance document presents a tiered structure for decision making and associated testing regimes. The document explicitly notifies the reader that it is only guidance and leaves significant room for best professional judgment in determining when advanced testing will be required. These allowances required development of the more site-specific guidance presented in the Guidelines for Implementing the Inland Testing Manual in the San Francisco Bay Region (EPA *et al*. 2001a). These two documents combine to produce an effects-based testing program that frequently requires proposed dredging projects to generate chemical specific concentration data for a proposed project.

<u>Water Column Toxicity Testing and Impacts</u>

The San Francisco Bay Guidelines document (EPA *et al*. 2001a) states that ten years of water column toxicity data from SF-09, SF-10 and SF-11 were examined and it was determined that water column toxicity was not significant. The Framework for Assessment of Potential Effects of Dredging on Sensitive Fish Species in San Francisco Bay document (LFR Levine Fricke 2004) summarizes USACE studies from the 1970s that found elevated levels of dissolved metals in disposal plumes in the Central Bay. However these elevated levels lasted for less than 1.5 hours. No data was presented in the EFH assessment to support this determination. The EFH Assessment does state that direct bioassay tests are conducted on the liquid-suspended phase of the dredged material. Presumably, this data and sediment concentration data is then evaluated using models that were developed at the national level (Short Term Fate of Dredged material model - STFATE). The output from the models is considered with a 100-fold safety factor applied to the predicted concentrations at the edge of its calculated (or predetermined) mixing zone in order to meet the State's narrative toxicity standard. Formal mixing zones have apparently never been defined for the disposal sites in Clean Water Act (CWA) terms.

Recent communication among cooperating agencies through informal consultation has clarified that if testing of a dredged material sample shows toxicity, that dredged material will be declared not suitable for aquatic disposal (Ross, B. pers. comm 2010a,b). Contaminant testing of the bulk sediments is also frequently conducted and these contaminant levels are entered into the USACE' models to examine the potential for water column toxicity during disposal caused by trace organic and inorganic contaminants. If the sediments pass these screening methods, it is unlikely that they will cause impacts sufficient to detrimentally affect EFH. Elevated levels of contaminants may cause species to leave the impacted area for a period of time, but any impacts to water column EFH will be intermittent and short-lived (Hansen *et al*. 1999a and 1999b).

<u>Benthic Toxicity Testing and Impacts</u>
Although not always required, benthic toxicity tests are frequently conducted due to known elevated levels of contaminants in San Francisco Bay at many of the sites which require periodic maintenance dredging. This benthic toxicity testing must account for three life history stages (filter feeder, deposit feeder and burrower) and usually is conducted using an approved amphipod and a *Mysid* shrimp or worm species. Typically, benthic toxicity testing generates acute mortality data, which does not provide information regarding the potential for bioaccumulation or food web effects (EPA *et al.* 2001b). Growth, development and reproduction tests are also sometimes conducted on an approved, appropriate invertebrate species which varies by salinity at the dredging site. Although there is not a clearly recorded policy for disposing of toxic sediments from maintenance dredging in SF Bay, informal consultation with the action agencies has clarified that sediments are barred from in-Bay disposal if there is any toxicity indicated by the testing (Ross, B., pers. comm.. 2010a,b).

<u>Bioaccumulation Testing and Impacts</u>
In San Francisco Bay, bioaccumulative pollutants such as chlorinated hydrocarbons (*e.g.,*, PCBs, DDTs, dieldrin, chlordane, dioxins/furans), mercury, and many PAHs are known contaminants present in sediments at problematic levels in many locations and especially along the Bay margins where some maintenance dredging occurs. Total Maximum Daily Load (TMDL) plans, required under the CWA, have been developed for PCBs and mercury

and are in development for the other pollutants listed. The CWA Section 303(d) list of impaired waterbodies includes listings for the chlorinated hydrocarbons (*i.e.*,, chlordane, DDTs, dieldrin, and PCBs (dioxin-like)) that were made by EPA Region IX. These listings mean that those areas of San Francisco Bay do not have the capacity to assimilate additional contaminant loads. Additional measures are necessary to reduce levels in the bay in order to achieve unimpaired beneficial use. Beneficial uses currently impacted because of these contaminants include aquatic life, estuarine habitat, and recreational and sport fishing.

In regards to dredging, bioaccumulation tests may be recommended by the reviewing agencies (EPA, USACE, San Francisco Bay Conservation and Development Commission, California State Lands Commission and the San Francisco Bay Regional Water Quality Control Board) assembled through the DMMO process. Ultimately, the USACE is responsible for requiring the bioaccumulation tests as the permitting agency. It is not clear from the assessment documents provided for this consultation how often these tests are required in the absence of defined triggers. Although the SF Bay ITM guidelines (EPA *et al*. 2001a) and associated Response to Comments documents (EPA *et al*. 2001b) allude to the development of bioaccumulation triggers, screening levels, and to a national bioaccumulation model, it seems that these tools were never developed and are not utilized in the SF Bay district. They are not mentioned in the EFH assessment document, which instead states that bioaccumulation testing will be required on a best professional judgment basis.

Bioaccumulation triggers were developed in the Pacific Northwest, but are now being replaced with a more rigorous process for evaluating bioaccumulation potential (USACE *et al*. 2009). The Sediment Evaluation Framework for the Pacific Northwest (USACE *et al*. 2009) uses a “reason to believe” standard meaning, “a bioaccumulation evaluation is conducted if there is reason to believe chemicals present in the sediments may contribute to levels in the aquatic food chain that could be harmful to fish or shellfish, or to wildlife or humans eating fish or shellfish.” In areas without sediment bioaccumulation triggers, or for individual chemicals for which bioaccumulation triggers have not been developed in the Pacific Northwest, a comparison to background concentrations is conducted. Exceedances of a bioaccumulation trigger, or (in the interim in the three participating USACE districts) elevations above background, can trigger the need for bioaccumulation testing. Sediments containing chemical concentrations below screening levels and bioaccumulation guidelines (or background, in the interim) are considered suitable for unconfined open-water disposal. The flipside of this statement is that sediments above screening levels and bioaccumulation guidelines (or background, in the interim) are not suitable for unconfined open-water disposal. At the least it indicates that a bioaccumulation study must be conducted to determine their status. This framework has been adopted by three USACE districts (Portland, Seattle and Walla Walla), the Northwest Division of the Army Corps, US EPA Region X, the States of Washington, Oregon and Idaho as well as the US Fish and Wildlife Service and NMFS Northwest Region. This seems to be a sound system to import to the San Francisco Bay area as well.

The following sections deal with bioaccumulative (or biotransformed) compounds found in elevated concentrations in San Francisco Bay sediments that may affect EFH and/or ESA listed species and their critical habitats. Just as the contaminants often co-occur, much of the reviewed, pertinent literature examines sites with multiple pollutants or end-points that may be affected by multiple contaminants. Studies which focus on Polycyclic Aromatic Hydrocarbons (PAHs) and chlorinated hydrocarbons (particularly Polychlorinated biphenyls (PCBs), but also chlorinated pesticides) are given prominence as these contaminants have been shown to be the most likely to detrimentally impact fish health in San Francisco Bay.

PAHs are known to cause cancer, reproductive anomalies, and immune dysfunction; to impair growth and development; and to cause other impairments in fish exposed to sufficiently high concentrations over periods of time (Johnson *et al.* 1999, Karrow *et al*. 1999, Johnson 2000, Stehr *et al.* 2000, Collier *et al.* 2002, Johnson *et al.* 2002, Sherry *et al*. 2005). Embyonic exposures can result in edema (swelling) of the yolk sac, hemorrhaging, disruption of cardiac function, enzyme induction, mutation of progeny, craniofacial and spinal deformities, neuronal cell death, anemia, reduced growth and impaired swimming (Barron *et al.* 2003, Billiard *et al.* 1999, 2002, Brinkworth *et al.* 2003, Marty *et al.* 1997: all cited in Barron *et al.* 2004, Incardona *et al.* 2004, 2005, Wassenberg and Di Giulio 2004a, 2004b). Exposure to sunlight has been observed to result in a 48-fold increase in toxicity of some PAHs to herring larvae (Barron *et al.* 2003), an increased medaka embryo failure rate (Diamond *et al*. 2006), impacts to invertebrates (Pelletier *et al.* 1997, Swartz *et al*. 1997) and in water column exposures as low as 2 µg/L becoming toxic to calanoid copepods (Duesterloh *et al.* 2002)). Several studies demonstrate that PAHs harm the egg-larval lifestage of Pacific herring (Vines *et al.* 2000, Carls *et al.* 1999), surf smelt (Misitano *et al.* 1994) and pink salmon (Heintz *et al.* 1999, Bue *et al*. 1998). Carls *et al.* (1999) showed that total dissolved PAH concentrations from weathered oil of 0.7 µg/L caused morphological malformations, genetic damage, inhibited swimming, decreased size and mortality of larval Pacific herring. Sublethal effects (such as yolk sac edema and delayed mortality) were observed at concentrations as low as 0.4 µg/L total dissolved PAH. Poston (2001) reviews several other studies of the effects of weathered crude oil and other PAHs or sources on various endpoints including the spawning success of pink salmon and herring.

The main exposure scenario of concern for PAHs occurs as they accumulate in sediments and are assimilated into the food web. It is the chronic and dietary exposures, particularly to the higher weight PAHs remaining in sediments, that cause many of the effects listed above (*i.e.*,, cancer, reproductive anomalies, immune dysfunction, growth and development impairment, and other impairments to fish over periods of time or exposed during their egg or larval life stages). PAHs bioaccumulate in many invertebrate species (Varanasi *et al.* 1989, 1992; Meador *et al.* 1995), but are metabolized significantly by many vertebrates (including fishes) where they are converted to water-soluble forms and excreted (Varanasi *et al.* 1989). Some of the intermediate metabolites in this process exhibit carcinogenic, mutagenic and cytotoxic properties. Metabolic capacity is generally very high in vertebrates, intermediate in crustaceans and limited in bivalves (Meador *et al.* 1995).

There is a significant debate over what level of PAHs in sediments causes the adverse effects discussed and how effectively environmental factors such as total organic carbon (TOC) in sediments mediates these effects. Attention to field studies is given in this review as these studies document effects in real environments that include TOC and potential confounding factors such as co-occurring contaminants. Research by scientists at the NMFS Northwest

Fisheries Science Center (Johnson *et al.* 2002) suggested that a sediment threshold level for total PAH of 1 part per million (mg/kg dry weight) would protect estuarine, bottom dwelling fish (such as the English sole examined in the study), from detrimental effects (*e.g.*,, liver lesions, spawning inhibition and reduced egg viability). This level (1 mg/kg) was the lowest at which effects to English sole began to be observed and English sole is considered a relatively sensitive species making it appropriate to use in proposing protective levels. The author of this paper has also calculated degenerative lesion thresholds for starry flounder (1950 ng/g), which is found within San Francisco Bay and is an EFH managed species, for winter flounder (300 ng/g), which is an Atlantic species (Johnson, unpublished data). The background concentrations in large portions of San Francisco Bay are at or above the 1 mg/kg level (SFEI 2009). A model developed as part of this study (Johnson *et al*. 2002) predicted a 10-fold increase in DNA adducts (a complex formed when a carcinogen combines with DNA or a protein) at 5 mg/kg total PAH compared to control fish, resulting in liver disease to approximately 30% of the exposed fish and increasing failure to spawn. The increasing trend in liver lesions and negative reproductive effects at lower PAH concentrations, closer to the seven-year Bay-wide average concentration of 2.3 mg/kg, is evident in the study as well. Table three from that study (Johnson *et al*. 2002) has been reproduced below to present these trends.

Table 3. Estimated effect levels associated with increasing sediment PAH concentration for selected liver lesions and indicators of reproductive function in English sole.

PAH (ppb dry wt.)	Neoplasm prevalence	FCA prevalence	SDN prevalence	Proliferative lesion prevalence	Any lesion prevalence
Liver lesions					
50	0.00	0.01	0.00	0.02	0.00
100	0.00	0.02	0.00	0.02	0.00
1000	**0.00**	**0.06**	**0.01**	**0.08**	**0.09**
2000	0.00	0.07	0.12	0.11	0.18
3000	0.01	0.08	0.20	0.13	0.24
5000	0.03	0.09	0.27	0.14	0.31
10000	0.06	0.10	0.38	0.17	0.40
100000	0.16	0.14	0.75	0.26	0.71
Reproductive indicators					
PAH (ppb dry wt.)	Inhibited gonadal development prevalence	Inhibited spawning prevalence	Infertile proportion eggs of eggs spawned		DNA Damage (nmol adducts per mol nucleotides)
50	0.15	0.12	0.38		5
100	0.15	0.12	0.38		5
1000	**0.15**	**0.17**	**0.42**		**25**
2000	0.15	0.25	0.48		36
3000	0.15	0.30	0.51		43
5000	0.18	0.35	0.55		51
10 000	0.27	0.43	0.61		63
100 000	0.58	0.69	0.80		100

For all liver lesions, inhibited gonadal development, and inhibited spawning, the effect level is the proportion of fish estimated to be affected at the indicated sediment PAH concentration; for infertile eggs, the effect level is the proportion of eggs produced by an individual female that are estimated to be unfertile. Effect levels for liver lesions were calculated with hockey-stick regression. For reproductive indicators, effect levels at the sampling sites where PAH concentrations were lowest were used to estimate background effect levels (i.e. effect levels at PAH concentrations below 5000 ppb for inhibited gonadal development, and below 1000 ppb for inhibited spawning and infertile eggs).

The authors noted a concern that other carcinogenic contaminants (PCBs, chlorinated pesticides, and trace metals) were present in the sediments of the Puget Sound at the various study locations and may be significant confounding factors. However the study noted that

PAH exposure was more highly correlated than PCB exposure with inhibited gonadal development, inhibited spawning, and reduced egg quality. PCBs and PAHs often co-occur at problematic levels in urbanized estuaries, and this is a common mixture of contaminants in San Francisco Bay (SFEI 2009) as will be shown in the following paragraphs. Therefore the study is extremely relevant in evaluating the proposed action.

There have been several studies conducted in San Francisco Bay that show effects to EFH and EFH managed species from elevated PAH and other chlorinated contaminant levels in sediments. PAH metabolites (flourescent aromatic compounds (FACs)) were measured in fish bile to show exposure to PAHs in starry flounder and white croaker in eight years of samples from San Francisco Bay (Stehr *et al.* 1997). The concentrations of both low and high molecular weight FACs were significantly higher in both species at all sites sampled compared to control fish from Bodega Bay. Three of the six sampling locations had geometric mean concentrations of PAHs in the sediment >1 mg/kg with the highest concentration found at Hunters Point at approximately 5 mg/kg. High molecular weight PAHs were significantly higher in the stomach contents of starry flounder at all six sampling sites compared to Bodega Bay and in the stomach of white croaker at three of the sites (Hunters Point, Oakland Estuary and Southampton Shoal). This exposure was highly correlated with the occurrence of liver lesions found in both of these species which were more prevalent in fish from San Francisco Bay compared to the control fish. These two species represent different foraging strategies and prey preferences. Starry flounder often completely bury themselves in sediment leading to increased chance of exposure to sedimented contaminants. Sediments at the sampling sites were also contaminated by PCBs and DDT at levels significantly above the control location.

Starry flounder were also examined in the 1980s (Spies and Rice 1988, Spies *et al.* 1988) with fish collected in the Central Bay (near Berkeley) and in San Pablo Bay. Sediment concentrations of PAHs from the Central Bay samples were reported at 4.6 ± 1.8 mg/kg while those from the San Pablo Bay sites were reported to be 2.6 ± 1.3 mg/kg. PAH levels in the Central Bay fish were nearly twenty times greater than the San Pablo Bay fish. The sites were also contaminated by PCBs with levels in San Pablo Bay at 9.3 ± 2.3 ng/g. Data from Oakland was used to estimate concentrations at the Central Bay site with PCB sediment concentrations at 61 ± 12 ng/g. The starry flounder from the Central Bay were found to have poorer reproductive success (percent viable eggs, fertilization and embryological success) than those from San Pablo Bay, but greater than 95% of the fish from both sites showed signs of inhibition of hepatic aryl hydrocarbon hydroxylase (AHH) activity. These enzymes mediate chemical transformations of compounds that are foreign to the body, thus facilitating their depuration and excretion (Gruger *et al*. 1977), and are important for maintaining fish health and reproductive fitness.

