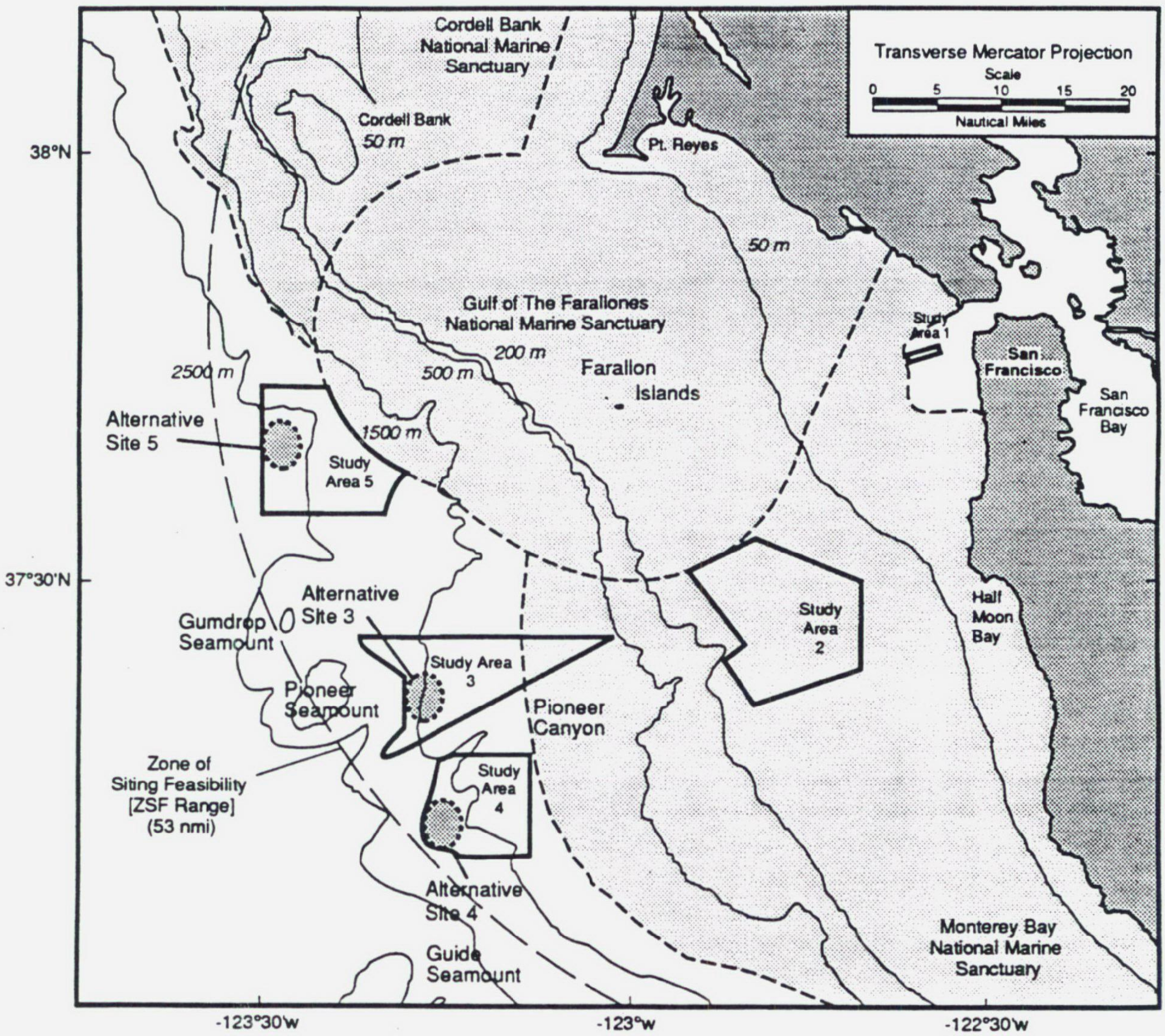
FINAL

Environmental Impact Statement (EIS) for Designation of a Deep Water Ocean Dredged Material Disposal Site off San Francisco, California

August 1993



EPA

U.S. Environmental Protection Agency
Region IX, 75 Hawthorne Street, San Francisco, CA 94105

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August 1993

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FINAL
ENVIRONMENTAL IMPACT STATEMENT
FOR DESIGNATION OF A
DEEP WATER
DREDGED MATERIAL DISPOSAL
SITE OFF SAN FRANCISCO, CALIFORNIA

U.S. Environmental Protection Agency
Region IX
San Francisco, California

Comments on this administrative action should be addressed to:

Mr. Harry Seraydarian, Director
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U.S. Environmental Protection Agency
75 Hawthorne Street
San Francisco, California 94105

Comments must be received no later than:

October 29, 1993, 45 days after publication of the notice of availability in the Federal Register for the FEIS.

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ABSTRACT

This environmental impact statement (EIS) evaluates the proposed designation of a deep-water ocean dredged material disposal site as part of the Long-Term Management Strategy (LTMS) for San Francisco Bay, California. The LTMS is a Federal and State partnership responsible for addressing options for dredged material disposal, including ocean sites, sites within the Bay, nonaquatic/reuse sites, and beneficial uses of dredged material. Once designated, the proposed ocean site will provide a disposal option for an estimated 6 million yd^3 per year of dredged material over a 50-year period. Before ocean disposal may take place, proposed projects must demonstrate a need for ocean disposal and material must be acceptable according to U.S. Environmental Protection Agency and U.S. Army Corps of Engineers criteria and regulations.

The preferred alternative site (Alternative Site 5) is located on the continental slope off San Francisco approximately 50 nautical miles (nmi) from shore and in 2,500 to 3,000 m of water. Selection of the preferred alternative site, as compared to two alternative ocean sites (Alternative Sites 3 and 4) and the No-Action alternative, is based on evaluation of the 5 general and 11 specific criteria of the Ocean Dumping Regulations listed at 40 CFR sections 228.5 and 228.6, respectively. Alternative Site 5 was chosen as the preferred alternative site primarily because, in contrast to the other alternative sites, it is located in deeper waters away from productive fishery areas and in an area that has been used historically for disposal of low-level radioactive waste and chemical and conventional munitions.

Use of the site is not expected to cause any significant long-term adverse environmental effects outside of site boundaries. Within the site, sediment composition will be altered and benthic infaunal and epifaunal communities will be affected due to burial and smothering by dredged material. However, because this site is located in deep water where organism abundances are low, impacts are expected to be minimal. Potential impacts on water quality, plankton communities, pelagic invertebrates, pelagic and demersal fishes, marine birds, marine mammals, threatened and endangered species, and marine sanctuaries are expected to be insignificant. Similarly, potential impacts to socioeconomic resources, such as commercial and recreational fishing, military and commercial shipping, oil and gas or other mineral development, or cultural and historical resources, are expected to be insignificant due to the distance offshore of the preferred alternative site and minimal resource use in this area.

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ACSAR	Atlantic Continental Slope and Rise Program (U.S.)
ADCP	acoustic doppler current profiler
AEC	Atomic Energy Commission
ASBS	Area of Special Biological Significance
BART	Bay Area Rapid Transit
BCDC	Bay Conservation and Development Commission
BFBA	Bay Farm Borrow Area
CalCOFI	California Cooperative Oceanic Fisheries Investigations
CBNMS	Cordell Bank National Marine Sanctuary
CCC	California Coastal Commission
CDFG	California Department of Fish and Game
CEQ	Council on Environmental Quality
CEQA	California Environmental Quality Act
CFR	Code of Federal Regulations
CHASE	Cut Holes and Sink 'Em
CMDA	chemical munitions dumping area
CO	carbon monoxide
CODE	Coastal Ocean Dynamics Experiment
COE	Corps of Engineers (U.S. Army)
CSWRCB	California State Water Resources Control Board
CWA	Clean Water Act
CZMA	Coastal Zone Management Act
CZMPs	California Coastal Zone Management Plans
DDD	dichlorodiphenyldichloroethane
DDE	dichlorodiphenyldichloroethylene
DDT	dichlorodiphenyltrichloroethane

DEIS	Draft EIS
Eh	redox potential
EIR	Environmental Impact Report
EIS	Environmental Impact Statement
ENSO	El Niño/Southern Oscillation
EPA	Environmental Protection Agency (U.S.)
ESA	Endangered Species Act (Federal)
FEIS	Final EIS
FR	Federal Register
FWS	Fish and Wildlife Service (U.S.)
GOFNMS	Gulf of the Farallones National Marine Sanctuary
INPFC	International North Pacific Fisheries Commission
kg	kilogram(s)
km	kilometer(s)
LDC	London Dumping Convention
LSM	least-squares mean
LTMS	Long-Term Management Strategy
MB	Monterey Bay
MBNMS	Monterey Bay National Marine Sanctuary
mCi	millicurie(s)
MD	mid-depth
MMPA	Marine Mammal Protection Act
MMS	Minerals Management Service
MPRSA	Marine Protection, Research and Sanctuaries Act
NDBC	National Data Buoy Center
NEPA	National Environmental Policy Act
NESS	Normalized Expected Species Shared
NMFS	National Marine Fisheries Service
nmi	nautical mile(s)
NMS	National Marine Sanctuary(ies)