Gunther *et al.* (1997) examined speckled sanddabs exposed to sediments from San Pablo Bay, Castro Cove, and a control location and found a biomarker of chemical exposure (ethoxyresorufin-O-deethylase (EROD)) and cytochrome P4501A (CYP1A) induced toxicity at PAH concentrations as low as 1.2 mg/kg dry weight in the sediment. PCBs were also present in the sediments at levels as low as 12.8 ng/g dry weight. These sediments were toxic to the amphipod *Eohaustorius estuarius*.

In San Francisco Bay, monitoring by the RMP program has established a Bay-wide average concentration for the seven year period from 2002 to 2008 of total PAHs at 2.3 mg/kg. This seven year average was higher in the Central Bay (3.6 mg/kg) which is heavily influenced by the urban centers, historical sources of contamination and the SF-11 dispersive disposal site. This multi-year average concentration was lower in San Pablo Bay (1.0 mg/kg) achieving the sediment threshold proposed by Johnson et al. (2002). In Suisun Bay, the average concentration was lower still at 0.50 mg/kg over the seven-year time period. SFEI (2009) notes that PAH concentrations have been quite variable from year to year and do not suggest an overall trend.

There have been several screening methods developed since the 1980s that examine potential threshold levels for effects across a broad range of species (*e.g.*, ER-Ms and ER-Ls, PELs and TELs, etc.). This suite of numbers is often used to evaluate contaminant levels in sediments, although their usefulness is frequently questioned as being both over-protective or under protective. There are more recent studies that are not built into the screening level databases (*e.g.*, anything published after the latest versions of the databases) and new methods being put into place to address these shortcomings. The information is presented here for comparative purposes. The Effects Range – Low (ER-L) for total PAHs is approximately 4 mg/kg, while the Threshold Effects Level (TEL - approximately 1.7 mg/kg) is closer to the threshold level suggested by Johnson *et al.* (2002). The concentrations of concern are even lower for total high molecular weight (HMW) PAHs, which typically remain in the sediments, with an ER-L of 1.7 mg/kg and a TEL of 0.66 mg/kg (Buchman 1999). These are environmentally realistic concentrations that may be exceeded in industrialized or urbanized areas; however, these are the levels where effects are predicted to begin. The Effects Range – Median (ER-M) for total PAHs is approximately 44.8 mg/kg (total HMW PAH = 9.6 mg/kg), while the Probable Effects Level (PEL) is approximately 16.7 mg/kg (total HMW PAHs = 6.7 mg/kg). Sediments with PAH levels above the lower thresholds warrant protection from additional contamination in order to protect the function of the sediment for EFH as well as ESA-listed species.

PCB concentration have declined significantly since the production and new use of the compounds was banned in the United States in the late 1970s (Davis *et al*. 2007, SFBRWQCB 2008). However there is still a significant reservoir of PCBs in sediment below current surface levels and in particularly contaminated locations around San Francisco Bay. Levels in surficial sediments Bay-wide averaged 6.6 ng/g over the five year period from 2004-2008 (SFEI 2009). The Central Bay averaged 8.0 ng/g during this period of time while San Pablo Bay averaged 4.4 ng/g and Suisun Bay was at 2.3 ng/g. These levels are well above the sediment level (0.75 ng/g dry weight) predicted as being necessary to achieve fish tissue concentration protective of human health (10 ng/g wet weight) and, by assumption, ecological risk criteria (Gobas and Arnot 2010, 2005).

Several studies that showed potential effects to fish species in San Francisco Bay from the bioaccumulation of PCBs and other contaminants have already been presented (Stehr *et al*. 1997, Spies and Rice 1998, Gunther *et al*. 1997). An additional study examining striped bass larval development (SFEI 2005 in Davis *et al.* 2007) showed that wild hatched striped bass (whose mothers spent most of their time in the San Francisco Bay) had significantly higher burdens of several pollutants including PCBs, chlorinated pesticides and PBDEs. Compared to eggs and larvae reared in a hatchery, the wild hatched striped bass produced larvae that had developmental problems (reduced growth, altered liver development, more rapid yoke sac depletion) that could lead to population level impacts.

Another study currently underway (SFEI 2009) found that topsmelt, an important prey item for piscivorous fish and wildlife, were taking up PCBs along six nearshore areas throughout the Bay at a surprisingly high level. This shows an unexpected avenue for PCBs entering the food web at existing environmental concentrations. A second year of data will be gathered in 2010.

A recent report (Kelley and Reyes 2009) prepared for the RMP examined endocrine disruption incidences and spatial patterns in San Francisco Bay. Utilizing shiner surfperch and staghorn sculpin, two prey items for many EFH managed species which occupy different ecological niches, the researchers found that endocrine system function has been significantly altered in fish from several different locations within San Francisco Bay. Elevated levels of PCBs, PAHs and chlorinated pesticides were found in fish tissues with compromised cortisol functions. Evidence of altered function in systems regulating the hormone cortisol were found at potentially dredged areas such as the Oakland Inner Harbor, the Richmond area and the San Francisco waterfront. Impacts to the thyroid system were also noted and were closely associated with exposure to PCBs and chlorinated pesticides. Abnormal regulation of cortisol levels impacts fish health by compromising immune systems (which led to increased parasitic infections in the study), reducing growth rates, and impairing physiological response to stressors such as poor water quality, life-threatening circumstances, crowding, etc. Cortisol regulates functions such as hepatic glucose release in response to energy demands, tissue repair functions and immune system function among others. Abnormal regulation of thyroid hormone levels impacts growth and development processes in all vertebrate animals (Kelley and Reyes 2009).

The concentration of PCBs allowed in dredged sediments disposed of in-Bay is regulated by the San Francisco Bay Regional Water Quality Control Board through the TMDL for PCBs in San Francisco Bay (SFBRWQCB 2008) which was approved by EPA Region IX on March 29, 2010. The TMDL states, "In order to ensure that buried PCBs are not being spread through the Bay via dredge material disposal at dispersive sites, sediments disposed of in-Bay should have total PCBs concentrations no greater than that in ambient surface sediments in the Bay. To provide this assurance, we propose that the PCB concentrations in dredged material disposed of in the Bay not exceed the 99th percentile of total PCBs concentration of the previous 10 years of Bay surface sediment samples collected through the RMP (excluding stations outside the Bay like the Sacramento River, San Joaquin River, Guadalupe River and Standish Dam stations)." At the time of this writing, the allowable concentration of PCBs in dredged material disposed of in-Bay appears to be 25.1 ng/g dry weight (Christian, B., pers. comm. 2010). This is more than three times higher than the Bay-wide average (6.6 ng/g) for the five year period between 2004-2008 calculated through the RMP (SFEI 2009), which provides the reference conditions for consideration in making disposal decisions (Ross, B., pers. comm. 2010a). This allowance of elevated contaminant levels in dredged material disposed of in-Bay, potentially without undergoing bioaccumulation testing, is not protective and will serve to prolong and exacerbate impacts to aquatic habitat function and fisheries through bioaccumulation.

Mercury

The element mercury and its compounds have no known normal metabolic function. Sublethal concentrations of mercury are known to adversely affect aquatic organisms through inhibition of reproduction, reduction in growth rate, increased frequency of histopathology, impairment in ability to capture prey and olfactory receptor function, alterations in blood chemistry and enzyme activities, disruption of thyroid function, chloride secretion and other metabolic and biochemical functions (Eisler 2000). Mercury levels are elevated in several sections of San Francisco Bay to the point that the waterbody is listed on EPA's Clean Water Act Section 303(d) list of impaired waters. Mercury remains a persistent contaminant in the sediments of San Francisco Bay and the concentrations in some fish remain elevated (Conaway *et al*. 2007). Several fish consumption advisories related to mercury in the Bay have been issued and mercury levels have been determined to be negatively impacting several bird species (SFBRWQCB 2006). Unfortunately the extent of effects of mercury and other contaminants on fish is not well understood because there have not been many studies of consequences of these long-term, low level exposures (Thompson *et al*. 2007).

Eisler (2000) summarized that at lower trophic levels, the efficiency of mercury transfer was low through natural aquatic food chains, but in animals of higher trophic levels, such as predatory fish and birds, the transfer was markedly amplified. However trends are not consistent between species and it is difficult to generalize (Eisler 2000). Total mercury concentrations in San Francisco Bay sediments have been decreasing with an overall 22% decrease in the North Bay, a 17% decrease in the Central Bay and 32% decrease in the South Bay from 1993-2001 (Conaway *et al*. 2007). Median concentrations in this paper (Conaway *et al*. 2007) were noted as highest where the estuary interfaced with urbanized areas (0.35 mg/kg), lowest in the rivers (0.10 mg/kg) and in-between in the Central Bay (0.22 mg/kg) and the Southern Sloughs (0.24 mg/kg). It must be noted however that variability in sediment concentrations is noted from year to year by the RMP (SFEI 2007). Conaway *et al*. (2007) instead links the lower sediment mercury concentrations to the transport of relatively lower-mercury sediment to the estuary from the Sacramento River and San Joaquin River watersheds. The paper concludes that there is a need to better understand and more effectively manage mercury in the estuary in light of the toxicological effects on human and wildlife health (Conaway et al. 2007).

Conaway *et al*. (2007) noted that mercury levels in monitored sport fish have not changed significantly and can not be linked to falling sediment concentrations. RMP monitoring has found mercury levels to be above the EPA approved fish tissue standard for the protection of human health of 0.2 mg/kg wet weight and the standard of 0.03 mg/kg in smaller fish (3-5 cm) that is meant to protect piscivorous wildlife. Concentrations in leopard sharks averaged about 0.80 mg/kg wet weight between 1997 and 2003 (SFEI 2007) while concentrations in striped bass were approximately 0.35 mg/kg wet weight (SFEI 2006). Median concentrations in white sturgeon were reported just above 0.3 mg/kg wet weight, California halibut median concentration were just below 0.3 mg/kg wet weight and white croaker concentrations were reported at the 0.2 mg/kg wet weight level using RMP data from 2003 (SFEI 2006).

There are several studies available that review mercury concentrations in tissues noted to have ecological effects to fish at levels currently found within the estuary that can be used to examine impacts to ESA listed fish and EFH. Matta *et al*. (2001) conducted a dietary study of mercury effects with mummichogs (an estuarine and coastal species) and found that tissue methylmercury concentrations of 0.5 mg/kg wet weight resulted in nearly 50% mortality of male fish. Mortality was increased over controls of 0.2 mg/kg, but not significantly, meaning that the threshold for effects is somewhere between 0.2 and 0.5 mg/kg. The draft methylmercury TMDL for the Sacramento-San Joaquin Delta Estuary (CVRWQCB 2010) notes that independent research demonstrates that most mercury (85%-100%) in fish muscle is methyl mercury.

Friedman et al. (1996) conducted a laboratory based dietary study of methylmercury effects to juvenile walleye where their lowest exposure group accumulated tissue methylmercury concentrations of 0.254 mg/kg. While the males exhibited signs of testicular atrophy, it was not to a degree significantly different that control fish. However, levels of plasma cortisol, which is important to mediating responses to stressors and for immune system function, were significantly lower than the control fish. Subsequent work by the author (Freidman *et al*. 2002 in USFWS 2003) with largemouth bass from reservoirs in New Jersey did not replicate these findings, potentially showing a difference between lab and field studies or species sensitivity.

Webber and Haines (2003) found altered predator avoidance in golden shiners with tissue methylmercury concentrations of 0.536 mg/kg wet weight. Golden shiners are a trophic level three fish with a diet of zooplankton and aquatic insects similar to Mississippi silversides and other San Francisco Bay forage fish.

The concentration of total mercury allowed in dredged sediments disposed of in-Bay is regulated by the San Francisco Bay Regional Water Quality Control Board through the Total Maximum Daily Load (TMDL) for Mercury in San Francisco Bay (SFBRWQCB 2006). The TMDL states, "The mercury concentration in dredged material disposed of in the Bay shall not exceed the 99th percentile mercury concentration of the previous 10 years of Bay sediment samples collected through the RMP (excluding stations outside the Bay like the Sacramento River, San Joaquin River, Guadalupe River and Standish Dam stations)." At the time of this writing, the allowable concentration of mercury in dredged material disposed of in-Bay is 0.53 parts per million (ppm) dry weight. This is more than twice the Bay-wide average for the seven year period between 2002-2008 calculated through the Regional Monitoring Plan (RMP) (SFEI 2009) which provides the reference conditions for consideration in making disposal decisions (Ross, B. pers. comm.. 2010a). The Bay-wide average concentration for total mercury is 0.24 ppm dry weight. This allowance of elevated contaminant levels in dredged material without undergoing bioaccumulation testing is not protective and will serve to prolong and exacerbate impacts to aquatic habitat function and fisheries through bioaccumulation.

Dredging Residuals

Dredging operations alter the condition of the project site by exposing a new surface layer of bottom material to direct contact with biota and the water column. This newly exposed surface may have greater concentrations of contaminants than existed before dredging. Dredging residuals are also generated when contaminated sediments are resuspended during dredging and re-deposited on the surface of the project area where they may continue to be exposed to the aquatic community after the project is complete. Dredging residuals contribute to long-term risk at the site, potentially including bioaccumulative risk, if they are sufficiently thick and extensive (USACE *et al.* 2009).

A set process for evaluating and ensuring that EFH and ESA listed species are not detrimentally impacted by dredging residuals is not presented in the EFH assessment, but this situation has periodically occurred during the consultation process on maintenance dredging projects. The action agencies need establish a set protocol to address dredging residuals and contaminated new surface materials.

Conclusion

Dredging can transfer contaminated surface sediments and bring buried contaminants from the subsurface where they have limited bioavailability while in-Bay disposal practices reintroduce those contaminants to the biologically active surface layers of the Bay. The in-Bay disposal sites are managed to be dispersive, which means the contaminants are spread out to a large area as they resettle. This dispersion serves to dilute the contributions of "new" contaminants to the dispersion area and, in many cases, likely results in negligible increases in contaminant levels. However caution must be taken when dispersing bioaccumulative contaminants, particularly those at concentrations above known effect levels in the dredged material or the ambient sediments, or for which the Bay has been determined to have no assimilative capacity. The action agencies have significant reserved discretionary authority to address this avenue of impact in order meet their obligations under EFH and ESA regulations while meeting their primary goal to restore and maintain the chemical, physical and biological integrity of the Nation’s waters.

References

Barron, M.G., R. Heintz, and S.D. Rice. 2004. Relative Potency of PAHs and Heterocycles as Aryl Hydrocarbon Receptors Agonists in Fish. *Marine Environmental Research* 58:95-100.

Barron, M.G., M.G. Carls, R. Heintz, and S.D. Rice. 2003. Evaluation of Fish Early Life-Stage Toxicity Models of Chronic Embryonic Exposures to Complex Polycyclic Aromatic Hydrocarbon Mixtures. *Toxicological Sciences* 78(1):60-67.

Billiard, S.M., M.E. Hahn, D.G. Franks, R.E. Peterson, N.C. Bols, and P.V. Hodson. 2002. Cinding of Polycyclic Aromatic Hydrocarbons (PAHs) to Teleost Arylhydrocarbon receptors (AHRs). *Comp. Biochem. Physiol.* B.133:55-68

Billiard, S.M., K. Querbach, and P.V. Hodson. 1999. Toxicity of Retene to Early Life Stages of Two Freshwater Fish Species. *Environmental Toxicology and Chemistry* 18:2070-2077.

Brinkworth, L.C., P.V. Hodson, S. Tabash and P. Lee. 2003. CYP1A induction and Blue Sac Disease in Early Developmental Stages of Rainbow Trout (Oncorhynchus mykiss) Exposed to Retene. *Journal of Toxicological and Environmental Health – Part A* 66:47-66.

Bue, B.G., S. Sharr. And J.E. Seeb. 1998. Evidence of Damage to Pink Salmon Populations Inhabiting Prince William Sound, Alaska, Two Generations After the *Exxon Valdez* Oil Spill. *Transactions of the American Fisheries Society* 127:35-43.

Carls, M.G., S.D. Rice and J.E. Hose. 1999. Sensitivity of Fish Embryos to Weathered Crude Oil: Part 1 Low Level Exposure during Incubation Causes Malformations, Genetic Damage, and Mortality in Larval Pacific Herring (*Clupea pallasi*). *Environmental Toxicology and Chemistry* 18:481-493.

Christian, Beth, 2010. Personal Communication. April 26, 2010.

Collier, T.K., J.P. Meador and L.L. Johnson 2002. Introduction: Fish Tissue and Sediment Effects Thresholds for Polychlorinated Biphenyls, Polycyclic Aromatic Hydrocarbons, and Tributyl tin. *Aquatic Conservation: Marine and Freshwater Ecosystems* 12:489-492.

Conaway, C.H., J.R.M. Ross, R. Looker, R.P. Mason and A.R. Flegal, 2007. Decadal Mercury Trends in San Francisco Estuary Sediments. *Environ. Research* 105:53-66.

CVRWQCB 2010. Sacramento-San Joaquin Delta Estuary TMDL for Methylmercury, Staff Report, Draft Report for Public Review, February 2010. 370 pages. Available at: http://www.swrcb.ca.gov/centralvalley/water_issues/tmdl/central_valley_projects/delta_hg/april_2010_hg_tmdl_hearing/index.shtml

Davis, J.A., F. Hetzel, J.J. Oram and L.J. McKee, 2007. Polychorinated biphenyls (PCBs) in San Francisco Bay. *Environmental Research* 105 (2007):67-86

Diamond, S.A., D.R. Mount, V.R. Mattson, L.J. Heinis, T.L. Highland, A.D. Adams, and M.F. Simcik. 2006. Photoactivated Polycyclic Aromatic Hydrocarbon toxicity in Medaka (*Oryzias latipes*) Embryos: Relevance to Environmental Risk in Contaminated Sites. *Environ. Toxicol. Chem.* 25:3015-3023.

Duesterloh, S,., J. Short, and M.G. Barron. 2002. Photoenhanced Toxicity of Weathered Alaska North Slope Crude Oil to the Calanoid Copepods *Calanus marchallae* and *Metridia okhotensis. Environmental Science and Technology* 36:3953-3959

Eisler, Ronald 2000. Handbook of Chemical Risk Assessment: Health Hazards to Humans, Plants, and Animals, Volume 1: Metals. First CRC Press LLC Printing, 2000.

EPA, SFB BCDC, USACE, SFBRWQCB, and CSLC, 2001a. Guidelines for Implementing the Inland Testing Manual in the San Francisco Bay Region, September 21, 2001. 21 pages. Available at: http://www.spn.usace.army.mil/conops/sfitm092101.pdf

EPA, SFB BCDC, USACE, SFBRWQCB, and CSLC, 2001b. Response to Comments on DMMO Public Notice (PN) 99-3, Draft Guidelines for Implementing the ITM in the USACE San Francisco District (retitled Guidelines for Implementing the ITM in the San Francisco Bay Region), October 26, 2001. Available at: http://www.spn.usace.army.mil/conops/responsetocomments.pdf

EPA and USACE 1998. Evaluation of Dredged Material Proposed for Discharge in Waters of the U.S. – Testing Manual, Inland Testing Manual. United States Environmental Protection Agency, Office of Water and Department of the Army, US Army Corps of Engineers. EPA-823-B-98-004, February 2008.

Friedmann, A.S., M.C Watzin, T. Brink-Johnsen and J.C. Leiter, 1996. Low Levels of Dietary Methylmercury Inhibit Growth and Gonadal Development in Juvenile Walleye (*Stizostedion vitreum*). *Aquatic Toxicology* 35:265-278.

Gobas, Frank A.P.C. and Jon A. Arnot, 2010. Food Web Bioaccumulation Model for Polychlorinated Biphenyls in San Francisco Bay, California, USA. *Environmental Toxicolocgy and Chemistry*, vol 29: In press.

Gobas, F., and J. Arnot. 2005. San Franicsco Bay PCB Food Web Model. Prepared for the Clean Estuary Parnership, Oakland, CA. Available at: http://www.bacwa.org/Committees/CleanEstuaryPartnership/tabid/126/Default.aspx

Gruger, E.H., M.M. Wekell, P.T. Numoto and D.R. Craddock. 1977. Induction of Hepatic Aryl Hydrocarbon Hydroxylase in Salmon Exposed to Petroleum Dissolved in Seawater and to Petroleum and Polychlorinated Biphenyls, Separate and Together, in Food. *Bulletin of Environmental Contamination and Toxicology*, 17(5):512-520.

Gunther, A.J., R.B. Spies, J. Stegeman, B. Woodin, D. Carney, J. Oakden, and L. Hain. 1997. EROD Activity in Fish as an Independent Measure of Contaminant-Induced Mortality of Invertebrates in Sediment Bioassays. *Marine Environmental Research*, 44(1):41-49.

Hansen, J.A., J.C.A. Marr, J. Lipton, D. Cacela, and H.L. Bergman. 1999a. Differences in Neurobehavioral Responses of Chinook salmon (Oncorhynchus tshawytscha) and Rainbow Trout (Oncorhynchus mykiss) exposed to copper and cobalt: Behavioral Avoidance. Environ. Toxicol. Chem. 18:1972-1978.

Hansen, J.A., J.D. Rose, R.A. Jenkins, K.G. Gerow and H.L. Bergman. 1999b. Chinook salmon (Oncorhynchus tshawytscha) and Rainbow Trout (Oncorhynchus mykiss) Exposed to Copper: Neurophysiological and histological effects on the olfactory system. Environ. Toxicol. Chem. 18:1979-1991.

Heintz, R.A., J.W. Short, and S.D. Rice. 1999. Sensitivity of Fish Embryos to Weathered Crude Oil: Part II.. Increased Mortality of Pink Salmon (*Oncorhynchus gorbuscha*) Embryos Incubating Downstream from Weathered Exxon Valdez Crude Oil. *Environmental Toxicology and Chemistry* 18:494-503.

Incardona, J.P., M.G. Carls, H. Teraoka, C.A. Sloan, T.K. Collier and N.L. Scholz. 2005. Aryl Hydrocarbon Receptor-Independent Toxicity of Weathered Crude Oil During Fish Development. *Environmental Health Perspectives* Online: August 10, 2005

Incardona, J.P., T.K. Collier, and N.L. Scholz. 2004. Defects in Cardiac Function Precede Morphological Abnormalities in Fish Embryos Exposed to Polcyclic Aromatic Hydrocarbons. *Toxicol. Applied Pharm.* 196:191-205.

Johnson, L.L., T.K. Collier and J.E. Stein 2002. An analysis in support of sediment quality thresholds for polycyclic aromatic hydrocarbons (PAHs) to protect estuarine fish. *Aquatic Conservation: Marine and Freshwater Ecosystems* 12:517-538.

Johnson, L. 2000. An Analysis in Support of Sediment Quality Thresholds for Polycyclic Aromatic hydrocarbons (PAHs) to protect estuarine fish. White Paper form National Marine Fisheries Service, Northwest Fisheries Science Center, Seattle, WA. 29 p.

Johnson, L., S.Y. Sol, G.M. Ylitalo, T. Hom, B. French, O.P. Olson, and T.K. Collier. 1999. Reproductive Injury in English Sole (*Pleuronectes vetulus*) from the Hylebos Waterway, Commencement Bay, Washington. *Journal of Aquatic Ecosystems Stress and Recovery* 6:289-310.

Karrow, N.A., H.J. Boermans, D.G. Dixon, A. Hontella, K.R. Solomon, J.J. Whyte, and N.C. Bols. 1999. Characterizing the Immunotoxicity of Creosote to Rainbow Trout (*Oncorhynchus mykiss*): a Microcosm Study. *Aq. Toxicol*. 45:223-239.

Kelley, K.M. and J.A. Reyes, 2009. Initial Characterization of Environmental Endocrine Disruption in Wild Fishes of San Francisco Bay, Final Report. Prepared for: Regional Monitoring Program for Water Quality in San Francisco Bay, San Francisco Estuary Institute, Exposure and Effects Workgroup, 7770 Pardee Lane, Oakland, CA 94621.

LFR Levine Fricke 2004. Framework for Assessment of Potential Effects of Dredging on Sensitive Fish Species in San Francisco Bay, Final Report. Prepared for U.S. Army Corps of Engineers, San Francisco District, San Francisco, California. August 5, 2004.

Marty, G.D., J.W. Short, D.M. Dambach, N.H. Willits, R.A. Heintz, S.D. Rice, J.J. Stegeman and D.E. Hinton. 1997. Ascites, premature emergence, increased gonadal cell apoptosis, and cytochrome P4501A Induction in Pink Salmon Larvae Continuously Exposed to Oil-Contaminated Gravel during Development. *Canadian Journal of Zoology* 75:989-1007.

Matta, M.B., J. Linse, C. Cairncross, L. Francendese, and R.M. Kocan, 2001. Reproductive and Transgenerational Effects of Methylmercury or Aroclor 1268 on Fundulus Heteroclitus.

Environmental Toxicology and Chemistry 20(2):327-335.

Meador, J.P., J.E. Stein. W.L. Reichert, and U. Varanasi. 1995. A Review of Bioaccumulation of Polycyclic Aromatic Hydrocarbons by Marine Organisms. *Reviews Environmental Contamination and Toxicology* 143:79-165.

Misitano, D.A., E. Casillas and C.R. Haley. 1994. Effects of Contaminated Sediment on Viability, Length DNA, and Protein Content of Larval Surf Smelt, *Hypomesus pretiosus. Marine Environmental Research* 37:1-21.

Pelletier, M.C., R.M. Burgess, K.T. Ho, A. Kuhn, R.A. McKinney and S.A. Ryba. 1997. Phototoxicity of Individual Polycyclic Aromatic Hydrocarbons and Petroleum to Marine Invertebrate Larvae and Juveniles. *Environ. Toxicol. Chem*. 16:2190-2199.

Poston, T. 2001. Treated Wood Issues Associated with Overwater Structures in Marine and Freshwater Environments. Prepared for the Washington Departments of Fish and Wildlife, Ecology, and Transportation. April 5, 2001. Olympia Washington, 85 p.

Ross, Brian 2010a. Personal Communication, E-mail: DMMO Threshold Criteria. Dated February 16, 2010.

Ross, Brian, 2010b. Personal Communication, E-mail: EFH and the LTMS Contaminated Sediment Data. Dated April 8, 2010.

SFEI 2009. The Pulse of the Estuary: Monitoring and Managing Water Quality in the San Francisco Estuary. SFEI Contribution 583. San Francisco Estuary Institute, Oakland, CA.

SFEI 2007. The Pulse of the Estuary: Monitoring and Managing Water Quality in the San Francisco Estuary. SFEI Contribution 533. San Francisco Estuary Institute, Oakland, CA.

SFEI 2006. The Pulse of the Estuary: Monitoring and Managing Water Quality in the San Francisco Estuary. SFEI Contribution 517. San Francisco Estuary Institute, Oakland, CA.

SFBRWQCB 2008. Total Maximum Daily Load for PCBs in San Francisco Bay, Final Staff Report for Proposed Basin Plan Amendment. California Regional Water Quality Control Board, San Francisco Bay Region, February 13, 2008. 135 pages. Available at: http://www.swrcb.ca.gov/sanfranciscobay/water_issues/programs/TMDLs/sfbaypcbs/Staff_Report.pdf

SFRWQCB 2006.Mercury in san Francisco Bay, Proposed Basin Plan amendment and Staff Report for Revised Total maximum Daily Load (TMDL) and Proposed Mercury Water Quality Objectives. California Regional Water Quality Control Board, San Francisco Bay Region, Agust 1, 2006. 116 pages. Available at: http://www.swrcb.ca.gov/sanfranciscobay/water_issues/programs/TMDLs/sfbaymercury/sr080906.pdf

Sherry, J.P., J.J. Whyte, N.A. Karrow, A. Gamble, H.J. Boerman, N.C. Bol, D.G. Dixon and K.R. Solomon. 2006. The Effect of Creosote on Vitellogenin Production in Rainbow Trout (*Oncorhynchus mykiss*). *Arch. Environ. Contam. Toxicol*. 50:65-68.

Spies, R.B., D.W. Rice Jr., and J. Felton. 1988. Effects of Organic Contaminants on Reproduction of the Starry Flounder *Platichthys stellatus* in San Francisco Bay, I. Hepatic Contamination and Mixed-oxidase (MFO) activity during the Reproductive Season. *Marine Biology*, 98:181-189.

Spies, R.B. and D.W. Rice, Jr., 1988. Effects of Organic Contaminants on Reproduction of the Starry Founder *Platichthys stellatus* in San Francisco Bay, II. Reproductive Success of Fish Captured in San Francisco Bay and Spawned in the Laboratory. *Marine Biology* 98:191-200.

Stehr, C.M., D.W. Brown, T. Hom, B.F. Anulacion, W.L. Reichert and T.K. Collier. 2000. Exposure of juvenile Chinook and chum salmon to chemical contaminants in the Hylebos Waterway of Commencement Bay, Tacoma, Washington. *Journal of Aquatic Ecosystem Stress and Recovery* 7:215-227.

Stehr, C.M., M.S. Myers, D.G. Burrows, M.M. Krahn, J.P. Meador, B.B. McCain and U. Varanasi. 1997. Chemical Contamination and Associated Liver Diseases in Two Species of Fish from San Francisco and Bodega Bay. *Ecotoxicology* 6:35-65.

Swartz, R.C., S.P. Ferraro, J.O. Lamberson, F.A. Cole, R.J. Ozretich, B.L. Boese. D.W. Schults, M. Behrenfeld and G.T. Ankley. 1997. Photoactivation and Toxicity of Mixtures of Polycyclic Aromatic Hydrocarbon Compounds in Marine Sediment. *Environ. Toxicol. Chem.* 16:2151-2157.

Thompson, B., T. Adelsbach, C. Brown, J. Hunt, J. Kuwabara, J. Neale, H. Ohlendorf, S. Schwarzbach, R. Spies and K. Taberski, 2007. Biological Effects of Anthropogenic Contaminants in the San Francisco Estuary. *Environ Research* 105:156-174.

USACE, US EPA, WDOE, WDNR, ODEQ, IDEQ, NMFS, and USFWS, 2009. Sediment Evaluation Framework for the Pacific Northwest, Prepared by US Army Corps of Engineers – Portland District, Seattle District, Walla Walla District, and Northwestern Division, U.S. Environmental Protection Agency Region 10, Washington Department of Ecology, Washington Department of Natural Resources, Oregon Department of Environmental Quality, Idaho Department of Environmental Quality, National Marine Fisheries Service and U.S. Fish and Wildlife Service. May 2009, 211 pages. Available at: http://www.nwp.usace.army.mil/pm/e/rset/sef/2009-Final_SEF.pdf

USFWS 2003. Evaluation of the Clean Water Act Section 304(a) Human Health Criterion for Methylmercury: Protectiveness for Threatened and Endangered Wildlife in California. U.S. Fish and Wildlife Service, Sacramento Fish and Wildlife Office, Environmental Contaminants Division. October 2003. Available at: http://www.fws.gov/sacramento/ec/Methylmercury%20Criterion%20Evaluation%20Final%20

Report%20October%202003.pdf

Varanasi, U., J.E. Stein, W.L. Reichert, K.L. Tilbury and S.L. Chan. 1992. Chlorinated and Aromatic Hydrocarbons in Bottom Sediments, Fish and Marine Mammals in US Coastal Waters: Laboratory and Field Studies of Metabolism and Accumulation. In: *Persistent Pollutants in the Marine Environment*, Eds.: Colin Walker and D.L. Livingstone, Pergamon Press, New York, NY, p. 83.

Varanasi, U. Ed. 1989. *Metabolism of Polycyclic Aromatic Hydrocarbons in the Aquatic Environment*, CRC Press, Inc., Boca Raton, FL. 341 p.

Vines, C.A., T. Robbins, F.J. Griffin, and G.N. Cherr. 2000. The Effects of Diffusible Creosote-derived Compounds on Development in Pacific Herring (*Clupea pallasi*). *Aquatic Toxicology* 51:225-239.