NO_2	nitrogen dioxide
NOAA	National Oceanic and Atmospheric Administration
NODS	Navy Ocean Disposal Site
NO_x	oxides of nitrogen
NS&T	National Status & Trends
OAQPS TTN	Office of Air Quality, Planning and Standards Technology Transfer Network Bulletin Board System
OCS	Outer Continental Shelf
ODMDS	ocean dredged material disposal site
ODSS	Ocean Dumping Surveillance System
OMZ	oxygen minimum zone
OSC	Oakland Scavenger Company
PAH	polynuclear aromatic hydrocarbon(s)
PC	Pioneer Canyon
PCBs	polychlorinated biphenyls
pCi	picocurie(s)
PDEIS	preliminary draft EIS
PM	particulate matter
ppb	parts-per-billion
ppm	parts-per-million
ppt	parts-per-thousand
PRBO	Point Reyes Bird Observatory
ROV	remotely operated vehicle
RPD	redox potential discontinuity
RWQCB	Regional Water Quality Control Board
SFBRWQCB	San Francisco Bay Regional Water Quality Control Board
SHPO	State Historic Preservation Officer
SO_2	sulfur dioxide
SWOOP	Southwest Ocean Outfall Project
T-S	temperature-salinity

TSS	total suspended solids
USCG	United States Coast Guard
USFWS	United States Fish and Wildlife Service
USGS	United States Geological Survey
USN	United States Navy
USSC	United States Steel Corporation
VOC	volatile organic compound(s)
VTS	Vessel Traffic Service (San Fransisco)
yd^3	cubic yard(s)
ZSF	zone of siting feasibility
μ	micro

Unit Conversion Table (Metric System with U.S. Equivalents)

Metric Unit	U.S. Equivalent(s)
Length/Depth	
millimeter (mm)	0.039 inches (in)
centimeter (cm)	0.39 inches (in)
meter (m)	39.37 inches (in)
	3.28 feet (ft)
	0.55 fathoms (fm)
kilometer (km)	0.62 statute miles (mi)
	0.54 nautical miles (nmi)
Area	
square centimeter (cm^2)	0.155 square inches (in^2)
square meter (m^2)	1.196 square yards (yd^2)
square kilometer (km^2)	0.3861 square statute miles (mi^2)
	0.292 square nautical miles (nmi^2)
hectare (ha) = 10,000 m^2	2.471 acres
Volume	
cubic centimeter (cm^3)	0.061 cubic inches (in^3)
milliliter (ml)	
cubic meter (m^3)	1.31 cubic yards (yd^3)
liter (l)	61.02 cubic inches (in^3)

Metric Unit	U.S. Equivalent(s)
Mass	
gram (g)	0.035 ounces (oz)
1,000 milligram (mg)	
kilogram (kg)	2.2046 pounds (lb)
metric ton (MT)	1.1 tons
	2,205 pounds (lb)
Speed	
centimeter per second (cm/sec)	0.02 knots (kn)*
meter per second (m/sec)	1.94 knots (kn)
	2.24 statute miles per hour (mi/hr)
kilometer per hour (km/h)	0.54 knots (kn)
Temperature	
degree Celsius (°C)	degree Fahrenheit (°F) = (1.8 x °C) + 32
0°C	32°F (freezing point of water)
100°C	212°F (boiling point of water)

*1 knot (1 nautical mile per hour) equals 1.15 statute (land) miles per hour.

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EXECUTIVE SUMMARY

S.1 Introduction

This Final Environmental Impact Statement (FEIS) evaluates the proposed designation of a deep water ocean dredged material disposal site (ODMDS) off San Francisco, California (Figure S-1). The U.S. Environmental Protection Agency (EPA), Region IX, is issuing this EIS in accordance with Title I of the Marine Protection, Research, and Sanctuaries Act (MPRSA), and as required by EPA's national policy on the designation of ocean disposal sites (39 FR 37119, October 21, 1974).

The EIS has been prepared in coordination with other components of the Long-Term Management Strategy (LTMS) for San Francisco Bay, an effort led by a Federal and State partnership consisting of EPA, U.S. Army Corps of Engineers (COE), the San Francisco Bay Regional Water Quality Control Board (SFBRWQCB), and the San Francisco Bay Conservation and Development Commission (BCDC). An LTMS goal is to provide "timely, technically feasible, cost-effective, and environmentally acceptable disposal alternatives for dredged material." Disposal options, including sites within the Bay, nonaquatic/reuse sites, and ocean disposal sites, as well as beneficial uses of dredged material are being developed by the LTMS.

An ODMDS is required to fulfill the LTMS objective of a range of disposal options for sediments dredged from San Francisco Bay. Presently, no ocean disposal site is available to accept this dredged material. Maintenance dredging of channels and expansion of dock capacities are essential to sustain economic growth and strategic use of the ports. An estimated 6 million yd^3 per year and a total of 400 million yd^3 of dredged material could be disposed at the ODMDS over the next 50 years.

The specific goal of this EIS is to provide an acceptable ocean disposal site which will not cause unreasonable degradation of the ocean with respect to human health and the marine environment. Other non-ocean alternatives are being addressed by the LTMS In-Bay Work Group and the Nonaquatic/Reuse Work Group. The suitability of alternative sites for ocean disposal is evaluated according to 5 general and 11 specific site-selection criteria (40 CFR 228). Criteria for evaluating changes to conditions within and adjacent to the ODMDS associated with dredged material disposal, as indicated by results from site monitoring, are presented separately in the Site Management and Monitoring Plan (SMMP).

Information contained in this EIS is used to characterize the physical, biological, and socioeconomic environments (Section S.2) and evaluate the potential environmental consequences of dredged material disposal at the preferred alternative (Alternative Site 5) and two alternative sites (Alternative Sites 3 and 4) (Section S.3). The environmental characteristics and potential

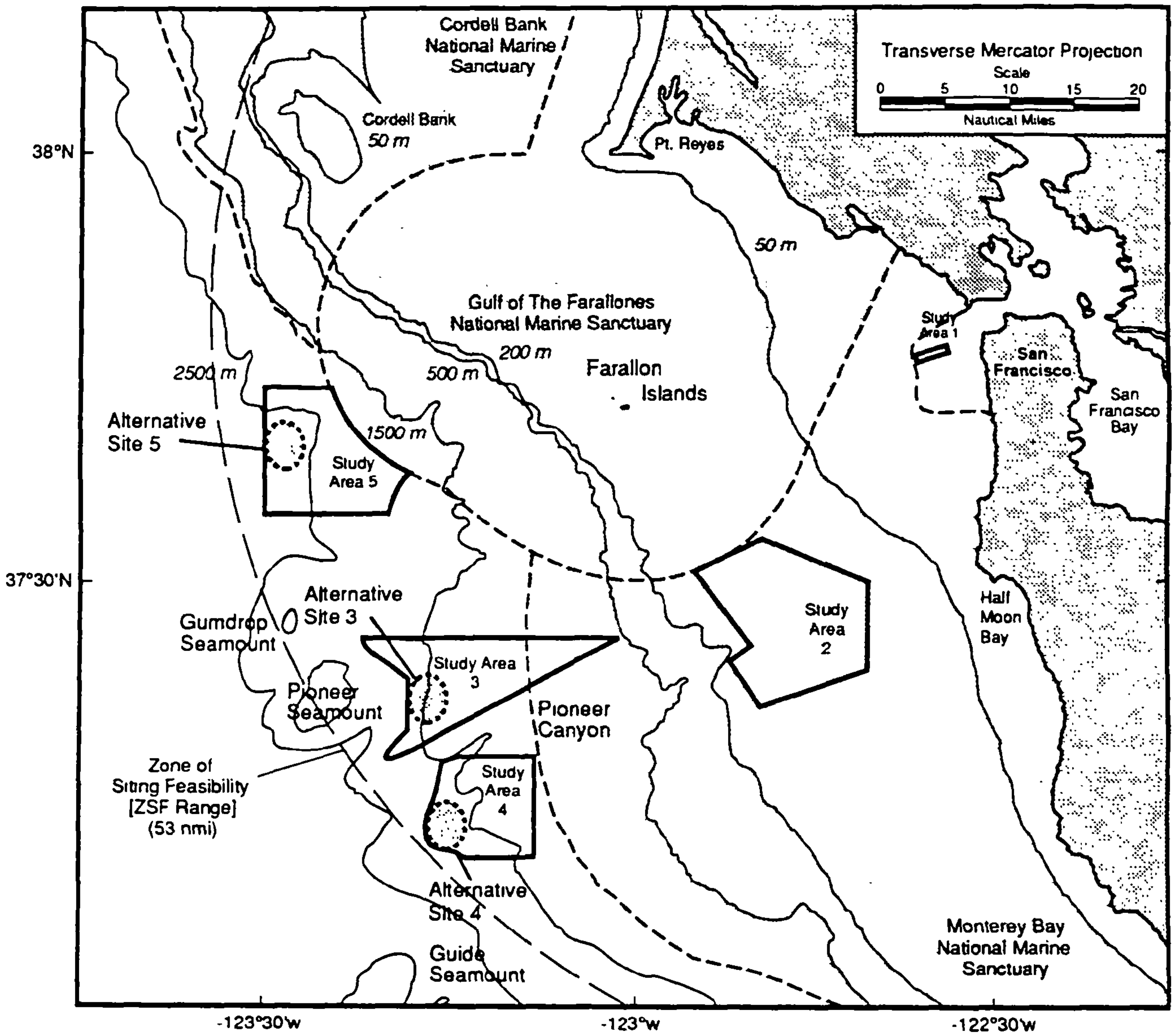

Figure S-1. **Locations of Study Areas and Alternative Sites in the LTMS Study Region.**

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disposal-related impacts are compared and evaluated according to the five general and eleven specific site-selection criteria (Section S.4).

Based on this information, the proposed action is to designate Alternative Site 5 (Figure S-1) as the ODMDS to receive dredged material from San Francisco Bay, in accordance with LTMS objectives. The designated site can only be used for the disposal of dredged material from Federal projects and permit applications that meet EPA and COE criteria and regulations. The site will not be used for disposal of industrial or municipal wastes.

S.2 Affected Environment

The following sections summarize the physical, biological, and socioeconomic environments of the preferred and alternative sites.

S.2.1 Physical Environment

The preferred and alternative ocean disposal sites are located on the continental slope off San Francisco (Figure S-1). The size and configuration of the sites are similar with an oval shape of dimensions of approximately 3.7 nmi (6.9 km) long and 2.2 nmi (4.1 km) wide. Alternative Site 3 is located in the western part of Study Area 3 (depths ranging between 1,400 and 1,900 m), south of the Gulf of the Farallones National Marine Sanctuary (GOFNMS), north of Pioneer Canyon, and approximately 47 nmi from the Golden Gate. Alternative Site 4 is located in the southwestern part of Study Area 4 (depths ranging between 1,900 and 2,100 m), approximately 55 nmi from the Golden Gate and 15 nmi SE of Pioneer Seamount. Alternative Site 5 (the preferred alternative) is located on the lower continental slope (depths between 2,500 and 3,000 m), approximately 49 nmi from the coast and 50 nmi from the Golden Gate.

The coastal environment off San Francisco has a maritime climate, characterized by a general lack of weather extremes, with cool summers and mild, wet winters. Fog occurs off the coast throughout the year, but is most persistent during summer. Winds are an important influence on water column characteristics and currents over the continental shelf and upper continental slope. Strong north and northwest winds in spring and early summer promote offshore-directed flow of surface waters and upwelling.

Current flow in the vicinity of Alternative Site 3 is primarily to the northwest in the upper 800 to 900 m of the water column, although periodic reversals in flow occur. Currents below 1,000 m are generally weaker than near-surface currents, while the direction and velocity of near-bottom flows are affected by tidal influences and topography. Similar trends in current flows occur in Alternative Sites 4 and 5. Considerable seasonal variability in surface water temperature and salinity reflect large-scale current patterns, outflow from the Bay, and small-scale flow features. Although the site-specific data are limited, the existing water quality conditions, including dissolved oxygen, suspended particle concentrations, trace chemical constituent concentrations, and turbidity levels, at all alternative sites likely are similar.

Sediments at Alternative Site 3 are mostly silt-sized particles, while sediments at Alternative Site 4 comprise mostly sand and silt-sized particles, and sediments at the preferred alternative site comprise mainly fine-grained silts and clays. All of the sites are characterized by background or low concentrations of chemical constituents. No known hard-bottom areas occur within any of the sites.

S.2.2 Biological Environment

The preferred alternative site is characterized by somewhat lower infaunal diversity and abundance than Alternative Sites 3 or 4. The number of species and abundances of megafaunal invertebrates at Alternative Site 5 is moderate, with sea cucumbers, brittlestars, and sea pens predominating. Some species of midwater fishes, such as juvenile rockfishes, have higher seasonal abundances at the preferred alternative than at Alternative Sites 3 or 4. Based on limited data on plankton communities and other midwater species, there do not appear to be any significant differences among the sites. The preferred alternative site has relatively higher apparent use by marine birds and mammals as compared to Alternative Sites 3 and 4.

Alternative Site 3 is characterized by a diverse and abundant infaunal community comprised of polychaetes, amphipods, tanaids, and isopods. Abundances and species diversity for megafaunal invertebrates is moderate at this site, with sea cucumbers, seastars, and brittle stars predominating. Juvenile rockfishes are seasonally abundant, while marine birds and mammals make moderate use of this site.

Alternative Site 4 is characterized as having a very similar infaunal species composition as Alternative Site 3, but with fewer amphipods. This site also has moderate numbers of species and abundances of megafaunal invertebrates. Juvenile rockfishes use this site seasonally, while marine birds and mammals utilize this site less than Alternative Site 3.

S.2.3 Socioeconomic Environment

The region off San Francisco supports important commercial and recreational fisheries, consisting of a variety of pelagic and demersal fishes and megafaunal invertebrates. However, use of the preferred or alternative sites for commercial and recreational fisheries is minimal due to the great depths and limited resource value. Commercial and recreational catches of pelagic fishes in the vicinity of the sites consist mainly of tunas, mackerels, and some salmon, while commercial catches of demersal fishes consist primarily of flatfishes, such as Dover sole, and rockfishes, such as thornyheads.

The area offshore of San Francisco is one of the nation's largest naval operating zones. However, of the alternative sites, none is located within submarine operating areas or navigational lanes. The potential for conflicts with oil and gas development at any of the sites is extremely low. Although large repositories of oil and gas reserves are located in several areas along and offshore of the California coast, there are no existing or planned oil and gas development activities or structures within the general study region. Current technological limitations preclude such activities at depths greater than approximately 400 m, while bottom depths at the preferred and alternative sites are all greater than 1,400 m. Further, there are no known features of cultural or historical significance within the sites.

S.3 Environmental Consequences

Potential environmental consequences associated with dredged material disposal at the preferred and alternative sites are summarized in Table 4.1-1 (Chapter 4). The impact category and spatial and temporal extents of potential impacts to specific environmental conditions are identified in the table.

Evaluations of potential effects from dredged material disposal on air quality, water quality parameters (suspended particle concentrations), and sea floor conditions (bottom deposit thicknesses) were performed using computer models to simulate disposal at the preferred and alternative sites. Additional information concerning environmental impacts from research and monitoring of other dredged material disposal sites also was used to evaluate potential impacts at these sites.

S.3.1 Physical Environment

Impacts from dredged material disposal operations on air quality, water quality, and geology are considered insignificant. Exhaust emissions from dredged material transport operations would not result in concentrations of air pollutants that exceed State and Federal standards. The water quality model predicted a low probability that fine-grained sediments would reach the boundary of any of the National Marine Sanctuaries following disposal at the preferred or alternative sites. Therefore, potential effects on water quality are considered insignificant. A sediment deposition model predicted that, within the boundaries of the preferred and alternative sites, deposits with thicknesses greater than or equal to 10 cm (100 mm) would cover areas less than 10 km^2. Depending on the characteristics of the dredged material, significant localized changes in the grain size of the bottom sediments would be expected in areas with the highest deposition. However, according to the deposition model calculations, no measurable deposition and alteration of bottom sediments would occur within the sanctuaries. Significant impacts on sediment quality in any area are not expected given that the dredged material must be tested and determined suitable, according to EPA and COE testing criteria, for disposal in the ocean.

S.3.2 Biological Environment

Impacts on infauna, epifauna, and fishes at deep-water sites are expected to occur over a wider area than at shallow shelf sites because of greater sediment dispersal in the water column before it reaches the bottom. The benthic community would be affected similarly by dredged material disposal at the preferred or alternative sites as a result of smothering of some organisms and alteration of sediment characteristics. However, these impacts are expected to occur only in areas with depositional thicknesses equal to or greater than 10 cm. Areas with depositional thicknesses less than 10 cm would not be expected to incur significant changes in abundance or diversity of infauna, epifauna, or demersal fishes. Impacts on water column organisms such as plankton, pelagic fishes, pinnipeds, and cetaceans are expected to be minimal and temporary at the preferred and alternative sites. Further, exposure of marine organisms to dredged material is not expected to result in significant adverse effects because all dredged material must be determined to be suitable for ocean disposal according to EPA and COE testing criteria.

S.3.3 Socioeconomic Environment

At the preferred and alternative sites, it is unlikely that dredged material disposal will interfere with other ocean uses, including shipping, fishing, and recreation. The effects of disposal activities on commercial and recreational fishing are expected to be temporary and insignificant. Most disposal impacts will occur near the sea bottom, and no significant demersal fisheries exist within any of the alternative sites.

Potential hazards to commercial and recreational navigation resulting from dredged material transport and disposal also are expected to be minimal at the preferred and alternative sites. Dredged material barge transits to the preferred alternative site could cause some interference with commercial, recreational, and scientific boat traffic, particularly near the Farallon Islands. However, this will be mitigated by specifying barge transit routes that avoid the vicinity of the Islands. No existing or planned oil and gas development activities occur within the region, so no impacts on these activities would occur from dredged material disposal. Disposal activities at the preferred or alternative sites should not pose a significant danger or cause interference with military vessels because the number of dredged material barge trips is small compared to the overall volume of vessel traffic in the region.

Similarly, no known cultural or historical resources exist within the preferred or alternative sites, so no effects from dredged material disposal would occur. Potential impacts to human safety would be very low because the number of barge trips is small compared to the overall volume of traffic, and measures such as specifying barge transit routes should avoid interference in the vicinity of the Farallon Islands. As stated in MPRSA, no materials considered to be hazardous may be disposed at an ODMDS. Therefore, the potential for human health hazards is minimal at all the sites.