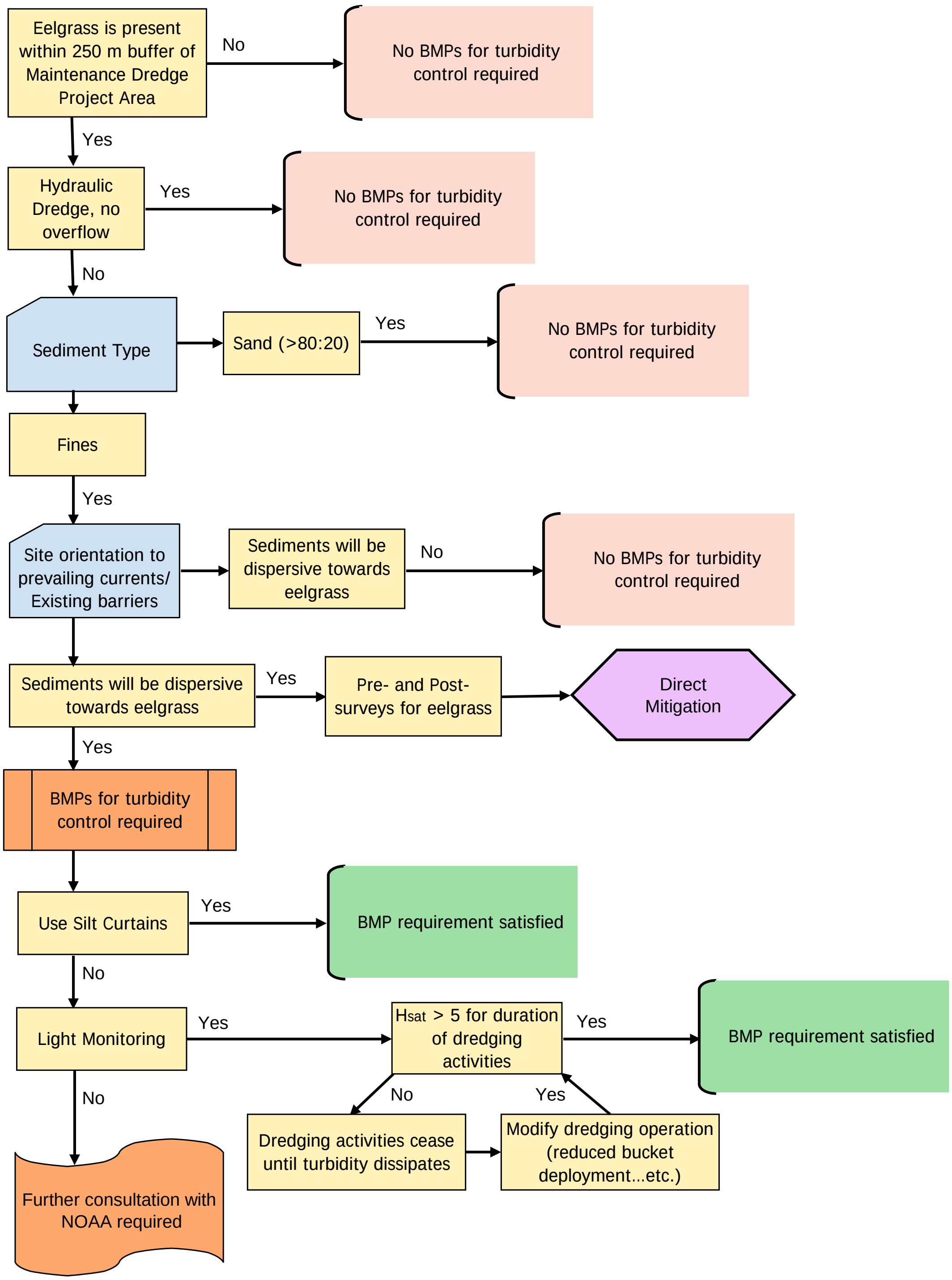
Wassenberg, D.M. and R.T. Di Giulio. 2004a. Synergistic Enbryotoxicity of Polycyclic Aromatic Hydrocarbon Aryl Hydrocarbon receptor Agonists with Cytochrome P4501A Inhibitors in *Fundulus heteroclitus*. *Environ. Health Perspect*. 112:1658-1664.

Wassenberg, D.M. and R.T. Di Giulio. 2004b. Teratogenesis in *Fundulus heteroclitus* Embryos Exposed to a Creosote Contaminated Sediment Extract and CYP1A Inhibitors. *Mar. Environ. Res*. 58:163-168.

Webber, H.M. and T.A. Haines, 2003. Mercury Effects on Predator Avoidance of a Forage Fish, Golden Shiner (*Notemigonus Crysoleucas*). *Environmental Toxicology and Chemistry* 22(7):1556-1561

Appendix 2. Eelgrass Indirect Effects Flowchart

Flowchart depicting step-wise decision making process for avoidance, minimization, and implementation of Best Management Practices (BMPs) for indirect effects of turbidity on eelgrass.



Appendix 3. Light Monitoring Protocol

National Marine Fisheries Service
Southwest Region Habitat Conservation Division
Santa Rosa Area Office

San Francisco Bay Light Monitoring Survey Protocol

Revised January 2010

The purpose of this protocol is to provide guidance to entities conducting activities in San Francisco (SF) Bay and northern California that may cause increases in turbidity above background levels and impact *Zostera marina* (eelgrass). Water column turbidity reduces the amount of light available for photosynthesis and consequently affects the depth distribution, density and productivity of eelgrass (Thayer *et al.* 1984; Zimmerman *et al.* 1991; Lee *et al.* 2007). Although eelgrass in SF Bay is adapted to growing in low light environments, if the period of irradiance-saturated photosynthesis (H_{sat}) decreases below 3-5 hours per day, the maintenance of whole plant carbon balance and growth period is negatively affected (Zimmerman *et al.* 1991). Due to high turbidity levels in SF Bay, eelgrass plants located at the deeper edges of established eelgrass beds are less likely to accumulate large carbon reserves making them unable to withstand 30 days of reduced light conditions (Zimmerman *et al.* 1991). This protocol was established to ensure consistent collection of light monitoring data, and to guide users on the appropriate application of such measurements.

NMFS Santa Rosa Office staff are available for guidance in the use of this protocol. The lead action agency should provide a detailed monitoring plan to NMFS for approval 60 days prior to the light monitoring survey.

Light survey during project activities:

Objective: Determine increased light attenuation associated with project activities in eelgrass beds.

1. During daylight project activities, photosynthetically active radiation (PAR) should be measured at selected sampling locations. These locations should include the deeper edges of established eelgrass beds near the project site. NMFS also recommends selecting a reference station at a similar depth, near eelgrass beds, but of adequate distance away from project activities and any other sources of turbidity. Reference stations should be selected with NMFS guidance and approval. A reference station will insure that project activities are not held responsible for lowered light conditions caused by natural variation. Sampling locations and frequency may vary due to site conditions and project activities and, therefore, should be approved by NMFS Santa Rosa Office staff 60 days before sampling occurs.
    a. Depth (meters) at mean lower low water and GPS coordinates should be recorded at each sampling location.

b. PAR measurements should be recorded near the top of eelgrass plants (approximately 0.5 meters above the substrate).
c. Measurements of PAR should be recorded at regular intervals throughout the duration of daylight project activities, and should always include a measurement at the noon hour. Number of days, frequency and start/end time of measurements will depend on time of year and equipment available. If automated equipment is available, NMFS recommends measurements of PAR be taken every 10 minutes from sunrise to sunset daily, for a minimum of seven days. Increasing the frequency of PAR measurements will improve the accuracy of measurements (Banas et al. 2005).
d. The timing of flood and ebb tides should be recorded.

2. The maximum daily PAR measurement (I_m) should be used to calculate the daily period of irradiance-saturated photosynthesis (H_{sat}):

$$H_{sat} = D\left[1 - \frac{2}{\pi}\sin^{-1}\left(\frac{I_k}{I_m}\right)\right]$$

D = day length from sunrise to sunset6 (= time that PAR>10 µmol photon $m^{-2}s^{-1}$)
I_k = 35 µmoles photon m^{-2} s^{-1} (Zimmerman *et al*. 1991).
I_m = daily maximum PAR measurement (CHM2HILL 1998).

H_{sat} should be calculated after sampling completion each day, at each sampling location.

Minimization Measures and Reporting:

1. If the daily period of H_{sat} is above 5 hours at the reference site, but below 5 hours near the project site, then project activities should cease during daylight hours until turbidity levels reduce and daily H_{sat} increases above 5 hours (typically within a few tidal cycles).

2. If sampling did not occur at a reference station and the calculated daily period of H_{sat} is below 5 hours at eelgrass beds near the project area, then project activities should cease during daylight hours until turbidity levels reduce and daily H_{sat} increases above 5 hours (typically within a few tidal cycles).

3. If project activities are continually reducing H_{sat} below 5 hours, modifications to operating procedures should be considered (*e.g.*,, timing of dredging, type of gear, use of silt curtains…etc.) in order to minimize impacts to eelgrass as well as continuity of dredging operations.

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6 Day length should not be calculated using theoretical sunrise and sunset estimates. Site-specific variability will great influence the actual day length at each site (*i.e.*, adjacent buildings or hills may shade an area for significant time at sunrise or sunset), as will daily climatic conditions. A minimum level of PAR will be set as 10 µmol photon $m^{-2}s^{-1}$, the light compensation point (H_{comp}) for eelgrass (Dennison and Alberte 1982), as a threshold level to determine actual day length hours.

4. The results of the light monitoring studies should be provided to NMFS within 30 days of completion.

Literature Cited:

CH2MHILL. 1998. Richmond Harbor Eelgrass Monitoring Draft Report #1. Prepared for: U.S. Army Corps of Engineers, San Francisco District, Environmental Planning Section. January 1998.

Banas, D., P. Grillas, I. Auby, F. Lescuyer, E. Coulet, J. C. Moreteau & B. Millet. 2005. Short time scale changes in underwater irradiance in a wind-exposed lagoon (Vaccares lagoon, France): efficiency of infrequent field measurements of water turbidity or weather data to predict irradiance in the water column. Hydrobiologia, 551: 3-16.

Dennison, W. C. & R. S. Alberte. 1982. Photosynthetic Responses of Zostera-Marina L (Eelgrass) to Insitu Manipulations of Light-Intensity. Oecologia, 55: 137-144.

Lee, K.-S., S. R. Park & Y. K. Kim. 2007. Effects of irradiance, temperature, and nutrients on growth dynamics of seagrasses: A review. Journal of Experimental Marine Biology and Ecology, 350: 144-175.

Thayer, G. W., W. J. Kenworthy & M. S. Fonseca. 1984. Ecology of eelgrass meadows of the Atlantic Coast: a community profile. pp. Pages: 165.

Zimmerman, R. C., J. L. Reguzzoni, S. Wyllie-Echeverria, M. Josselyn & R. S. Alberte. 1991. Assessment of Environmental Suitability for Growth of Zostera-Marina L (Eelgrass) in San-Francisco Bay. Aquatic Botany, 39: 353-366.

Appendix 4. Southern California Eelgrass Mitigation Policy

SOUTHERN CALIFORNIA EELGRASS MITIGATION POLICY
(Adopted July 31, 1991)

Eelgrass (Zostera marina) vegetated areas are recognized as important ecological communities in shallow bays and estuaries because of their multiple biological and physical values. Eelgrass habitat functions as an important structural environment for resident bay and estuarine species, offering both predation refuge and a food source. Eelgrass functions as a nursery area for many commercially and recreational important finfish and shellfish species, including those that are resident within bays and estuaries, as well as oceanic species that enter estuaries to breed or spawn. Eelgrass also provides a unique habitat that supports a high diversity of non-commercially important species whose ecological roles are less well understood.

Eelgrass is a major food source in nearshore marine systems, contributing to the system at multiple trophic levels. Eelgrass provides the greatest amount of primary production of any nearshore marine ecosystem, forming the base of detrital-based food webs and as well as providing a food source for organisms that feed directly on eelgrass leaves, such as migrating waterfowl. Eelgrass is also a source of secondary production, supporting epiphytic plants, animals, and microbial organisms that in turn are grazed upon by other invertebrates, larval and juvenile fish, and birds.

In addition to habitat and resource attributes, eelgrass serves beneficial physical roles in bays and estuaries. Eelgrass beds dampen wave and current action, trap suspended particulates, and reduce erosion by stabilizing the sediment. They also improve water clarity, cycle nutrients, and generate oxygen during daylight hours.

In order to standardize and maintain a consistent policy regarding mitigating adverse impacts to eelgrass resources, the following policy has been developed by the Federal and State resource agencies (National Marine Fisheries Service, U.S. Fish and Wildlife Service, and the California Department of Fish and Game). While the intent of this Policy is to provide a basis for consistent recommendations for projects that may impact existing eelgrass resources, there may be circumstances (*e.g.*,, climatic events) where flexibility in the application of this Policy is warranted. As a consequence, deviations from the stated Policy may be allowed on a case-by-case basis. This policy should be cited as the Southern California Eelgrass Mitigation Policy (revision 11).

For clarity, the following definitions apply. "Project" refers to work performed on-site to
accomplish the applicant's purpose. "Mitigation" refers to work performed to compensate for any adverse impacts caused by the "project". "Resource agencies" refers to National Marine Fisheries Service (NMFS), U.S. Fish and Wildlife Service (USFWS), and the California Department of Fish and Game (CDFG).

1. **Mitigation Need.** Eelgrass transplants shall be considered only after the normal

provisions and policies regarding avoidance and minimization, as addressed in the Section 404 Mitigation Memorandum of Agreement between the Corps of Engineers and Environmental Protection Agency, have been pursued to the fullest extent possible prior to the development of any mitigation program. Mitigation will be required for the loss of existing vegetated areas, loss of potential eelgrass habitat, and/or degradation of existing/potential eelgrass habitat. Mitigation for boat docks and/or related work is addressed in section 2.

2. **Boat Docks and Related Structures**. Boat docks, ramps, gangways and similar structures should avoid eelgrass vegetated or potential eelgrass vegetated areas to the maximum extent feasible. If avoidance of eelgrass or potential eelgrass areas is infeasible, impacts should be minimized by utilizing, to the maximum extent feasible, construction materials that allow for greater light penetration (*e.g.*,, grating, translucent panels, etc.). For projects where the impact cannot be determined until after project completion (*i.e.*,, vessel shading, vessel traffic) a determination regarding the amount of mitigation shall be made based upon two annual monitoring surveys conducted during the time period of August to October which document the changes in the bed (areal extent and density) in the vicinity of the footprint of the boat dock, moored vessel(s), and/or related structures. Any impacts determined by these monitoring surveys shall be mitigated per sections 3-12 of this policy. Projects subject to this section must include a statement from the applicant indicating their understanding of the potential mitigation obligation which may follow the initial two-year monitoring.

3. **Mitigation Map.** The project applicant shall map thoroughly the area, distribution, density and relationship to depth contours of any eelgrass beds likely to be impacted by project construction. This includes areas immediately adjacent to the project site which have the potential to be indirectly or inadvertently impacted as well as potential eelgrass habitat areas. Potential habitat is defined as areas where eelgrass would normally be expected to occur but where no vegetation currently exists. Factors to be considered in delineating potential habitat areas include appropriate circulation, light, sediment, slope, salinity, temperature, dissolved oxygen, depth, proximity to eelgrass, history of eelgrass coverage, etc.

Protocol for mapping shall consist of the following format:

1) Bounding Coordinates

Horizontal datum - Universal Transverse Mercator (UTM), NAD 83, Zone 11 is the preferred projection and datum. If another projection or datum is used, the map and spatial data must include metadata that accurately defines the projection and datum.

Vertical datum - Mean Lower Low Water (MLLW), depth in feet.

2) Units

Transects and grids in meters.

Area measurements in square meters/hectares.

3) File format

A spatial data layer compatible with readily available geographic information system software must be sent to NMFS and any other interested resource agency when the area mapped has greater than 10 square meters of eelgrass. For those areas with less than 10 square meters, a table must be provided giving the bounding x,y coordinates of the eelgrass areas. In addition to a spatial layer or table, a hard-copy map should be included within the survey report. The projection and datum should be clearly defined in the metadata and/or an associated text file.

All mapping efforts must be completed during the active growth phase for the vegetation (typically March through October) and shall be valid for a period of 60 days with the exception of surveys completed in August - October. Surveys completed after unusual climatic events (*i.e.,*, high rainfall) may have modified requirements and surveyors should contact NMFS, CDFG, and USFWS to determine if any modifications to the standard survey procedures will be required. A survey completed in August - October shall be valid until the resumption of active growth (*i.e.,*, in most instances, March 1). After project construction, a post-project survey shall be completed within 30 days. The actual area of impact shall be determined from this survey.

4. **Mitigation Site.** The location of eelgrass transplant mitigation shall be in areas similar to those where the initial impact occurs. Factors such as, distance from project, depth, sediment type, distance from ocean connection, water quality, and currents are among those that should be considered in evaluating potential sites.