S.4 Comparison of the Alternative Ocean Disposal Sites With the 5 General and 11 Specific Site Selection Criteria

The preferred alternative (Alternative Site 5) and the two alternative disposal sites (Alternative Sites 3 and 4) are compared to the 5 general criteria listed at 40 CFR 228.5 and the 11 specific site selection criteria listed at 40 CFR 228.6(a). A detailed summary of the 11 site selection criteria is contained in Table 2.2-1 (Chapter 2).

S.4.1 General Selection Criteria

1. **The dumping of materials into the ocean will be permitted only at sites or in areas selected to minimize the interference of disposal activities with other activities in the marine environment, particularly avoiding areas of existing fisheries or shellfisheries, and regions of commercial or recreational navigation.**

The preferred and alternative sites are located in water depths greater than 1,400 m, characterized by sparsely distributed fisheries species of potential commercial value. Use of the sites for dredged material disposal would have minimal effects on existing or potential fisheries or shellfisheries. None of the sites is located within the established precautionary zone, navigation lanes, or submarine operating areas. The additional vessel traffic represented by dredged material barge transits to the alternative sites is considered small compared to overall traffic volumes, therefore representing a negligible potential impact on commercial or recreational navigation.

2. **Locations and boundaries of the disposal sites will be so chosen that temporary perturbations in water quality or other environmental conditions during initial mixing caused by disposal operations anywhere within the site can be expected to be reduced to normal ambient seawater levels or to undetectable concentrations or effects before reaching any beach, shoreline, marine sanctuary, or known geographically limited fishery or shellfishery.**

The preferred and alternative sites are outside of any National Marine Sanctuary boundaries. Modeling results based on conservative parameters indicated low probabilities that dredged material disposed of at the sites would be transported into the sanctuaries. Further, predicted dilution rates would reduce the suspended particle concentrations to normal ambient levels at the sanctuary boundaries. Similarly, use of the sites is unlikely to affect water quality or other environmental conditions at any beach, shoreline, or resource or amenity area. This is due to the large distances offshore and the ability to specify barge transit routes to avoid resources associated with the Farallon Islands. Barge transit routes are specified in the SMMP.

3. **If at any time during or after disposal site evaluation studies, it is determined that existing disposal sites presently approved on an interim basis for ocean dumping do not meet the criteria for site selection set forth in Sections 228.5 through 228.6, the use of such sites will be terminated as soon as suitable alternate disposal sites can be designated.**

Continued use of a designated disposal site will be evaluated as part of the SMMP.

4. **The sizes of ocean disposal sites will be limited in order to localize for identification and control any immediate adverse impacts and permit the implementation of effective monitoring and surveillance programs to prevent adverse long-range impacts. The size, configuration, and location of any disposal site will be determined as a part of the disposal site evaluation or designation study.**

The sizes and configurations of the preferred and alternative sites are based on the results of water quality and deposition modeling studies. Site size will be limited, yet will encompass modeled regions of significant sediment deposition (i.e., greater than or equal to 10 mm). The site locations were chosen to coincide with depositional zones where resuspension and dispersion of dredged material will be minimized and monitoring of long-term effects will be facilitated.

5. **EPA will, wherever feasible, designate ocean dumping sites beyond the edge of the continental shelf and other such sites that have been historically used.**

All of the alternative sites are located beyond the edge of the continental shelf. Historical disposal operations of low-level radioactive wastes and chemical and conventional munitions have occurred in the general vicinity of the preferred alternative site. Additionally, the U.S. Navy is discharging approximately 1.2 million yd^3 of dredged material at the Naval Ocean Disposal Site (NODS), which coincides with the preferred alternative site. In contrast, no historical waste disposal has occurred at Alternative Sites 3 and 4.

S.4.2 Specific Site Selection Criteria

1. **Geographical position, depth of water, bottom topography, and distance from coast.**

The preferred alternative (Alternative Site 5) is located on the lower continental slope at depths ranging between 2,500 and 3,000 m, with a moderately sloping bottom with topographic containment features. Alternative Sites 3 and 4 are located in shallower depths (1,400 to 1,900 m and 1,900 to 2,100 m, respectively) on the continental slope. All alternative sites are located at least 45 miles from the Golden Gate.

2. **Location in relation to breeding, spawning, nursery, feeding, or passage areas of living resources in adult or juvenile stages.**

The preferred and alternative sites contain low numbers of fish species and abundances (as compared to inshore areas) and moderate numbers of megafaunal invertebrate species and abundances. The preferred alternative has higher use by some organisms, such as marine birds and mammals and some midwater fishes, but relatively lower diversity and abundances of infauna compared to Alternative Sites 3 and 4.

3. **Location in relation to beaches and other amenity areas.**

All alternative sites are located at least 45 nmi from any coastal resources and approximately 10 nmi or more from any National Marine Sanctuaries. Based on water quality modeling results, concentrations of sediment particles transported across sanctuary boundaries will be within the range of normal background levels.

4. **Types and quantities of wastes proposed to be disposed of, and proposed methods of release, including methods of packing the waste, if any.**

Up to 6 million yd^3 per year of predominantly silt and clay material dredged from San Francisco Bay could be disposed at the ODMDS. Disposal most likely will be from split hull barges. The total amount of dredged material disposed over a 50-year period could total 400 million yd^3. No dumping of toxic materials or industrial or municipal wastes would be allowed at the site.

5. **Feasibility of surveillance and monitoring.**

The USCG has surveillance responsibility at the designated site. Physical, chemical, and biological sampling is possible at all alternative sites. However, the preferred alternative is the deepest site and, therefore, may be more difficult to monitor compared to Alternative Sites 3 and 4. Additionally, monitoring activities at the preferred alternative site may require special precautions due to previously disposed waste materials.

6. **Dispersal, horizontal transport, and vertical mixing characteristics of the area, including prevailing current direction and velocity, if any.**

At all the sites, ocean currents flow primarily to the northwest in the upper 800 to 900 m of the water column, although periodic reversals in flow occur. Currents below 1,000 m are generally weaker than near-surface currents. Near-bottom current speeds may be influenced by tides and bottom topography. Sediment resuspension and transport is expected to be minimal within all the alternative sites.

7. **Existence and effects of current and previous discharges and dumping in the area (including cumulative effects).**

No current disposal activities occur within Alternative Sites 3 and 4. In contrast, the Navy has received an MPRSA Section 103 permit and is using the NODS for disposal of up to 1.2 million yd^3 of dredged material. In addition, disposal of radioactive waste containers was conducted between 1951 and 1954 in the vicinity of Study Area 5. Chemical and conventional munitions were disposed from approximately 1958 to the late 1960s at the Chemical Munitions Dumping Area, within which the preferred alternative site is located. No residual contamination from either source was detected during recent surveys and disposal of dredged material is unlikely to have any synergistic or additive effects. Dredged material disposal may, in fact, serve to isolate any residual contamination.

8. Interference with shipping, fishing, recreation, mineral extraction, desalination, fish and shellfish culture, areas of special scientific importance and other legitimate uses of the ocean.

Dredged material barge transit to the preferred alternative site could cause minor interference with recreation and scientific boat traffic in the vicinity of the Farallon Islands. However, under normal conditions, no interference is expected. A requirement that barges avoid the Farallones vicinity could minimize potential impacts. EPA and COE are the primary agencies responsible for site management. Specific site conditions and use, including transit routes, are specified in the SMMP. Further, no significant interferences with fishing or shipping would be expected at the preferred alternative site. The potential for interference of dredged material disposal with shipping, fishing, recreation, and areas of special scientific importance also would be minimal at Alternative Sites 3 and 4.

9. Existing water quality and ecology of the site as determined by available data, by trend assessment, or by baseline surveys.

The water quality conditions at the preferred and alternative sites likely are similar. Sediments at all the sites contain low to background concentrations of trace metal and organic contaminants. Ecological characteristics are discussed under site-specific Criterion 2. Potential impacts at any of the sites are expected to be transitory and insignificant.

10. Potentiality for the development of nuisance species at the disposal site.

It is unlikely that nuisance species would recruit to any of the sites due to dredged material disposal. This is based on the significant differences in depth and environment at the preferred and alternative sites compared to the dredging site(s).

11. Existence at or in close proximity to the site or any significant natural or cultural features of historical importance.

There are no known significant natural or cultural features within or in the vicinity of any of the alternative sites.

S.5 Conclusions

Impacts from disposal of dredged material at the preferred alternative site are expected to be minimal for the following reasons:

- Bathymetric and sediment surveys indicate Alternative Site 5 is located in a depositional area which, because of topographic containment features, is likely to retain dredged material which reaches the sea floor;

- No significant impacts to other resources or amenity areas (e.g., marine sanctuaries) are expected to result from designation of Alternative Site 5;

- Existing and potential fisheries resources within Alternative Site 5 are minimal and this site is removed from more important fishing grounds located nearer to Alternative Sites 3 and 4;

- Densities and biomass of demersal fishes and megafaunal invertebrates are estimated to be relatively low compared to those at Alternative Sites 3 and 4;

- Potential localized impacts to bottom-dwelling organisms are considered significant at all of the alternative sites, but the magnitude of the impacts varies because of differences in site-specific densities. Abundances and biomass of demersal fishes and megafaunal invertebrates, and the abundances and diversity of infaunal invertebrates, are lower at the preferred alternative site than at Alternative Sites 3 and 4. Thus, the relative magnitude of impacts at the preferred alternative site are expected to be less than those at the other alternative sites;

- Potential impacts to seabirds, mammals, and midwater organisms are expected to be insignificant regardless of which of the alternative sites is used for dredged material disposal;

- Waste disposal has occurred historically in the vicinity of the site (and disposal of dredged material has occurred as part of the Navy disposal activities at NODS under the MPRSA Section 103 permit).

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CHAPTER 1

INTRODUCTION

1.1 . General Introduction

This Final Environmental Impact Statement (FEIS) evaluates the proposed designation of a deep-water ocean dredged material disposal site (ODMDS) off San Francisco, California. A variety of maintenance dredging and new channel and harbor deepening projects proposed for San Francisco Bay will generate material that will be evaluated for disposal at the ODMDS (COE 1992a). The proposed ODMDS could receive up to 6 million cubic yards (yd^3) of sediments per year over the next 50 years (COE 1992c).

Sediment dredging and disposal are regulated under two federal laws: Title I of the Marine Protection, Research and Sanctuaries Act (MPRSA), and Section 404 of the Clean Water Act (CWA). Both Acts require that a number of alternative methods, including ocean disposal, be evaluated for environmental acceptability prior to disposal. The U.S. Environmental Protection Agency (EPA) and the U.S. Army Corps of Engineers (COE) share responsibility for the management of ocean disposal of dredged material. Under Section 102 of MPRSA, EPA has the responsibility for designating an acceptable location for the ODMDS. With concurrence from EPA, the COE issues permits under MPRSA Section 103 for ocean disposal of dredged material deemed suitable according to EPA criteria in MPRSA Section 102 and EPA regulations in 40 CFR Part 227.

It is EPA's policy to publish an Environmental Impact Statement (EIS) for all ODMDS designations (39 FR 37119, October 21, 1974). A site designation EIS is a formal evaluation of alternative sites in which the potential environmental impacts associated with disposal of dredged material at various locations are examined. The EIS must first demonstrate the need for the proposed ODMDS designation action (40 CFR §6.203(a) and 40 CFR §1502.13) by describing available or potential aquatic and nonaquatic (i.e., land-based) alternatives, and the consequences of not designating a site—the No-Action Alternative. Once the need for an ocean disposal site is established, potential sites are screened for feasibility through the Zone of Siting Feasibility (ZSF) process. Remaining alternative sites are evaluated using EPA's ocean dumping criteria at 40 CFR Part 228 (Table 1.1-1) and compared in the EIS. Of the sites which satisfy these criteria, the site which best complies with these criteria is selected as the preferred alternative for formal designation through rulemaking published in the *Federal Register*.

Formal designation of an ODMDS in the *Federal Register* does not constitute approval for ocean disposal. Designation of an ODMDS provides an ocean disposal alternative for consideration in the review of each proposed dredging project. Ocean disposal is allowed only when EPA and

Table 1.1-1. Five General and Eleven Specific Site Selection Criteria.

General Site Selection Criteria—40 CFR 228.5

(a) The dumping of materials into the ocean will be permitted only at sites or in areas selected to minimize the interference of disposal activities with other activities in the marine environment, particularly avoiding areas of existing fisheries or shellfisheries, and regions of heavy commercial or recreational navigation.

(b) Locations and boundaries of disposal sites will be so chosen that temporary perturbances in water quality or other environmental conditions during initial mixing caused by disposal operations anywhere within the site can be expected to be reduced to normal ambient seawater levels or to undetectable contaminant concentrations or effects before reaching any beach, shoreline, marine sanctuary, or known geographically limited fishery or shellfishery.

(c) If at any time during or after disposal site evaluation studies, it is determined that existing disposal sites presently approved on an interim basis for ocean dumping do not meet the criteria for site selection set forth in Sections 228.5 through 228.6, the use of such sites will be terminated as soon as suitable alternate disposal sites can be designated.

(d) The sizes of the ocean disposal sites will be limited in order to localize for identification and control any immediate adverse impacts and permit the implementation of effective monitoring and surveillance programs to prevent adverse long-range impacts. The size, configuration, and location of any disposal site will be determined as a part of the disposal site evaluation or designation study.

(e) EPA will, wherever feasible, designate ocean dumping sites beyond the edge of the continental shelf and other such sites that have been historically used.

Table 1.1-1. Continued.

Specific Site Selection Criteria—40 CFR 228.6(a)

(1) Geographical position, depth of water, bottom topography, and distance from the coast;

(2) Location in relation to breeding, spawning, nursery, feeding, or passage areas of living resources in adult or juvenile phases;

(3) Location in relation to beaches and other amenity areas;

(4) Types and quantities of wastes proposed to be disposed of, and proposed methods of release, including methods of packaging the waste, if any;

(5) Feasibility of surveillance and monitoring;

(6) Dispersal, horizontal transport and vertical mixing characteristics of the area, including prevailing current direction and velocity, if any;

(7) Existence and effects of current and previous discharges and dumping in the area (including cumulative effects);

(8) Interference with shipping, fishing, recreation, mineral extraction, desalination, fish and shellfish culture, areas of special scientific importance and other legitimate uses of the ocean;

(9) Existing water quality and ecology of the site as determined by available data or by trend assessment or baseline surveys;

(10) Potentiality for the development or recruitment of nuisance species in the disposal site; and

(11) Existence at, or in close proximity to, the site of any significant natural or cultural features of historical importance.

COE determine that the proposed activity is environmentally acceptable according to the criteria at 40 CFR Part 227. Decisions to allow ocean disposal are made on a case-by-case basis through the MPRSA Section 103 permitting process.

Upon application for a permit, an evaluation process, shown diagrammatically in Figure 1.1-1, ensures that the proposed disposal operation conforms to the provisions of EPA's Ocean Dumping Regulations (40 CFR Parts 220, 225, 227-228) and COE's dredged material disposal permit requirements under MPRSA Section 103 (33 CFR Parts 320-330 and 335-338). Material proposed for disposal at the designated ODMDS must conform to EPA's permitting criteria for acceptable quality (40 CFR Parts 225 and 227), as determined from physical, chemical, and bioassay/bioaccumulation testing (EPA and COE 1991). Permits to use a designated ODMDS also can specify the times, rates, and methods of disposal, as well as the quantities, types, and sources of the dredged material.

1.2 Purpose of and Need for Action

The purpose of the proposed action is to provide an ocean disposal site for sediments dredged from San Francisco Bay. Dredging is required to remove millions of cubic yards of accumulated sediments transported by natural processes into San Francisco Bay (COE 1992b). In depositional areas with weak currents, these sediments settle to the bottom, accumulate, and gradually cause portions of the Bay to become shallower. Sediment deposition and accumulation, particularly in the navigation channels and port facilities, may seriously interfere with vessel traffic, vessel loading and unloading, and vessel mooring or storage.

Dredging is needed to maintain over 85 miles of authorized deep and shallow navigation channels in San Francisco Bay that provide vessel access to commercial, recreational, and fishing facilities. The COE (1990a) stated that:

> "Navigation channel maintenance and improvements are essential to the nation's ability to compete effectively in international import/export markets. The San Francisco Bay and estuary act as a critical thoroughfare for the nation's increasing role in Pacific Rim Trade with its numerous ports and intermodal links. As of 1983, the San Francisco Bay Area was the fifth largest export manufacturing center in the United States with export-related employment of over 68,000 and a dollar value of close to 7 billion dollars (Skinkle, 1989). In 1980, trade with the Pacific Rim nations (Japan, Korea, Taiwan, Australia and other countries in the Far East) accounted for one-quarter of the nation's imports/exports—today the share is over one-third and rising (Skinkle, 1989)."