5. **Mitigation Size.** In the case of transplant mitigation activities that occur concurrent to the project that results in damage to the existing eelgrass resource, a ratio of 1.2 to 1 shall apply. That is, for each square meter adversely impacted, 1.2 square meters of new suitable habitat, vegetated with eelgrass, must be created. The rationale for this ratio is based on, 1) the time (*i.e.,*, generally three years) necessary for a mitigation site to reach full fishery utilization and 2) the need to offset any productivity losses during this recovery period within five years. An exception to the 1.2 to 1 requirement shall be allowed when the impact is temporary and the total area of impact is less than 100 square meters. Mitigation on a one-for-one basis shall be acceptable for projects that meet these requirements (see section 11 for projects impacting less than 10 square meters).

Transplant mitigation completed three years in advance of the impact (*i.e.,*, mitigation banks) will not incur the additional 20 percent requirement and, therefore, can be constructed on a one-for-one basis. However, all other annual monitoring requirements (see sections 8-9) remain the same irrespective of when the transplant is completed. Project applicants should consider increasing the size of the required mitigation area by 20-30 percent to provide greater assurance that the success criteria, as specified in Section 10, will be met. In addition, alternative contingent mitigation must be specified, and included in any required permits, to address situation where performance standards (see section 10) are not likely to be met.

For potential eelgrass habitat, a ratio of 1 to 1 of equivalent habitat shall be created.

Degradation of existing eelgrass vegetated habitat that results in a reduction of density greater than 25 percent shall be mitigated on a one-for-one basis. For example, a 25 percent reduction in density of a 100 square meter (100 turions/meter) eelgrass bed to 75 turions/meter would require the establishment of 25 square meters of new eelgrass with a density at or greater than the pre-impact density. All other provisions of the Policy would apply.

6. **Mitigation Technique.** Techniques for the construction and planting of the eelgrass mitigation site shall be consistent with the best available technology at the time of the project. Donor material shall be taken from the area of direct impact whenever possible, but also should include a minimum of two additional distinct sites to better ensure genetic diversity of the donor plants. No more than 10 percent of an existing bed shall be harvested for transplanting purposes. Plants harvested shall be taken in a manner to thin an existing bed without leaving any noticeable bare areas. Written permission to harvest donor plants must be obtained from the California Department of Fish and Game. Plantings should consist of bare-root bundles consisting of 8-12 individual turions. Specific spacing of transplant units shall be at the discretion of the project applicant. However, it is understood that whatever techniques are employed, they must comply with the stated requirements and criteria.

7. Mitigation Timing. For off-site mitigation, transplanting should be started prior to or concurrent with the initiation of in-water construction resulting in the impact to the eelgrass bed. Any off-site mitigation project which fails to initiate transplanting work within 135 days following the initiation of the in-water construction resulting in impact to the eelgrass bed will be subject to additional mitigation requirements as specified in section 8. For on-site mitigation, transplanting should be postponed when construction work is likely to impact the mitigation. However, transplanting of on-site mitigation should be started no later than 135 days after initiation of in-water construction activities. A construction schedule which includes specific starting and ending dates for all work including mitigation activities shall be provided to the resource agencies for approval at least 30 days prior to initiating in-water construction.

8. **Mitigation Delay.** If, according to the construction schedule or because of any delays, mitigation cannot be started within 135 days of initiating in-water construction, the eelgrass replacement mitigation obligation shall increase at a rate of seven percent for each month of delay. This increase is necessary to ensure that all productivity losses incurred during this period are sufficiently offset within five years.

9. **Mitigation Monitoring.** Monitoring the success of eelgrass mitigation shall be required for a period of five years for most projects. Monitoring activities shall determine the area of eelgrass and density of plants at the transplant site and shall be conducted at initial planting, 6, 12, 24, 36, 48, and 60 months after completion of the transplant. All

monitoring work must be conducted during the active vegetative growth period and shall avoid the winter months of November through February. Sufficient flexibility in the scheduling of the 6 month surveys shall be allowed in order to ensure the work is completed during this active growth period. Additional monitoring beyond the 60 month period may be required in those instances where stability of the proposed transplant site is questionable or where other factors may influence the long-term success of transplant.

The monitoring of an adjacent or other acceptable control area (subject to the approval of the resource agencies) to account for any natural changes or fluctuations in bed width or density must be included as an element of the overall program.

A monitoring schedule that indicates when each of the required monitoring events will be completed shall be provided to the resource agencies prior to or concurrent with the initiation of the mitigation (see attached monitoring and compliance summary form).

Monitoring reports shall be provided to the resource agencies within 30 days after the completion of each required monitoring period and shall include the summary sheet included at the end of this policy.

10. **Mitigation Success.** Criteria for determination of transplant success shall be based upon a comparison of vegetation coverage (area) and density (turions per square meter) between the **adjusted project impact area** (*i.e.*,, original impact area multiplied by 1.2) and **mitigation site(s)**. Extent of vegetated cover is defined as that area where eelgrass is present and where gaps in coverage are less than one meter between individual turion clusters. Density of shoots is defined by the number of turions per area present in representative samples within the original impact area, control or transplant bed. Specific criteria are as follows:

a. the mitigation site shall achieve a minimum of 70 percent area of eelgrass and 30 percent density as compared to the adjusted project impact area after the first year.

b. the mitigation site shall achieve a minimum of 85 percent area of eelgrass and 70 percent density as compared to the adjusted project impact area after the second year.

c. the mitigation site shall achieve a sustained 100 percent area of eelgrass bed and at least 85 percent density as compared to the adjusted project impact area for the third, fourth and fifth years.

Should the required eelgrass transplant fail to meet any of the established criteria, then a Supplementary Transplant Area (STA) shall be constructed, if necessary, and planted. The size of this STA shall be determined by the following formula:

$$STA = MTA \times (|At + Dt| - |Ac + Dc|)$$

MTA = mitigation transplant area.
At = transplant deficiency or excess in area of coverage criterion (%).

Dt = transplant deficiency in density criterion (%).
Ac = natural decline in area of control (%).
Dc = natural decline in density of control (%).

The STA formula shall be applied to actions that result in the degradation of habitat (*i.e.*,, either loss of areal extent or reduction in density).

Five conditions apply:

1) For years 2-5, an excess of only up to 30% in area of coverage over the stated criterion with a density of at least 60% as compared to the project area may be used to offset any deficiencies in the density criterion.
2) Only excesses in area criterion equal to or less than the deficiencies in density shall be entered into the STA formula.
3) Densities which exceed any of the stated criteria shall not be used to offset any deficiencies in area of coverage.
4) Any required STA must be initiated within 120 days following the monitoring event that identifies a deficiency in meeting the success criteria. Any delays beyond 120 days in the implementation of the STA shall be subject to the penalties as described in Section 8.
5) Annual monitoring will be required of the STA for five years following the implementation and all performance standards apply to the STA.

11. **Mitigation Bank.** Any mitigation transplant success that, after five years, exceeds the mitigation requirements, as defined in section 10, may be considered as credit in a "mitigation bank". Establishment of any "mitigation bank" and use of any credits accrued from such a bank must be with the approval of the resource agencies and be consistent with the provisions stated in this policy. Monitoring of any approved mitigation bank shall be conducted on an annual basis until all credits are exhausted.

12. **Exclusions.**

1) Placement of a single pipeline, cable, or other similar utility line across an existing eelgrass bed with an impact corridor of no more than 1 meter wide may be excluded from the provisions of this policy with concurrence of the resource agencies. After project construction, a post-project survey shall be completed within 30 days and the results shall be sent to the resource agencies. The actual area of impact shall be determined from this survey. An additional survey shall be completed after 12 months to insure that the project or impacts attributable to the project have not exceeded the allowed 1 meter corridor width. Should the post-project or 12 month survey demonstrate a loss of eelgrass greater than the 1 meter wide corridor, then mitigation pursuant to sections 1-11 ofthis policy shall be required.

2) Projects impacting less than 10 square meters. For these projects, an exemption may be requested by a project applicant from the mitigation requirements as stated in this policy, provided suitable out-of-kind mitigation is proposed. A case-by-case evaluation

and determination regarding the applicability of the requested exemption shall be made by the resource agencies.
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(last revised 08/30/05)

Appendix 5. EFH Dredge Programmatic Report Form

Recommended EFH Dredge Programmatic Report Form to be cumulatively submitted for all dredge projects where active dredging occurred for each calendar year.

EFH Dredge Programmatic Report Form
20___ (calendar year)

1. Project name.
2. Was eelgrass within 250 m of project footprint?
   a. If yes, was BMP employed?
      i. If no, explain why not.
      ii. If yes, describe BMP.
3. Did project overlap with eelgrass?
   a. If yes, did appropriate mitigation occur?
      i. If no, explain why not.
      ii. If yes, describe (include acreage).
4. What were the sediment contaminant levels?
   a. PAH
   b. PCB
   c. Hg

Appendix 6. Comments provided by USACE and USEPA on draft consultation

DEPARTMENT OF THE ARMY
SAN FRANCISCO DISTRICT, U.S. ARMY CORPS OF ENGINEERS
1455 MARKET STREET
SAN FRANCISCO, CALIFORNIA 94103-1398

AND

U.S. ENVIRONMENTAL PROTECTION AGENCY
REGION IX
75 HAWTHORNE STREET
SAN FRANCISCO, CALIFORNIA 94105

MAY 21, 2010

Mr. Steve Edmondson
National Oceanic and Atmospheric Administration – Fisheries
777 Sonoma Avenue, Room 325
Santa Rosa, California 95404

Dear Mr. Edmondson:

This is in response to the advance copy of the draft San Francisco Bay LTMS Magnuson-Stevens Fishery Conservation and Management Act Essential Fish Habitat Consultation prepared by your staff dated April 30, 2010. We appreciate the opportunity to comment on the advance draft document and conservation recommendations. We realize that this programmatic consultation is a federal consultation between your agency, the United States Army Corps and Engineers (USACE) and the United States Environmental Protection Agency (USEPA). However, because this consultation is on the San Francisco Bay Long Term Management Strategy (SF Bay LTMS) program, we have invited our LTMS partner agencies, the San Francisco Bay Conservation and Development Commission (BCDC) and San Francisco Bay Regional Water Quality Control Board (SFRWQCB) to review the document as well.

Enclosed is a list of our overall and specific comments on the analysis presented in the document. In addition, a brief discussion of our comments on the proposed Conservation Recommendations is summarized below.

Overall, some of the Conservation Recommendations appear to be appropriate and implementable. However, we have significant concerns about the appropriateness, and even the legality, of some of the Conservation Recommendations.

Soft Bottom Habitat: we agree that a working group should be established to discuss possible studies to evaluate the potential effects of dredging activities on soft bottom habitat; however, any study deemed feasible would be subject to available SF Bay LTMS funding.

Eelgrass: while we appreciate the three mitigation options provided in the Conservation Recommendations, it is likely that we will opt for mitigation option 3 and provide your agency with an alternative mitigation plan. In particular, although a mitigation bank for eelgrass is a good concept, it is not possible to establish a bank as proposed. The USACE and USEPA do not have the authority to establish a mitigation bank that could be used by other dredgers. At this time, any mitigation would have to be on a project-by-project basis.

Contaminants: USACE, USEPA, BCDC, and the SFRWQCB have significant disagreements about NOAA's proposed approaches to sampling and analysis of dredged material and subsequent requirements for placement. The information in the document does not appear to clearly reflect the national and local regulations and guidelines. Unfortunately, the SF Bay LTMS agencies have not had adequate opportunity to meet with your staff regarding contaminant issues. Prior to formalizing this Conservation Recommendation in a signed draft document, we would like to establish a working group with your agency to clarify the testing requirements and regulations and guidelines.

Invasive Species: we also agree that a working group could be developed to investigate the potential effects of dredging activities on invasive species; however, the document does not clearly state how dredging is linked to invasive species in San Francisco Bay and the LTMS agencies do not believe that such a link could be established, based on the use of San Francisco Bay by other vectors that have resulted in invasive species in the Bay.

Thank you again for allowing us to comment on the draft of this document. We look forward to working closely with your staff to address these comments and complete a programmatic consultation that both streamlines consultations and benefits Essential Fish Habitat throughout the LTMS region.

A copy of this letter was sent to Ms. Beth Christian and Ms. Naomi Fager of the SFRWQCB; Mr. Steve Goldbeck and Ms. Brenda Goeden of BCDC; and Mr. Brian Ross of the USEPA.

If you have any questions regarding this letter or the enclosed specific comments, please contact Ms. Cynthia Jo Fowler (USACE) at 415.503.6870, or by email at Cynthia.J.Fowler@usace.army.mil; Mr. Robert Lawrence (USACE) at Robert.J.Lawrence@usace.army.mil; Mr. Brian Ross (USEPA) at 415.972.3475, or by email at Ross.Brian@ epa.gov; or Ms. Brenda Goeden (BCDC) at 415.352.3623, or by email at brendag@bcdc.ca.gov.

Sincerely,

Jason Brush, Chief
Wetlands Regulatory Office
USEPA Region 9

Thomas R. Kendall
Chief, Planning Branch
USACE, San Francisco District

Project: Draft SF Bay LTMS Magnuson-Stevens Fishery Conservation and Management Act Essential Fish Habitat Consultation (April 30, 2010)
Author: National Marine Fisheries Service (NMFS)

Date: May 21, 2010

Subject: Comments on the *Draft SF Bay LTMS Magnuson-Stevens Fishery Conservation and Management Act Essential Fish Habitat Consultation*, dated April 30, 2010 from the United States Army Corps of Engineers (USACE), United States Environmental Protection Agency (USEPA), San Francisco Bay Conservation and Development Commission (BCDC), and the San Francisco Bay Regional Water Quality Control Board (SFRWQCB).

Overall Comments:

1) Please replace dredged 'spoil' with dredged 'material' or 'sediment'.
2) Please replace dredged material 'disposal' and 'dumping' with dredged material 'placement'.
3) Beneficial use does not only mean upland placement.
4) The LTMS agencies disagree with NMFS' interpretation of dredging and invasive species – dredging itself is not responsible for invasive species; especially since there is an average of 250 boats that utilize San Francisco Bay per day. If dredging did not occur, boats would still use the Bay, but would be shallower draft.
5) The LTMS agencies agree that significant recovery of benthic communities is unlikely at the annually disturbed aquatic dredged material placement sites; however, these sites should not be considered EFH.
6) Regarding the analysis and Conservation Recommendations (CR) for contaminants, NMFS, USACE, USEPA, BCDC, and the SFRWQCB have significant disagreements about NMFS's proposed approaches to sediment sampling and analysis of dredged material, and the subsequent requirements for placement. Prior to formalizing the CRs for contaminants, the LTMS agencies would like to meet with your staff to discuss this issue further.
7) The USACE, USEPA, BCDC, and the SFRWQCB agree that establishing a working group to discuss possible studies for the dredging and dredged material placement effects on benthic habitat and invasive species would be beneficial. Any studies that would be conducted would be subject to SF Bay LTMS funding.
8) Regarding the eelgrass CR mitigation options: of the three mitigation options provided, is likely that option 3 – *Alternative mitigation plan (USACE and USEPA may develop an alternative mitigation plan for impacts to eelgrass from dredge related activities subject to NMFS approval*) will be chosen.
9) Regarding Conservation Recommendations (CR) 3, 9 and 11: USACE and the USEPA have no authority to *fund a single NMFS Fishery Biologist*. The assertion that *USEPA, USACE and NMFS are authorized to enter into an Interagency Reimbursable Agreement pursuant to the Economy Act (31 U.S.C. 1535), which provides that an agency may place an order with*

another major organizational unit within another agency for goods and services is not entirely correct. The statue reads:

(a) The head of an agency or major organizational unit within and agency may place an order within the same agency or another agency for goods or services if:

(1) Amounts are available;
(2) The head of the ordering agency or unit decides the order is in the best interest of the United States Government;
(3) The agency or unit to fill the order is able to provide or get by contract the ordering goods or services; and
(4) The head of the agency decides ordered goods or services cannot be provided by contract as conveniently or cheaply by a commercial enterprise.

Even conceding that conditions 1, 2 and 4 are applicable (*i.e.,*, that the amounts are available, the order is in the best interest of the United States, and we could not obtain the services as conveniently or cheaply by a commercial enterprise, we are still left with the need to find an authority to provide or get by contract a fisheries biologist position to participate in the DMMO and LTMS Science Committee for purposes of complying with a "non-mandatory" recommendation from NMFS. There is no such authority in any WRDAs. However, if Congress were to make special legislation (authorization/appropriations) to comply with Conservation Recommendations 3, 9 and 11, then we would be able to meet condition 3 of the Economy Act and "the agency or unit to fill the order is able to provide or get by contract the ordered goods or services."