Furthermore, the COE (1992a) concluded that:

> "Dredging needs to continue in order to provide adequate depths for deep and shallow draft vessels serving the commercial and recreational needs of the Bay. Over 4,000 deep draft vessels annually call at container ports, oil and auto facilities, bulk terminals and other facilities throughout the Bay and the inland ports of Sacramento and Stockton. The U.S. Navy and Coast Guard maintain a

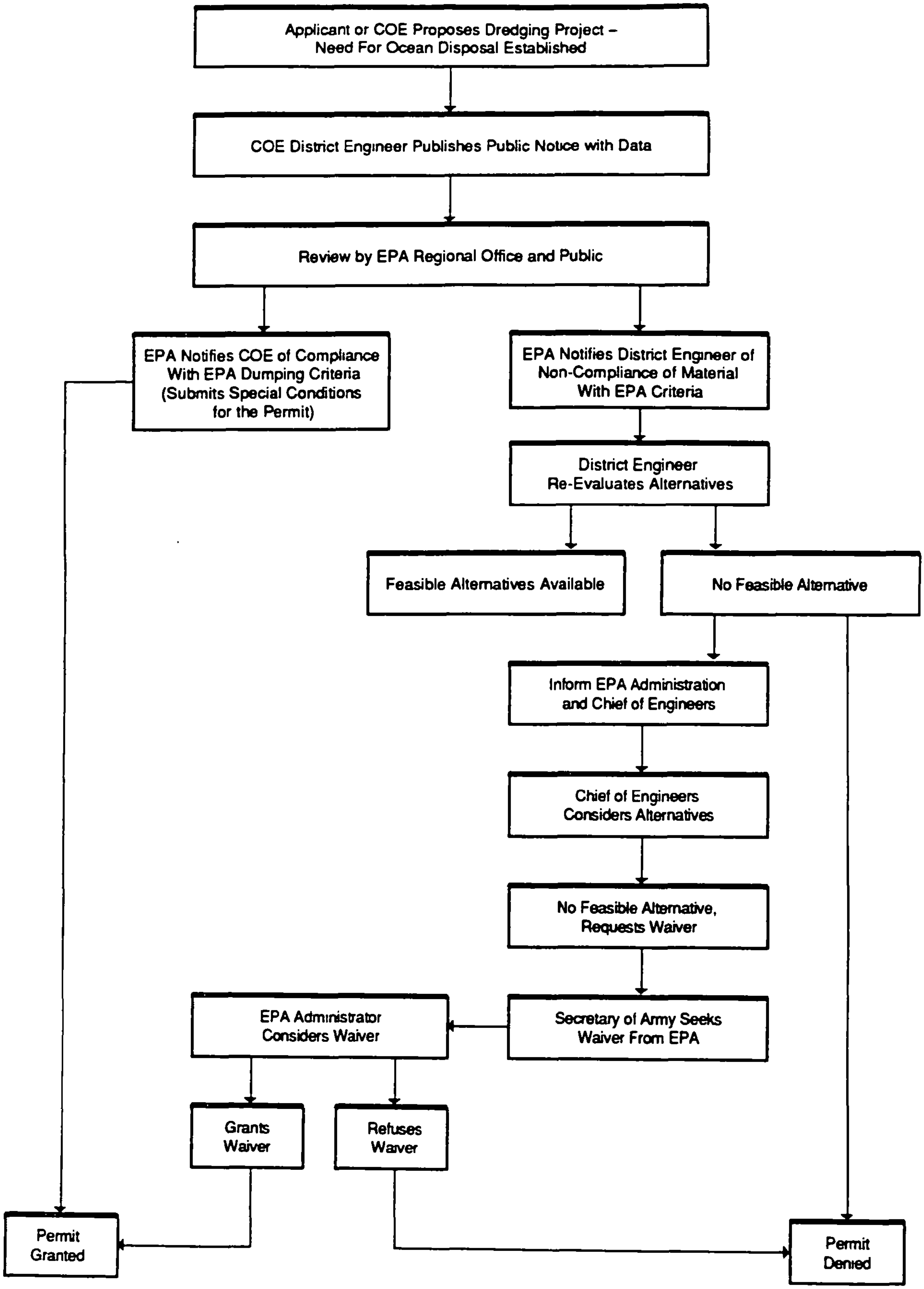

Figure 1.1-1. Evaluation Processes for Dredged Material Permits.

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major presence in the Bay Area and many of their facilities require dredging. Dredging is also required to maintain the depths necessary for shallow draft vessels serving recreational boaters, tourists and ferry riders, commercial fishing and miscellaneous other activities."

Under the Rivers and Harbors Act of 1889, as amended (33 USC Sections 401 *et seq.*), the COE is responsible for maintaining the navigability of major waterways. The COE's maintenance dredging operations throughout the Bay comprise 13 civil works projects that historically have generated approximately 5 million yd^3 per year of dredged material. Other channel-deepening and new work projects have been proposed that would generate additional volumes of dredged material. The annual and projected 50-year volumes for dredging projects within San Francisco Bay are approximately 7.6 million yd^3 and 400 million yd^3, respectively (Table 1.2-1; COE 1992a). Approximately 6 million yd^3 of the 7.6 million yd^3 annual volume is under consideration for disposal at the ODMDS.

Disposal options, including the use of sites within the Bay, nonaquatic sites, and ocean disposal sites, as well as beneficial uses of dredged material are being evaluated as components of the Long-Term Management Strategy (LTMS) for San Francisco Bay (COE 1992a). The goal of the LTMS is "to secure timely, technically feasible, cost-effective, and environmentally acceptable disposal alternatives for dredged material." Evaluations of these alternatives are scheduled for completion in 1994. The LTMS envisions that several options will be available for disposal, depending on the volumes and characteristics of the dredged material and the location of the dredging project. Disposal options are necessary because it is unlikely that a single site can satisfactorily accommodate the planned volumes and characteristics of the dredged material (COE 1990a).

Historically, most sediments dredged from the Bay have been disposed at sites within the Bay. The primary disposal site within the Bay, the Alcatraz Site, is mounding (i.e., shoaling) due to previous disposal practices (COE 1992a). Due to present mounding problems and concerns about potential effects of dredged material disposal on fisheries resources, water quality, and habitat alteration, restrictions have been placed on the use of sites within the Bay (COE 1990a). The present capacities of existing sites within the Bay for dredged material disposal are unknown (COE 1990a). The continued feasibility of dredged material disposal at sites within the Bay is being evaluated by the LTMS In-Bay Work Group.

Nonaquatic sites also have been used historically for the disposal of dredged material from the Bay. Dredged material has been used primarily as fill at these sites, although disposal at nonaquatic sites also can have beneficial effects, such as marsh restoration, creation of wetlands, and levee maintenance. However, nonaquatic sites generally have limited capacities. At present, no sites are available to accommodate the large volume of material projected to be dredged from San Francisco Bay (COE 1992a), although some sites, such as Sonoma Baylands and the Montezuma Wetlands Project, are being developed and other potential sites are under study. The high costs associated with land acquisition and transport, constraints against filling wetlands, and a variable and vaguely defined permitting process complicate the selection of nonaquatic areas

Table 1.2-1. Projected Annual and 50-Year Dredging Volumes for Projects in San Francisco Bay. Dredging Volumes in Cubic Yards.

Project	Annual Volume	50-Year LTMS Volume
COE Maintenance	4,276,000	213,800,000 *
John F. Baldwin New Work		9,000,000
Oakland New Work		7,000,000
Richmond New Work		1,500,000
Navy Maintenance	1,780,000	89,000,000
Navy New Work		1,200,000
Oakland Permit**	140,000	7,000,000
San Francisco Permit**	200,000	10,000,000
Chevron Permit**	196,000	9,800,000
Other Permit**	1,040,000	52,000,000
TOTAL	**7,632,000**	**400,300,000 ***

Source: COE 1992a

*Includes maintenance dredging volumes from new work projects (T. Wakeman, COE, pers. comm. 1992).
**Permit projects are non-Congressionally authorized projects that may include maintenance or new work dredging (T. Wakeman, COE, pers. comm. 1992).

as disposal sites (COE 1990a). The feasibility of dredged material disposal at nonaquatic sites is being evaluated by the LTMS Nonaquatic/Reuse Work Group. Given the lack of capacity at sites within the Bay and nonaquatic sites, the COE (1990a) concluded that "clearly, there exists a shortfall in disposal capacity for the improvement projects scheduled by the USACE [COE], the Navy and the ports for this region."

Presently no ocean disposal site is available to accept dredged material from San Francisco Bay. The Channel Bar Site is a designated ODMDS [40 CFR 228.12(b)(14)]; however, only coarse-grained sediments dredged from the entrance channel to San Francisco Bay are permitted for disposal. Most sediments from San Francisco Bay are fine-grained and, therefore, are not suitable for disposal at the Channel Bar ODMDS (EPA 1982). Thus, although the goal of the LTMS is to provide a range of options that include ocean disposal, presently no ODMDS is available. Designation of an ODMDS for large quantities of dredged material from San Francisco Bay is considered an integral component of the LTMS (COE 1992a). The California State Water Resources Control Board's (SWRCB) resolution 90-37 "places all dredging parties and agencies on notice that failure to reach specific commitments for designation of [such] an ocean disposal site in a timely manner will result in the State Board exercising its full authority regarding water quality certification [for disposal within the Bay]..." Designation, monitoring, and management of an ODMDS are being evaluated by the LTMS Ocean Studies Work Group.

1.3 Proposed Action

The proposed action is the designation of a deep-water ODMDS that could be used for disposal of sediments dredged from San Francisco Bay. This FEIS evaluates three alternative disposal sites, according to the five general and eleven specific criteria promulgated at 40 CFR §228 (Table 1.1-1), as well as the No-Action Alternative, and recommends a preferred alternative. The locations of the alternative disposal sites are shown in Figure 1.3-1. Alternative Sites 3, 4, and 5 are located within LTMS Study Areas 3, 4, and 5, respectively. Alternative Site 5 is the preferred alternative.

Study Areas 3, 4, and 5 are located off the continental shelf. Study Area 3 is south of the Gulf of the Farallones National Marine Sanctuary (GOFNMS), north of Pioneer Canyon, and approximately 47 nautical miles (nmi) from the Golden Gate. Study Area 4 is south of Pioneer Canyon, 55 nmi from the Golden Gate, and between two former explosives disposal areas. Study Area 5 is south of the Cordell Bank National Marine Sanctuary (CBNMS), adjacent to the western side of the GOFNMS, and approximately 50 nmi from the Golden Gate. This study area encompasses a former chemical munitions disposal site and is near a previously used low-level radioactive waste site. Study areas were selected through a screening process which considered proximity to marine sanctuaries and designated areas of special biological significance, vessel traffic lanes, submarine operating areas, Pioneer Canyon, areas with significant hard-bottom features, and sites used historically for disposal of chemical munitions, explosive munitions, and low-level radioactive wastes (EPA 1991; see Chapter 2).

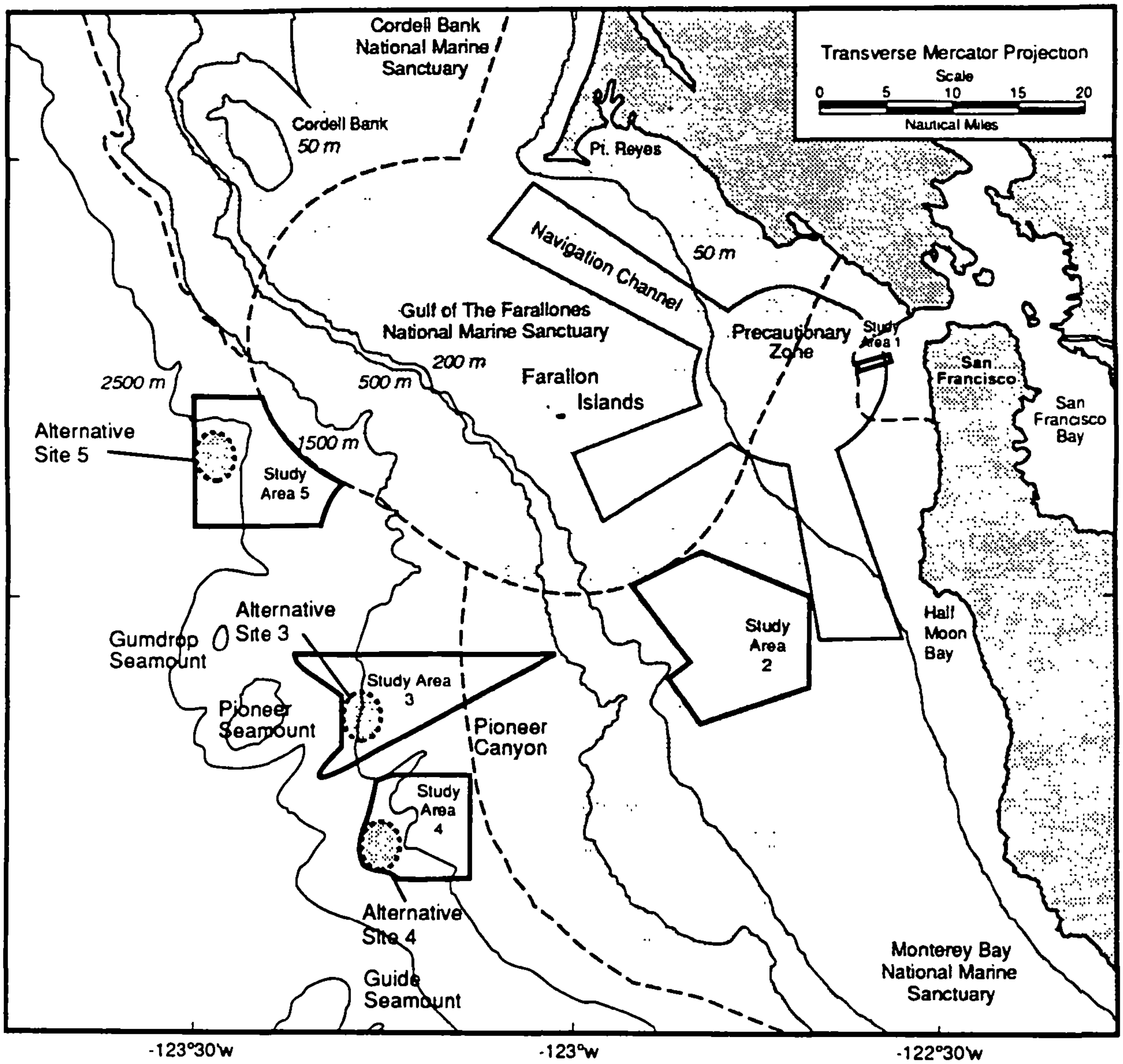

Figure 1.3-1. Locations of Study Areas 1 Through 5 and Alternative Sites 3, 4, and 5 in the LTMS Study Region.

The 50m, 200m, 500m, 1,500m, and 2,500m contours correspond to the 28, 110, 275, 825, and 1,375 fathom contours, respectively.

Alternative sites within each of Study Areas 3, 4, and 5 were delineated from the results of EPA-sponsored surveys at Study Areas 3, 4, and 5 (SAIC 1992b,c; Chin et al. 1992; Karl 1992; Jones and Szczepaniak 1992; Noble *et al.* 1992) and Navy-sponsored surveys at Study Area 5 (SAIC 1991, 1992a; Nybakken et al. 1992; Cailliet et al. 1992). These results are summarized in Chapter 3. Specific portions of these study areas that are characterized as low-energy, depositional zones containing sediments which are similar in grain size to those within the Bay were selected as alternative sites. These conditions are considered important for minimizing dispersion of dredged material and the area of potential impacts. The site sizes and positions of the site boundaries were determined by modeling the fate of dredged material based on simulated discharges over a one-year period (see Chapter 4).

No alternative sites are considered for Study Areas 1 or 2. Study Area 1 corresponds to the Channel Bar ODMDS; however, as noted above and discussed in Chapter 2 of this FEIS, Study Area 1 was dropped from further consideration as an alternative for disposal of dredged material from San Francisco Bay. Study Area 2 is located on the continental shelf, in depths shallower than 180 meters (m), and adjoins the boundary of the GOFNMS. This study area also was dropped from further consideration because it lies within the boundaries of the Monterey Bay National Marine Sanctuary (MBNMS). The Final Rule for MBNMS designation prohibits dredged material disposal at any new ODMDS within the Sanctuary boundaries. Therefore, EPA will not pursue designation of an ODMDS within Study Area 2.

1.4 Areas of Controversy

This section summarizes issues raised during the Public Scoping Meeting, the scoping period, and the LTMS public involvement process (Chapter 5). The general areas of controversy include:

- Proximity of the ODMDS to national marine sanctuaries (NMSs), areas of hard bottom, and Pioneer Canyon;
- Potential interferences with existing and/or future fisheries resources, and to feeding, breeding, and migratory activities of marine birds and mammals;
- Potential impacts to other water column organisms should particles remain suspended;
- Uncertainties associated with predictions of the area affected by disposal operations; and
- The scope, frequency, and costs of monitoring short- and long-term effects from disposal operations at a deep-water disposal site.

An additional area of controversy involves the relationship of the ODMDS to the NMSs. The 12-mile wide zone contiguous with the seaward boundary of the NMSs, as described in EPA site monitoring regulations [40 CFR §228.10(c)(1)(i)], includes Alternative Sites 3, 4, and 5.

Although the National Oceanic and Atmospheric Administration (NOAA) will not regulate dredged material within this zone (NOAA 1992), any site selected as an ODMDS may require a more intensive monitoring effort because of its proximity to NMS resources.

1.5 Issues To Be Resolved

Major issues identified in Section 1.4 are being resolved through the LTMS public involvement process (Chapter 5). Specifically, the locations, sizes, and boundaries of the alternative sites have been delineated in regions removed from NMSs and areas of known hard bottom. Potential impacts to marine birds, mammals, and fisheries resources have been evaluated based on existing information and from computer model predictions of the dispersion of dredged material from the sites (Chapter 4). A Site Management and Monitoring Plan (SMMP) has been developed that contains approaches for monitoring impacts to marine organisms, as well as verification of model predictions. Development of this SMMP was based on comments received on the DEIS, and the SMMP will undergo final public review as part of the proposed rule package required by NEPA.

1.6 Regulatory Framework

An international treaty and several laws, regulations, and orders apply to ocean disposal of dredged material and to the designation of an ODMDS. The relevance of these statutes to the proposed action and to related compliance requirements is described below.

1.6.1 International Treaty

The principal international agreement governing ocean disposal is the Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter (26 UST 2403: TIAS 8165), also known as the London Dumping Convention (LDC). This agreement became effective on August 30, 1975, after ratification by the participating countries, including the United States. Ocean dumping criteria incorporated into MPRSA have been adapted from the provisions of the LDC. Thus, material considered acceptable for ocean disposal under MPRSA also is acceptable for ocean disposal under the LDC.

1.6.2 Federal Laws and Regulations

1.6.2.1 Marine Protection, Research and Sanctuaries Act of 1972, as amended (33 USC Section 1401 *et seq.*)

The MPRSA regulates the transportation and ultimate disposal of material in the ocean, prohibits ocean disposal of certain wastes without a permit, and prohibits the disposal of certain materials entirely. Prohibited materials include those which contain radiological, chemical, or biological warfare agents, high-level radiological wastes, and industrial waste. MPRSA has jurisdiction over all United States ocean waters in and beyond the territorial sea, vessels flying the U.S. flag, and vessels leaving U.S. ports. The territorial sea is defined as waters three miles seaward of the nearest shoreline. For bays or estuaries, the three-mile territorial sea begins at a baseline drawn across the opening of the water body.