Additionally, there is another fiscal law concerned with the subject of Conservation Recommendations 3, 9, and 11. In a legal opinion, GAO found that one organization within the Department of Homeland Security pooled its appropriations to fund what it refers to as shared services. Pooling funds across appropriations is a transfer, and, unless otherwise authorized by law, transfers of funds between agency appropriation accounts are prohibited by law. Likewise, the pooling of USEPA appropriations and USACE appropriations for shared services (participation in DMMO and LTMS) is prohibited by law.

Moreover, there may be an augmentation of appropriations issue with respect to NMFS and the funding of a fisheries biologist, however, that is not necessarily a violation attributable to the procuring agency.

Lastly, these CRs may violate the Anti-Deficiency Act, given that USACE and USEPA funding may be limited.

Specific Comments		
Page	**Section**	**Comment**
2	II	Please insert *Because of this partnership and at the request of the USEPA and USACE, this programmatic consultation has included the state agencies.*
2	II	2004 – 2007 and February – analysis and May 2010: Please include BCDC in the consultation process.
4	III.B.1.a	Please insert *or use* after *into a barge or scow for transport to a dredged material disposal -*
4	III.A	Stating that the EFH consultation document does not cover (2) *any deepening of areas below the currently authorized depths* directly conflicts with CR D.8 – residuals, which requires dredging below authorized depths. So, add "plus allowable overdepth" after "currently authorized depth"
6	III.B.3.a	Please insert *These sites are dispersive and located in areas where the dredged sediment is redistributed through the sediment transport system* at the end of this statement.
6	III.B.3.b	Please insert *SF-DODS is a depositional site, sediment that is deposited there remains in place* at the end of this paragraph. Please clarify this on page 17 when discussing the SF-DODS site.
6	III.B.3.c	SF-17 is still a demonstration site that is only used to place clean sand from the SF Main Ship Channel; it is not yet designated; however, it is under consideration for designation. Please clarify this on page 18 when discussion of nearshore sites.
6	III.B.3.d	The LTMS agencies do not consider beneficial use to only be comprised of upland placement, or vice versa; especially for aquatic habitat restoration. Please separate these two placement sites out or state *Beneficial Use and Upland Placement.*
6	III.C.1	Please clarify the duration for the in-bay dredged material placement volume decrease (*e.g.,*, from 6 mcy pre-1990 to less than 2 mcy in 2009). 2.0 mcy is now 1.64 mcy.
7	III.C.3	Please clarify the statement. The testing requirements are nation-wide requirement of USACE and USEPA, not merely mandated by the DMMO.
9		The 1987 Wetland Delineation Manual was updated with a regionally-specific document; please update this reference.

Specific Comments		
Page	**Section**	**Comment**
10	IV.B.3	Suggest defining eelgrass beds, patches and sporadic to reference the subsequent discussion.
10	IV.B.3	Suggest including the various features of eelgrass: inter-annual fluctuations of visible eelgrass may be at least a factor of 10; there is a very large area of potential eelgrass that is not inhabited in any particular year due to a combination of environmental factors, such as turbidity, and limitation of propagules (*e.g.,*, no seeds distributed to the particular site that year) - as described by Merkel; accurate and complete eelgrass surveys are difficult to perform in SF Bay because it can occur more sparsely than anywhere else in the world (<1 plat per square meter), making it difficult to map.
11/12/13	V.B	There appears to be confusion in the headings for the types of effects for sections 4 and 5 – turbidity, loss of primary production (eelgrass and algae?), loss of prey, short-term dissolved oxygen depletion, etc. For example, the discussion in 4 regarding 'reduced clarity' and 'increases in nutrients can favor one group of organisms…' does not belong in the 'Release of oxygen consuming substances' section; and 5. Entrainment discusses loss of prey species.
11	V.B.1.a	There is also literature available that indicates benthic communities recover much more quickly than 1 year. A broader search of the pertinent literature would suggest both a much shorter and much longer recolonization/recovery time, depending on location, sampling methods, and what is considered important.
11	V.B.1.a	Several different terms are used here: recolonize, recovery... Please clarify 'recovery' – is it number of organisms, number of species, return of specific species, return of habitat value for prey?
11	V.B.1.a	The last statement of paragraph 1 does not follow from the references. Please correlate the benthic community to fish feeding.
11	V.B.1.a	Regarding 'forage resources for benthic feeders may substantially be reduced' – there is research on post-dredging communities (*i.e.,*, Galveston) – literature by Doug Clarke, ERDC, Bob Diats, VIMS, etc. discusses research regarding dredging and benthic habitat.
11/12	V.B.1.b	Regarding "Associated impacts may result from vessel groundings, direct damage from propellers, and anchor scour." This is likely an indirect effect of dredging and a direct effect of boating. Please clarify.

Specific Comments		
Page	**Section**	**Comment**
11/12	V.B.1.b	Regarding "The contents of the suspended material may react with the dissolved oxygen…" Please specify what contents. We note that the suspended phase bioassays provide a direct measurement of whether this potential phenomenon would in fact be a concern on a case-by-case basis.
12	V.B.2.b.c	Sabol *et al* 2005 may not be an appropriate reference for this point.
12	V.B.2	Is there evidence beyond conceptuality that *reduction in available eelgrass canopy due to dredging related turbidity can result in loss, especially where growing at its lower depth limit* is true? Has any evaluation been done for SF Bay to establish this?
12	V.B.2	Final sentence in paragraph 2 (Cloern 1987) may not be accurate. *Slight reductions in light may result in short-term decreases in the instantaneous photosynthetic rate.* Unless the total daily amount of light is below that of the threshold level, there are no discernable effects on the plants. If light values are reduced, there can be instances of no effect, if resultant light values are still above the saturation level. Note that the instantaneous saturation level for seagrass in SF Bay is less than 1% of surface intensity. Suggest reviewing other literature, such as Alterti.
12	V.B.2	Please do not use Rich 2007 – this reference is not yet released and is largely a review of reviews that focuses on tools for fish behavior regarding dredging and not fish behavior per se.
12	V.B.2	Please qualify the reference to Nightengale & Simenstad 2001 and the preceding statement. There are no specific data for many of the SF Bay species.
12	V.B.3	Suggest citing LTMS-sponsored paper on effects of contaminants on fish (SFEI).
12	V.B.7	Use of Sabol *et al* 2005 – there are perhaps more appropriate references.
13	V.B.8	Is the intent of this analysis qualitative (*i.e.,*, new species arriving which may establish and proliferate) or qualitative (lots of individuals of existing species)? This section is missing some important references.
14	V.B.2.b.8	The final sentence regarding the introduction of bacteria, viruses, and parasites – this is probably not a result of dredging but of ballast water. Dredging moves material and equipment within the Bay.

Specific Comments		
Page	**Section**	**Comment**
14		Dredge equipment varies greatly. Cutterhead hydraulic dredges have the least control over the depth of bottom disturbance; whereas, mechanical dredges are more precise and hopper dredges are the most precise.
14	V.B.9	Perhaps alteration of benthic topography could also affect navigation/migration of some species (based on a comment by Pete Klimley, UCD).
15	V.C.1.a	Regarding the Clarke 2002 citation and peak sound pressure levels of 124 dB measured at 150 meters – this is probably not dredging in soft bay mud, as occurs in the Bay.
16	V.C.b.ii	Stating that hopper dredges overflow at the surface is incorrect; they overflow at the bottom of the dredge. There is an anti-turbidity valve on the *Essayons* that reduces turbidity released with overflow.
16	VI.C – Option 1	Please include USEPA in the sentence "USACE may establish…"
17	V.C.3	Paragraph 2 – *Recover of benthic community is unlikely at the disposal sites where disposal occurs at a frequency greater than annually*. It is interesting to speculate on the habitat value of regularly disturbed areas. Arrival of some organisms occurs very shortly after disturbance, and these are typically the rapidly producing species. They would presumably have some food value, albeit of less ecological value, than a fully mature community that would take the presumed 3 – 5 years to develop. A fully mature community could conceivably have less food value (biomass) than that of earlier stages.
18 (and 13 V.B.1.b.5)	V.C.3.d	The offloader is equipped with a fish screen that prohibits entrainment of fish. The design of the fish screen slows the velocity of the water intake as well.
20	Indirect eelgrass effects	The LTMS believes that the indirect effects would be a *low* level effect, rather than high. Also, please provide a summary of the acreage reference in table 6.
20	V.D.3.a	The final sentence seems to be predicated on loss of eelgrass, even if moderately impacted by shading; does this provide essential resources by way of epiphytes (food for mesograzers which are fish food) and also structural habitat?

Specific Comments		
Page	**Section**	**Comment**
21	V.D.3.b	'The buffer was clipped to remove areas where it is not feasible for eelgrass to grow (*i.e.,*, depths greater than 4 meters)' - Please provide technical reference for this. There are areas where this is too deep a limit.
21	Eelgrass direct effects	Please mention that the fluctuations in distribution and the direct effects associated with them will be for 39 years (the duration of the EFH Assessment).
21	Contaminant effects	Please provide some specifications regarding the additional mitigation required in this section.
22	VI.A.	Please provide some specifications regarding benthic recovery in this section.
22	VI.A.2.a	
22	VI.A.1	Suggestion that a team be established to design the study based on proper conceptual model and literature review. Also note that 'doing it right' is an extremely expensive proposition; particularly in light of the fact that most of the benthos is invasive. Not sure of the point...perhaps this could recast as a Benthic Resources Analysis Technique (BRAT) where the fish and fish food are analyzed in parallel. USACE can provide references on the BRAT.
22	VI.A.2.a	Is there technical evidence that this will resort in less severe impacts to EFH and EFH-managed species?
22	VI.A.2.b	Dredging for any project is dependent on funding; therefore, dredging to the authorized depth is often all that dredgers can accomplish. Perhaps change this statement to read: *Dredged areas are maintained to the authorized depth in a single episode to reduce the frequency of dredging.* However, this is still not within agency control as the DMMO cannot require dredging below authorized depth.
23	VI.4.a	Suggest including that dredging in water deeper than 4 meters be listed as fourth area under the header of avoidance.
23	VI.B.4.a.i	Regarding no overflow. In SF Bay, overflow is not allowed for fine-grained material and is only allowed for 15 minutes in sandy material.
23	VI.B.4.b.iii.a	Please state what the H_{sat} value is for eelgrass in the Bay.
23	VI.B.4.b.iii.a	There are instances when daily light saturation is a more accurate means of determining impact that this statement represents (Zimmerman *et al* 1991).

Specific Comments		
Page	**Section**	**Comment**
23	VI.B.4.a.iii.b	Please clarify the appropriate distance to an area outside the 'reference area not influenced by turbidity above ambient for the area.'
24	VI.B.4.b.iii.c	Please clarify 'all circumstances'. Does this apply to projects only within the 250 m buffer for indirect impacts on eelgrass?
24	VI.B.4.b.iii.c	Please clarify what is meant by 'certain conditions'. Can you provide examples of these types of conditions that would deem BMPs infeasible?
24	VI.B.4.b.iii.c.i	Slowing down the cycle time of clamshell dredging increases costs as well as the duration of a dredging project.
24	VI.B.4.c	Please clarify what is meant by 'suitable' in the statement 'determines that none of the above avoidance measures are adequate or suitable for a specific project. Does suitable mean necessary?
25	VI.C.5.v (Mitigation Option 1)	Please clarify *average*; as average density is too vague. Suggest some surrogate for biomass, compared to the impacted area.
25	VI.C.5 (mitigation option 1)	USACE and USEPA do not have the authority to establish an eelgrass mitigation bank that would benefit (be used by) all LTMS dredgers. Any authority to create a bank would most likely be limited to mitigation for USACE projects.
26	VI.C.5 (mitigation option 1)	Has there been success in establishing such a large eelgrass bed through current restoration efforts in the bay? We recognize the value of larger habitats, but are concerned about feasibility, is it possible that smaller beds could additively address the 20 acres?
27	VI.C.5.a (mitigation option 2)	Please clarify how far outside of the project area needs to be mapped in the surveys.
27	VI.C.5.a (mitigation option 2)	Suggest that 'and other appropriate agencies' be inserted after NMFS; as other agencies are required to approve eelgrass mitigation plans.
27	VI.C.5.a (mitigation option 2)	Providing information 'within 30 days of the star of dredging activities' can be interpreted in different ways. Perhaps better to state in the 30 days before or after the start…
27	VI.C.5.b (mitigation option 2)	Please insert 'as appropriate' after 'strictly employed'.
27	VI.C.5.c (mitigation option 2)	Please specify the number of buoys and the distance they are apart.

Specific Comments		
Page	**Section**	**Comment**
27	VI.C.5.d (mitigation option 2)	Please specify 'adversely impacted eelgrass'. This may be difficult to ascertain. What level of pre-dredge survey should there be to serve as 'control'.
27	VI.C.5.c (mitigation option 2)	Regarding 'no dredging equipment will be located, temporarily or at anchor, in eelgrass areas outside the project footprint.' There may be cases where there is no other option; such as when an empty scow is being maneuvered to replace a full scow and has no other place to be temporarily located. Suggest stating that such an activity shall be avoided to the maximum extent possible.
27	VI.C.5.d (mitigation option 2)	Please clarify what is meant in this statement – is it any further mitigation plans? This implies that already approved mitigation plans can be changed.
28	VI.D.6	Regarding formalizing the restriction against placing dredged material in bay when it fails to meet benthic toxicity tests – please see USACE Public Notice 01-01, paragraph 7.5.1, which states that unsuitable dredged material cannot be placed in bay. Further, this is already required under USEPA and USACE national policy (see 401(b)(1) guidelines at 40 C.F.R. 230.60 (subpart G). The national Inland Testing Manual and local guidance further addresses when and how 'toxicity' is determined on a case-by-case basis. Per these regulations and guidance, unconfined aquatic placement is not allowed for any material failing the toxicity bioassays.
28	VI.D.6	DMMO can develop more specific guidance for when bioaccumulation testing is required, in accordance to the existing regulations and manuals; however, exceeding ambient levels is not by itself always a sufficient basis for requiring bioaccumulation testing for all compounds, or even the specific compounds listed, in order to reach in-bay suitability requirements.
28	VI.D.6	Sediment testing in the LTMS area generally does not include sublethal effects from growth or development tests. Sublethal tests appropriate for nationwide use have not yet been identified by USEPA and USACE.

Specific Comments		
Page	**Section**	**Comment**
28	VI.D.8 (Residuals)	DMMO can develop more specific guidance regarding where we require residuals to be measured and what constitutes an 'elevated' residual (not always just 'ambient' for all the compounds) and when site-specific evaluation of whether an elevated residual represents a risk that must be addressed with active measures (under another program, see below). (removal or capping of sediments). Case-by-case evaluation of whether the new surface represents a significant risk is needed to determine this, in consideration of actual site-specific exposure, in addition to contaminant concentrations. There are specific programs (*e.g.,*, under CERCLA, CWA and Porter-Cologne) designed to identify whether and when a site constitutes a 'hot spot' that requires remediation. When the DMMO identifies locations where dredging would expose very high concentrations of contaminants (even if localized), that information is passed along and the DMMO processing of the dredging approval either ceases until those programs have made their determinations, or DMMO works directly with the programs to ensure the process and decisions are consistent.
29	V*I.E.,*10	The working group should establish its own working plan, which may include a literature review first.
29	V*I.E.,*10	Suggest that the final statement in this paragraph state that USACE and USEPA will 'investigate alternative measures' rather than 'will develop'; understanding that spending funds may or may not exist.
29	VI.F.12	Suggest reporting requirements should be changed from 30 days to 90 days post calendar year. The agencies don't often receive the post dredge surveys within 30 days.
30	Literature Cited	Use of Abbott & Bing-Sawyer – this 8-year old draft report may not be an appropriate reference.
34	Literature Cited	Merkel 2004 – please reference the later Merkel studies, even if in preparation.
34	Literature Cited	Rich, A. A. 2007 is not an acceptable reference, since it was not released.
35	Literature Cited	Setchell 1929 – please check spelling of *phonological*
38	Table 1	Please mention the Brooklyn Basin federal dredging project on this table (it is included in the Oakland Harbor federal dredging project footprint).

Specific Comments		
Page	**Section**	**Comment**
45	Table 5	Does the USACE dredging of sand area include the Main Ship Channel? Also, Conoco Philips (non-federal) is sand and the acres should be included in this table.
46	Table 6	Does the Sausalito Bay Model dredging project (federal) in Richardson Bay affect eelgrass? If so, please include it on this table.
46	Table 6	Due to the depth clipping, there may be an error in the assumption that dredging the federal Richmond Harbor would directly affect 0.003 acres of eelgrass.
46	Table 6	Please clarify 'San Francisco Harbor' in this table – is it the Main Ship Channel, Islais Creek?
46	Table 6	It would be clearer to make two separate tables for dredging projects with indirect and direct effects on eelgrass.
47	Appendix 1, 3rd paragraph	Suggest discussing that the LTMS goal is to maximize beneficial use of sediment and minimize in-bay placement, while maintaining the SF-DODS site as a backup. The *minimum* for beneficial use of dredged material is 40 percent. Further, the goal for the maximum volume placed in-Bay after 2012 is 1.2 mcy.
47	Appendix 1, 3rd paragraph	The last statement in this paragraph may not be true.
48	Appendix 1	Please provide a reference for *Elevated levels of contaminants may cause species to leave the impacted area for a period of time.*
49	Appendix 1	Regarding USACE *et al* 2009 and *This seems to be a sound system to import to the San Francisco Bay* – The approach used in the Pacific Northwest is based on a unique region-specific data set, as well as on a promulgated sediment quality criteria. California does not have any similar database or regulation in place at the moment. In fact, the CA sediment quality objectives being developed specifically do not apply to management of dredged material or dredged material placement sites, either in a technical or policy manner. The Pacific Northwest system cannot simply be imported to San Francisco Bay.
52	Appendix 1	Please provide a discussion of the sites that were sampled in SF Bay and compared to fish control in Bodega Bay.

Specific Comments		
Page	**Section**	**Comment**
56/51	Appendix 1	Please clearly differentiate between mercury, methylmercury and reactive mercury; they have widely different toxicities, bioaccumulation rates, and implications for dredging and dredged material placement. Further, methylmercury is generally not an issue in subtidal areas.
53	Appendix 1	Please provide a discussion of the studies that were developed since 1980s and the more recent studies. Who developed these studies?

Appendix 7. NMFS Responses

NMFS responses to overall and specific comments provided by USACE and USEPA after review of the first draft of this document (Appendix 6).

Overall Comments—NMFS responses		
Comment number	**Change made to address comment**	**NMFS Response**
1	yes	Change made.
2	no	Unnecessary.
3	yes	NMFS has decided to limit use of the term "beneficial reuse" to upland wetland restoration sites only. Nearshore disposal sites, including SF-8 and the Ocean Beach Renourishment site are unconsolidated, open-water disposal sites. Even if there is an environmental benefit to disposing clean sand at these locations, *i.e.*, to relieve erosion on Ocean Beach, disposal at these sites still has potential impacts to EFH, *i.e.*, burial.
4	yes	Text added to document to demonstrate link between dredging and invasive species. However, NMFS stands by original interpretation. Without dredging, large ships from distant ports would not have access to the Bay.
5	no	Disagree - annual dredging affects quality of EFH, but areas are still included in EFH designations
6	yes	Modifications made based on discussions. Will need to respond to conservation recommendations.
7	no	understand link with LTMS, however, USACE/USEPA have authority to fund or seek funding separate from LTMS
8	no	Noted. Final choice by USACE/USEPA irrelevant to options provided in programmatic document
9	no	Our GC has indicated that the USACE and USEPA could fund a position as recommended. We have numerous staff funded by other federal agencies and would like to work with appropriate staff from all involved agencies to accomplish this recommendation.To the extent the affected habitat relates to species listed under the ESA [various salmon species, green sturgeon, delta smelt, etc.] every agency has a responsibility to utilize their existing authorities in furtherance of the purposes of the Endangered Species Act [ESA section 7(a)(1), 16 USC 1536(a)(1)]. The USACE and USEPA have legal authority to hire a biologist, and conduct this type of work, to assist them to comply with various "other applicable law" such as NEPA, ESA, and MSA [EFH].

Specific comments- NMFS responses					
Page	**Section**	**Comment**	**Change made**	**NMFS Response**	**Requested information provided/action taken**
2	II	Please insert *Because of this partnership and at the request of the USEPA and USACE, this programmatic consultation has included the state agencies.*	yes	Change made	
2	II	2004 – 2007 and February – analysis and May 2010: Please include BCDC in the consultation process.	yes	Change made	
4	III.B.1.a	Please insert *or use* after *into a barge or scow for transport to a dredged material disposal -*	yes	Change made	
4	III.A	Stating that the EFH consultation document does not cover (2) *any deepening of areas below the currently authorized depths* directly conflicts with CR D.8 – residuals, which requires dredging below authorized depths. So, add "plus allowable overdepth" after "currently authorized depth"	yes	Change made	
6	III.B.3.a	Please insert *These sites are dispersive and located in areas where the dredged sediment is*	yes	This is in effects by action (V.C.3.a)	

Specific comments- NMFS responses					
Page	**Section**	**Comment**	**Change made**	**NMFS Response**	**Requested information provided/action taken**
		redistributed through the sediment transport system at the end of this statement.			
6	III.B.3.b	Please insert *SF-DODS is a depositional site, sediment that is deposited there remains in place* at the end of this paragraph. Please clarify this on page 17 when discussing the SF-DODS site.	yes	This is in effects by action (V.C.3.b)	
6	III.B.3.c	SF-17 is still a demonstration site that is only used to place clean sand from the SF Main Ship Channel; it is not yet designated; however, it is under consideration for designation. Please clarify this on page 18 when discussion of nearshore sites.	no	Because we completed consultation on the designation of SF-17 and it is currently in use for dredge material disposal, we would prefer to include it in this consultation, therefore it will be covered when USACE makes the designation official.	
6	III.B.3.d	The LTMS agencies do not consider beneficial use to only be comprised of upland placement, or vice versa; especially for aquatic habitat restoration. Please separate these	no	NMFS does not include nearshore disposal (SF-8, 17) as beneficial reuse for the purposes of this consultation because of the impacts to marine environment associated with open water disposal.	

Specific comments- NMFS responses					
Page	**Section**	**Comment**	**Change made**	**NMFS Response**	**Requested information provided/action taken**
		two placement sites out or state *Beneficial Use and Upland Placement.*			
6	III.C.1	Please clarify the duration for the in-bay dredged material placement volume decrease (*e.g.,*, from 6 mcy pre-1990 to less than 2 mcy in 2009). 2.0 mcy is now 1.64 mcy.	yes	Change made	
7	III.C.3	Please clarify the statement. The testing requirements are nation-wide requirement of USACE and USEPA, not merely mandated by the DMMO.	no	This language was from the EFH assessment provided to NMFS from USACE. Please provide the appropriate language	No additional information provided.
9		The 1987 Wetland Delineation Manual was updated with a regionally-specific document; please update this reference.	yes	Please provide reference	Reference provided, change made.
10	IV.B.3	Suggest defining eelgrass beds, patches and sporadic to reference the subsequent discussion.	no	NA	
10	IV.B.3	Suggest including the various features of eelgrass: inter-annual fluctuations of visible eelgrass may be at least a factor of 10; there is a very large area of potential eelgrass that is not inhabited in any particular year due to a combination	no	Please provide reference	USACE provided citations but not actual papers for verification of statements.

Specific comments- NMFS responses					
Page	**Section**	**Comment**	**Change made**	**NMFS Response**	**Requested information provided/action taken**
		of environmental factors, such as turbidity, and limitation of propagules (*e.g.*,, no seeds distributed to the particular site that year) - as described by Merkel; accurate and complete eelgrass surveys are difficult to perform in SF Bay because it can occur more sparsely than anywhere else in the world (<1 plat per square meter), making it difficult to map.			
11/12 /13	V.B	There appears to be confusion in the headings for the types of effects for sections 4 and 5 – turbidity, loss of primary production (eelgrass and algae?), loss of prey, short-term dissolved oxygen depletion, etc. For example, the discussion in 4 regarding 'reduced clarity' and 'increases in nutrients can favor one group of organisms…' does not	yes	Changes made and clarification of overlap among effects provided in introductory paragraph V.B	

Specific comments- NMFS responses					
Page	**Section**	**Comment**	**Change made**	**NMFS Response**	**Requested information provided/action taken**
		belong in the 'Release of oxygen consuming substances' section; and 5. Entrainment discusses loss of prey species.			
11	V.B.1.a	There is also literature available that indicates benthic communities recover much more quickly than 1 year. A broader search of the pertinent literature would suggest both a much shorter and much longer recolonization/recovery time, depending on location, sampling methods, and what is considered important.	no	Please provide reference	Reference provided is already included.
11	V.B.1.a	Several different terms are used here: recolonize, recovery... Please clarify 'recovery' – is it number of organisms, number of species, return of specific species, return of habitat value for prey?	yes	Clarification provided in section V.B.1.a: in this document, recovery of the benthic community generally means the later phase of benthic community development after disturbance when species that inhabited the area prior to disturbance begin to re-establish	
11	V.B.1.a	The last statement of paragraph 1 does not follow from the references. Please correlate the benthic community to fish feeding.	yes	Changed final sentence to read: "Based on available literature, NMFS will assume recovery of prey resources will not occur within one year". Link between fish and benthic community as prey is clear from first sentence.	

Specific comments- NMFS responses					
Page	**Section**	**Comment**	**Change made**	**NMFS Response**	**Requested information provided/action taken**
11	V.B.1.a	Regarding 'forage resources for benthic feeders may substantially be reduced' – there is research on post-dredging communities (*i.e.*,, Galveston) – literature by Doug Clarke, ERDC, Bob Diats, VIMS, etc. discusses research regarding dredging and benthic habitat.	no	Please provide reference	USACE provided citations but not actual papers for verification of statements.
11/12	V.B.1.b	Regarding "Associated impacts may result from vessel groundings, direct damage from propellers, and anchor scour." This is likely an indirect effect of dredging and a direct effect of boating. Please clarify.	yes	Change made	
11/12	V.B.1.b	Regarding "The contents of the suspended material may react with the dissolved oxygen…" Please specify what contents. We note that the suspended phase bioassays provide a direct measurement of whether this potential phenomenon would in fact be a concern on a case-by-case basis.	no	Even if tested for in bioassays, still relevant to discuss in effects analysis.	
12	V.B.2.b.c	Sabol *et al* 2005 may not be an appropriate reference for this point.	no	Please provide reference	USACE provided citations but not actual papers for

Specific comments- NMFS responses					
Page	**Section**	**Comment**	**Change made**	**NMFS Response**	**Requested information provided/action taken**
					review.
12	V.B.2	Is there evidence beyond conceptuality that *reduction in available eelgrass canopy due to dredging related turbidity can result in loss, especially where growing at its lower depth limit* is true? Has any evaluation been done for SF Bay to establish this?	no	Using best available science to anticipate impacts for dredging-induced turbidity, and the resulting shade/light-limitation on adjacent eelgrass	
12	V.B.2	Final sentence in paragraph 2 (Cloern 1987) may not be accurate. *Slight reductions in light may result in short-term decreases in the instantaneous photosynthetic rate.* Unless the total daily amount of light is below that of the threshold level, there are no discernable effects on the plants. If light values are reduced, there can be instances of no effect, if resultant light values are still above the saturation level. Note that the instantaneous saturation level for seagrass in SF Bay is less than 1% of surface intensity. Suggest reviewing other literature, such as Alterti.	yes	Change made to clarify appropriate use of reference. Please provide additional reference	USACE provided citations but not actual papers for review.

Specific comments- NMFS responses					
Page	**Section**	**Comment**	**Change made**	**NMFS Response**	**Requested information provided/action taken**
12	V.B.2	Please do not use Rich 2007 – this reference is not yet released and is largely a review of reviews that focuses on tools for fish behavior regarding dredging and not fish behavior per se.	yes	References to Rich 2007 were removed. Please provide reference.	No additional information provided.
12	V.B.2	Please qualify the reference to Nightengale & Simenstad 2001 and the preceding statement. There are no specific data for many of the SF Bay species.	no	Best available information or please provide other references.	No additional information provided.
12	V.B.3	Suggest citing LTMS-sponsored paper on effects of contaminants on fish (SFEI).	yes	Please provide reference.	Reference provided, change made.
12	V.B.7	Use of Sabol *et al* 2005 – there are perhaps more appropriate references.	no	Please provide reference	No additional information provided.
13	V.B.8	Is the intent of this analysis qualitative (*i.e.,*, new species arriving which may establish and proliferate) or qualitative (lots of individuals of existing species)? This section is missing some important references.	yes	Clarified in text that intent covers both increase in species and increase in dist/abund. Please provide reference	No additional information provided.

Specific comments- NMFS responses					
Page	**Section**	**Comment**	**Change made**	**NMFS Response**	**Requested information provided/action taken**
14	V.B.2.b.8	The final sentence regarding the introduction of bacteria, viruses, and parasites – this is probably not a result of dredging but of ballast water. Dredging moves material and equipment within the Bay.	no	The connection between ballast water and invasive species is made in the introductory paragraph of this section. Were it not for dredging, large ships from exotic ports would not be able to enter SF Bay. Thus, the introduction of invasive species from the ballast water of these ships is an effect of dredging.	
14		Dredge equipment varies greatly. Cutterhead hydraulic dredges have the least control over the depth of bottom disturbance; whereas, mechanical dredges are more precise and hopper dredges are the most precise.	yes	Change made	
14	V.B.9	Perhaps alteration of benthic topography could also affect navigation/migration of some species (based on a comment by Pete Klimley, UCD).	no	NA	
15	V.C.1.a	Regarding the Clarke 2002 citation and peak sound pressure levels of 124 dB measured at 150 meters – this is probably not dredging in soft bay mud, as occurs in the Bay.	no	Please provide reference	No additional information provided.
16	V.C.b.ii	Stating that hopper dredges overflow at the surface is incorrect;	yes	Change made	

Specific comments- NMFS responses					
Page	**Section**	**Comment**	**Change made**	**NMFS Response**	**Requested information provided/action taken**
		they overflow at the bottom of the dredge. There is an anti-turbidity valve on the *Essayons* that reduces turbidity released with overflow.			
16	VI.C – Option 1	Please include USEPA in the sentence "USACE may establish…"	yes	Change made	
17	V.C.3	Paragraph 2 – *Recover of benthic community is unlikely at the disposal sites where disposal occurs at a frequency greater than annually*. It is interesting to speculate on the habitat value of regularly disturbed areas. Arrival of some organisms occurs very shortly after disturbance, and these are typically the rapidly producing species. They would presumably have some food value, albeit of less ecological value, than a fully mature community that would take the presumed 3 – 5 years to develop. A fully mature community could conceivably have less food value (biomass) than that of earlier stages.	no	NA	
18 (and 13 V.B.1.	V.C.3.d	The offloader is equipped with a fish screen that prohibits entrainment of fish. The design of the fish screen slows the velocity of the water	yes	Change made	

Specific comments- NMFS responses					
Page	**Section**	**Comment**	**Change made**	**NMFS Response**	**Requested information provided/action taken**
b.5)		intake as well.			
20	Indirect eelgrass effects	The LTMS believes that the indirect effects would be a *low* level effect, rather than high. Also, please provide a summary of the acreage reference in table 6.	no	NMFS does not agree that this is a low level effect; reference added to table title.	
20	V.D.3.a	The final sentence seems to be predicated on loss of eelgrass, even if moderately impacted by shading; does this provide essential resources by way of epiphytes (food for mesograzers which are fish food) and also structural habitat?	no		
21	V.D.3.b	'The buffer was clipped to remove areas where it is not feasible for eelgrass to grow (*i.e.,*, depths greater than 4 meters)' - Please provide technical reference for this. There are areas where this is too deep a limit.	yes	NMFS used 4 meters to be protective of eelgrass throughout the bay because there are areas where eelgrass has been observed to 4 m in some parts of the bay; Merkel (2008) reference added	
21	Eelgrass direct effects	Please mention that the fluctuations in distribution and the direct effects associated with them will be for 39 years (the duration of the EFH Assessment).	yes	Change made	

Specific comments- NMFS responses					
Page	**Section**	**Comment**	**Change made**	**NMFS Response**	**Requested information provided/action taken**
21	Contaminant effects	Please provide some specifications regarding the additional mitigation required in this section.	no	Mitigation in this section refers to additional actions the agencies can take to prevent or minimize impacts. They are further described later in the document.	
22	VI.A.	Please provide some specifications regarding benthic recovery in this section.	yes	Change made	
22	VI.A.2.a		no	NA	
22	VI.A.1	Suggestion that a team be established to design the study based on proper conceptual model and literature review. Also note that 'doing it right' is an extremely expensive proposition; particularly in light of the fact that most of the benthos is invasive. Not sure of the point...perhaps this could recast as a Benthic Resources Analysis Technique (BRAT) where the fish and fish food are analyzed in parallel. USACE can provide references on the BRAT.	yes	This may be proposed by the USACE/USEPA in response to the CR. Please provide reference.	Reference provided, change made.
22	VI.A.2.a	Is there technical evidence that this will resort in less severe impacts to EFH and EFH-managed species?	yes	change made	
22	VI.A.2.b	Dredging for any project is	yes	Change made	

Specific comments- NMFS responses					
Page	**Section**	**Comment**	**Change made**	**NMFS Response**	**Requested information provided/action taken**
		dependent on funding; therefore, dredging to the authorized depth is often all that dredgers can accomplish. Perhaps change this statement to read: *Dredged areas are maintained to the authorized depth in a single episode to reduce the frequency of dredging.* However, this is still not within agency control as the DMMO cannot require dredging below authorized depth.			
23	VI.4.a	Suggest including that dredging in water deeper than 4 meters be listed as fourth area under the header of avoidance.	no	NMFS does not agree that dredging in these deeper depths reduce the probability that turbidity may impact adjacent eelgrass.	
23	VI.B.4.a.i	Regarding no overflow. In SF Bay, overflow is not allowed for fine-grained material and is only allowed for 15 minutes in sandy material.	no	NMFS receomends no overflow.	
23	VI.B.4.b.iii.a	Please state what the H_{sat} value is for eelgrass in the Bay.	yes	That is clearly stated already.	
23	VI.B.4.b.iii.a	There are instances when daily light saturation is a more accurate means of determining impact that this	no	That may be true, but NMFS existing policy recommends the Hsat method.	

Specific comments- NMFS responses					
Page	**Section**	**Comment**	**Change made**	**NMFS Response**	**Requested information provided/action taken**
		statement represents (Zimmerman *et al* 1991).			
23	VI.B.4.a.iii.b	Please clarify the appropriate distance to an area outside the 'reference area not influenced by turbidity above ambient for the area.'	yes	Clarified in text that will depend on project-specifics and be determined on project-by-project basis	
24	VI.B.4.b.iii.c	Please clarify 'all circumstances'. Does this apply to projects only within the 250 m buffer for indirect impacts on eelgrass?	yes	Yes; change made to clarify	
24	VI.B.4.b.iii.c	Please clarify what is meant by 'certain conditions'. Can you provide examples of these types of conditions that would deem BMPs infeasible?	yes	Change made to clarify	
24	VI.B.4.b.iii.c.i	Slowing down the cycle time of clamshell dredging increases costs as well as the duration of a dredging project.	no	Increased costs may be associated with certain avoidance/minimization measures	
24	VI.B.4.c	Please clarify what is meant by 'suitable' in the statement 'determines that none of the above avoidance measures are adequate or suitable for a specific project.	yes	Change made to clarify	

Specific comments- NMFS responses					
Page	**Section**	**Comment**	**Change made**	**NMFS Response**	**Requested information provided/action taken**
		Does suitable mean necessary?			
25	VI.C.5.v (Mitigation Option 1)	Please clarify *average*; as average density is too vague. Suggest some surrogate for biomass, compared to the impacted area.	no	This level of specificity would be determined at a later date with development of mitigation bank	
25	VI.C.5 (mitigation option 1)	USACE and USEPA do not have the authority to establish an eelgrass mitigation bank that would benefit (be used by) all LTMS dredgers. Any authority to create a bank would most likely be limited to mitigation for USACE projects.	no	Comment does not affect language included in programmatic- rather is relevant to USACE/USEPA final response	
26	VI.C.5 (mitigation option 1)	Has there been success in establishing such a large eelgrass bed through current restoration efforts in the bay? We recognize the value of larger habitats, but are concerned about feasibility, is it possible that smaller beds could additively address the 20 acres?	yes	Bank(s) is used in document	
27	VI.C.5.a (mitigation option 2)	Please clarify how far outside of the project area needs to be mapped in the surveys.	yes	Clarified project-by-project determination depending on site specific conditions	
27	VI.C.5.a (mitigation option 2)	Suggest that 'and other appropriate agencies' be inserted after NMFS; as other agencies are required to approve eelgrass mitigation plans.	no	USACE/USEPA can add to conditions, but don't want to make this a part of NMFS' CR	

Specific comments- NMFS responses					
Page	**Section**	**Comment**	**Change made**	**NMFS Response**	**Requested information provided/action taken**
27	VI.C.5.a (mitigation option 2)	Providing information 'within 30 days of the star of dredging activities' can be interpreted in different ways. Perhaps better to state in the 30 days before or after the start…	no	This is standard NMFS language	
27	VI.C.5.b (mitigation option 2)	Please insert 'as appropriate' after 'strictly employed'.	yes	Change made	
27	VI.C.5.c (mitigation option 2)	Please specify the number of buoys and the distance they are apart.	no	Too specific, these should be determined as appropriate on project-by-project basis.	
27	VI.C.5.d (mitigation option 2)	Please specify 'adversely impacted eelgrass'. This may be difficult to ascertain. What level of pre-dredge survey should there be to serve as 'control'.	no	Too specific, these should be determined as appropriate on project-by-project basis.	
27	VI.C.5.c (mitigation option 2)	Regarding 'no dredging equipment will be located, temporarily or at anchor, in eelgrass areas outside the project footprint.' There may be cases where there is no other option; such as when an empty scow is being maneuvered to replace a full scow and has no other place to be temporarily located. Suggest stating	yes	Change made to clarify	

Specific comments- NMFS responses					
Page	**Section**	**Comment**	**Change made**	**NMFS Response**	**Requested information provided/action taken**
		that such an activity shall be avoided to the maximum extent possible.			
27	VI.C.5.d (mitigation option 2)	Please clarify what is meant in this statement – is it any further mitigation plans? This implies that already approved mitigation plans can be changed.	yes	Change made to clarify	
28	VI.D.6	Regarding formalizing the restriction against placing dredged material in bay when it fails to meet benthic toxicity tests – please see USACE Public Notice 01-01, paragraph 7.5.1, which states that unsuitable dredged material cannot be placed in bay. Further, this is already required under USEPA and USACE national policy (see 401(b)(1) guidelines at 40 C.F.R. 230.60 (subpart G). The national Inland	yes	Thank you for clarifying that sediments that fail toxicity bioassays for acute mortality will not be placed in-Bay in an unconfined manner that exposes EFH. We will note this clarification in our analysis and remove the recommendation.	

Specific comments- NMFS responses					
Page	**Section**	**Comment**	**Change made**	**NMFS Response**	**Requested information provided/action taken**
		Testing Manual and local guidance further addresses when and how 'toxicity' is determined on a case-by-case basis. Per these regulations and guidance, unconfined aquatic placement is not allowed for any material failing the toxicity bioassays.			
28	VI.D.6	DMMO can develop more specific guidance for when bioaccumulation testing is required, in accordance to the existing regulations and manuals; however, exceeding ambient levels is not by itself always a sufficient basis for requiring bioaccumulation testing for all compounds, or even the specific compounds listed, in order to reach in-bay suitability requirements.	yes	Comment addressed via subsequent discussion. Original recommendation altered to its current form. Please respond to the current recommendation.	
28	VI.D.6	Sediment testing in the LTMS area generally does not include sublethal effects from growth or development tests. Sublethal tests appropriate	yes	Comment addressed via subsequent discussion. Original recommendation altered to its current form. Please respond to the	

Specific comments- NMFS responses					
Page	**Section**	**Comment**	**Change made**	**NMFS Response**	**Requested information provided/action taken**
		for nationwide use have not yet been identified by USEPA and USACE.		current recommendation.	
28	VI.D.8 (Residuals)	DMMO can develop more specific guidance regarding where we require residuals to be measured and what constitutes an 'elevated' residual (not always just 'ambient' for all the compounds) and when site-specific evaluation of whether an elevated residual represents a risk that must be addressed with active measures (under another program, see below). (removal or capping of sediments). Case-by-case evaluation of whether the new surface represents a significant risk is needed to determine this, in consideration of actual site-specific exposure, in addition to contaminant concentrations. There	yes	Comment addressed via subsequent discussion. Original recommendation altered to its current form. Please respond to the current recommendation.	

Specific comments- NMFS responses					
Page	**Section**	**Comment**	**Change made**	**NMFS Response**	**Requested information provided/action taken**
		are specific programs (*e.g.*,, under CERCLA, CWA and Porter-Cologne) designed to identify whether and when a site constitutes a 'hot spot' that requires remediation. When the DMMO identifies locations where dredging would expose very high concentrations of contaminants (even if localized), that information is passed along and the DMMO processing of the dredging approval either ceases until those programs have made their determinations, or DMMO works directly with the programs to ensure the process and decisions are consistent.			
29	V*I.E.,*10	The working group should establish its own working plan, which may include a literature review first.	no	Draft language is clear enough	
29	V*I.E.,*10	Suggest that the final statement in this paragraph state that USACE and USEPA will 'investigate alternative measures' rather than 'will develop'; understanding that spending funds may or may not exist.	no	NMFS disagrees with suggested language change	
29	VI.F.12	Suggest reporting requirements should be changed from 30 days to 90 days post calendar year. The	yes	Change made.	

Specific comments- NMFS responses					
Page	**Section**	**Comment**	**Change made**	**NMFS Response**	**Requested information provided/action taken**
		agencies don't often receive the post dredge surveys within 30 days.			
30	Literature Cited	Use of Abbott & Bing-Sawyer – this 8-year old draft report may not be an appropriate reference.	no	Please provide reference	No additional information provided.
34	Literature Cited	Merkel 2004 – please reference the later Merkel studies, even if in preparation.	no		
34	Literature Cited	Rich, A. A. 2007 is not an acceptable reference, since it was not released.	yes	Rich 2007 removed. Please provide reference	No additional information provided.
35	Literature Cited	Setchell 1929 – please check spelling of *phonological*	yes	Change made	
38	Table 1	Please mention the Brooklyn Basin federal dredging project on this table (it is included in the Oakland Harbor federal dredging project footprint).	no	Project names listed in the document were provided by USACE in EFH assessment, lat/longs were provided so that discrepancies in different project names could be elucidated	
45	Table 5	Does the USACE dredging of sand area include the Main Ship Channel? Also, Conoco Philips (non-federal) is sand and the acres should be included in this table.	yes	Table 5 does not include the Main Ship Channel. Clarification added to text. Conoco Philips was listed in the EFH Assessment provided by the USACE/USEPA as sediment type "sand/mud" and was thus incorporated into the "fines" category for this analysis (see section IV.B.1.a for definition of categories). If documentation is provided that this project fits the "sand" category the table will be	No additional information provided.

Specific comments- NMFS responses					
Page	**Section**	**Comment**	**Change made**	**NMFS Response**	**Requested information provided/action taken**
				adjusted.	
46	Table 6	Does the Sausalito Bay Model dredging project (federal) in Richardson Bay affect eelgrass? If so, please include it on this table.	no	Sausalito Bay Model is included in analysis, and based on Merkel 2003/2009 eelgrass GIS layer, no acreage overlaps with this dredge footprint	
46	Table 6	Due to the depth clipping, there may be an error in the assumption that dredging the federal Richmond Harbor would directly affect 0.003 acres of eelgrass.	no	This is accurate.	
46	Table 6	Please clarify 'San Francisco Harbor' in this table – is it the Main Ship Channel, Islais Creek?	no	SF Harbor is not the Main Ship Channel; Project names listed in the document were provided by USACE in EFH assessment, lat/longs were provided so that discrepancies in different project names could be elucidated	
46	Table 6	It would be clearer to make two separate tables for dredging projects with indirect and direct effects on eelgrass.	no	NMFS disagrees	

Specific comments- NMFS responses					
Page	**Section**	**Comment**	**Change made**	**NMFS Response**	**Requested information provided/action taken**
47	Appendix 1, 3rd paragraph	Suggest discussing that the LTMS goal is to maximize beneficial use of sediment and minimize in-bay placement, while maintaining the SF-DODS site as a backup. The *minimum* for beneficial use of dredged material is 40 percent. Further, the goal for the maximum volume placed in-Bay after 2012 is 1.2 mcy.	yes	Some changes made to text in this section.	
47	Appendix 1, 3rd paragraph	The last statement in this paragraph may not be true.	no	We assume that the statement in question is "These two documents combine to produce an effects-based testing program that frequently requires proposed dredging projects to generate chemical specific concentration data for a proposed project." The fact that the action agencies are not sure if this statement is true or not reflects the uncertainties in the inadequate Biological Assessment prepared for this project. It did not include a SF Bay specific presentation of when this data generation is triggered or an analysis of how much dredging is approved with and without effects-based testing (*i.e.*, tier I v. tier II and III projects).	
48	Appendix 1	Please provide a reference for	yes	Hansen et al. (1999a and 1999b) found that	

Specific comments- NMFS responses					
Page	**Section**	**Comment**	**Change made**	**NMFS Response**	**Requested information provided/action taken**
		Elevated levels of contaminants may cause species to leave the impacted area for a period of time.		salmon will actively avoid dCu at levels 2 ug/L above background, if their olfactory abilities are not yet impaired. Hansen, J.A., J.C.A. Marr, J. Lipton, D. Cacela, and H.L. Bergman. 1999a. Differences in Neurobehavioral Responses of Chinook salmon (Oncorhynchus tshawytscha) and Rainbow Trout (Oncorhynchus mykiss) exposed to copper and cobalt: Behavioral Avoidance. Environ. Toxicol. Chem. 18:1972-1978. Hansen, J.A., J.D. Rose, R.A. Jenkins, K.G. Gerow and H.L. Bergman. 1999b. Chinook salmon (Oncorhynchus tshawytscha) and Rainbow Trout (Oncorhynchus mykiss) Exposed to Copper: Neurophysiological and histological effects on the olfactory system. Environ. Toxicol. Chem. 18:1979-1991. There are numerous references for fish, particularly salmonids avoiding areas of low dissolved oxygen and higher suspended sediment concentrations. Low DO related to dredging would come from elevated ammonia concentrations in the dredged material	

Specific comments- NMFS responses					
Page	**Section**	**Comment**	**Change made**	**NMFS Response**	**Requested information provided/action taken**
				oxydixing to nitrate.	
49	Appendix 1	Regarding USACE *et al* 2009 and *This seems to be a sound system to import to the San Francisco Bay* – The approach used in the Pacific Northwest is based on a unique region-specific data set, as well as on a promulgated sediment quality criteria. California does not have any similar database or regulation in place at the moment. In fact, the CA sediment quality objectives being developed specifically do not apply to management of dredged material or dredged material placement sites, either in a technical or policy manner. The Pacific Northwest system cannot simply be imported to San Francisco Bay.	no	Comment addressed via subsequent discussion. Original recommendation altered to its current form. Please respond to the current recommendation.	
52	Appendix 1	Please provide a discussion of the sites that were sampled in SF Bay and compared to fish control in Bodega Bay.	no	NMFS can provide the action agencies with a copy of the study for their information if they can not procure one using the information in the bibliography.	
56/51	Appendix 1	Please clearly differentiate between	no	Comment addressed via subsequent	

Specific comments- NMFS responses					
Page	**Section**	**Comment**	**Change made**	**NMFS Response**	**Requested information provided/action taken**
		mercury, methylmercury and reactive mercury; they have widely different toxicities, bioaccumulation rates, and implications for dredging and dredged material placement. Further, methylmercury is generally not an issue in subtidal areas.		discussion.	
53	Appendix 1	Please provide a discussion of the studies that were developed since 1980s and the more recent studies. Who developed these studies?	no	This comment is unclear. This section discusses and references numerous studies that are available to the action agencies. This section also references several sediment screening guideline systems and databases (*e.g.*, ER-L and ER-Ms, TELs and PELs, etc.) which are routinely considered by the action agencies. Studies which are more recent than the sediment screening database references (*e.g.*, Kelley and Reyes 2009, the Incardona et al work, etc) are by definition not included in generating the screening guidelines.	