Section 102 of the Act authorizes EPA to promulgate environmental criteria for evaluation of all dumping permit actions, to retain review authority over COE MPRSA 103 permits, and to designate ocean disposal sites for dredged material disposal. EPA's regulations for ocean disposal are published at 40 CFR Parts 220-229. Under the authority of Section 103 of the MPRSA, COE may issue ocean dumping permits for dredged material if EPA concurs with the decision. If EPA does not agree with a COE permit decision, a waiver process under Section 103 allows further action to be taken (Figure 1.1-1). The permitting regulations promulgated by COE, under the MPRSA, appear at 33 CFR Parts 320 to 330 and 335 to 338. Based on an evaluation of compliance with the regulatory criteria of 40 CFR Part 227, both EPA and COE may prohibit or restrict disposal of material that does not meet the criteria. The EPA and COE also may determine that ocean disposal is inappropriate because of ODMDS management restrictions or because options for beneficial use(s) exist. Site management guidance is provided in 40 CFR §228.7-228.11.

1.6.2.2 National Environmental Policy Act of 1969 (42 USC Section 4341 *et seq.*)

The National Environmental Policy Act (NEPA) was established to ensure that the environmental consequences of federal actions were incorporated into agency decision-making processes. It establishes a process whereby the parties most affected by the impact of a proposed action are identified and their opinions are solicited. The proposed action and several alternatives are evaluated in relation to their environmental impacts, and a tentative selection of the most appropriate alternative is made. A DEIS is developed which presents sufficient information to evaluate the suitability of the proposed and alternative actions. A Notice of Availability, announcing that the DEIS can be obtained for comment, is published in the *Federal Register*. After the DEIS comment period, the comments are addressed, revisions are made to the DEIS, and the document is published as a Final EIS. A proposed rule is published after the FEIS. For ODMDS designations, publication of a Final Rule in the *Federal Register* is equivalent to a NEPA Record of Decision.

The Council on Environmental Quality (CEQ) has published regulations at 40 CFR Parts 1500 to 1508 for implementing NEPA. EPA NEPA regulations are published at 40 CFR Part 6. The COE regulations for implementing NEPA are published at 33 CFR Part 220.

1.6.2.3 Clean Water Act of 1972 (33 USC Section 1251 *et seq.*)

The Clean Water Act (CWA) was passed to restore and maintain the chemical, physical, and biological integrity of the Nation's waters. Specific sections of the Act control the discharge of pollutants and wastes into aquatic and marine environments.

Section 404 of the CWA establishes a program to regulate the discharge of dredge and fill material into navigable waters of the U.S. The CWA and MPRSA overlap for discharges to the territorial sea. CWA supercedes MPRSA if dredged material is dumped in the ocean for beach restoration or some other beneficial use. MPRSA supercedes CWA if dredged material is transported and disposed in the territorial sea.

Section 401 of the CWA applies to dredging activities and requires certification that the permitted project complies with State Water Quality Standards for actions within State waters. Under Section 401, states must establish Water Quality Standards for waters in the territorial sea. Dredging may not cause the concentrations of chemicals in the water column to exceed State standards. To receive State certification, a permit applicant must demonstrate that these standards will not be exceeded.

1.6.2.4 Clean Air Act as Amended (42 USC Section 1451 *et seq.*)

The Clean Air Act is intended to protect the Nation's air quality by regulating emissions of air pollutants. The Act is applicable to permits and planning procedures related to dredged material disposal within the territorial sea. It is not applicable to the proposed designation of an ODMDS.

1.6.2.5 Fish and Wildlife Coordination Act of 1958 (16 USC Section 661 *et seq.*)

The Fish and Wildlife Coordination Act requires that water resource development programs consider wildlife conservation. Whenever any body of water is proposed or authorized to be impounded, diverted, or otherwise controlled or modified, the U.S. Fish and Wildlife Service (FWS) and the State agency responsible for fish and wildlife must be consulted. Section 662(b) of the Act requires federal agencies to consider recommendations based on the FWS investigations. The recommendations may address wildlife conservation and development, any damage to wildlife attributable to the project, and measures proposed for mitigating or compensating for these damages. The Act is applicable to the evaluation of MPRSA Section 103 permits and other water resource development projects.

1.6.2.6 Coastal Zone Management Act of 1972 (16 USC Section 1456 *et seq.*)

Under the Coastal Zone Management Act (CZMA), any federal agency conducting or supporting activities directly affecting the coastal zone must proceed in a manner consistent with approved State coastal zone management programs, to the maximum extent practicable. If a proposed activity affects water use in the coastal zone (i.e., the territorial sea and inland), the applicant may need to demonstrate compliance with a state's approved CZMA program.

The Coastal Zone Reauthorization Amendments of 1990 (Section 6208) state that any federal activity, regardless of its location, is subject to the CZMA requirement for consistency if it will affect any natural resources, land uses, or water uses in the coastal zone. No federal agency activities are categorically exempt from this requirement. As part of the site designation process, EPA will prepare a coastal consistency determination and will seek approval from the California Coastal Commission (CCC). The coastal consistency determination will address potential effects of dredged material disposal at the ODMDS on marine organisms, including threatened and endangered species. It will also describe provisions for sediment testing, to ensure that contaminated material is not discharged at the ODMDS, and other aspects of the SMMP. The CCC will continue to review permit applications for dredging projects and federal determinations of consistency for federal dredging projects, including the transport of dredged material through the coastal zone, for consistency with the California Coastal Zone Management Plan (CZMP).

1.6.2.7 Endangered Species Act of 1973 (16 USC Section 1531 *et seq.*)

The Endangered Species Act protects threatened and endangered species by prohibiting federal actions which would jeopardize the continued existence of such species or which would result in the destruction or adverse modification of any critical habitat of such species. Section 7 of the Act requires that consultation regarding protection of such species be conducted with the FWS and/or the National Marine Fisheries Service (NMFS) prior to project implementation. During the site designation process, the FWS and the NMFS evaluate potential impacts of ocean disposal on threatened or endangered species. These agencies are asked to certify, or concur with the sponsoring agency's findings, that the proposed activity will not adversely affect endangered or threatened species. Documentation of the consultation process on the proposed ODMDS designation is included in Chapter 5.

1.6.2.8 National Historic Preservation Act of 1966 (16 USC Parts 470 *et seq.*)

The purpose of the National Historic Preservation Act is to preserve and protect historic and prehistoric resources that may be damaged, destroyed, or made less available by a project. Under this Act, federal agencies are required to identify cultural or historical resources that may be affected by a project and to coordinate project activities with the State Historic Preservation Officer (SHPO). EPA is coordinating the proposed ODMDS designation with the SHPO (see Chapter 5).

1.6.3 Executive Orders

1.6.3.1 Executive Order 11593, Protection and Enhancement of the Cultural Environment (36 FR 8921, May 15, 1971)

This executive order requires federal agencies to direct their policies, plans, and programs so that federally-owned sites, structures, and objects of historical, architectural, or archaeological significance are preserved, restored, and maintained for the inspiration and benefit of the public. Compliance with this order is coordinated with the SHPO.

1.6.3.2 Executive Order 12372, Intergovernmental Review of Major Federal Programs (47 FR 3059, July 16, 1982)

This order requires federal agencies to consult with elected officials of state and local governments that may be affected directly by a proposed federal development. In providing for this consultation, existing state procedures must be accommodated to the maximum extent practicable. For this EIS, the EPA, through the LTMS program, has consulted with the Resources Agency of California, the California Environmental Protection Agency, and the appropriate state agencies, boards, and departments on the proposed action (see Chapter 5).

1.6.4 State of California

1.6.4.1 California Coastal Act of 1976, Public Resources Code Section 3000 *et seq.*

This Act establishes the CZMP, which has been approved by the U.S. Department of Commerce. All federal actions which affect the coastal zone must be determined to be as consistent as practicable with this plan (see CZMA above).

1.6.4.2 California Environmental Quality Act, June 1986 Public Resources Code Parts 21000-21177

The California Environmental Quality Act (CEQA) establishes requirements similar to those of NEPA for consideration of environmental impacts and alternatives, and for preparation of an Environmental Impact Report (EIR) prior to implementation of applicable projects. However, this proposed action is a federal action involving site designation outside state boundaries and, therefore, does not fall under the purview of CEQA.

1.7 Relationship to Previous NEPA Actions or Other Facilities That May Be Affected by Designation of the Disposal Site

Several NEPA actions in the project area potentially may be affected by disposal of dredged material at an ODMDS. Because disposal activities would occur over open-ocean water, no facilities or structures would be affected directly. However, resuspension of dredged material or disposal plumes from an ODMDS must be considered in terms of cumulative impacts to the water quality, sediment quality, and the biological environment. These projects are shown in Figure 1.7-1 and described briefly below.

- Channel Bar ODMDS: This site is designated for disposal of material from maintenance dredging of the San Francisco main ship channel [40 CFR section 228.12(b)(22)]. The site is 5.6 kilometers (km) from shore, adjacent to the ship channel.

- San Francisco Southwest Ocean Outfall Project (SWOOP): The outfall is located 10.2 km from shore off San Francisco at a depth of 23 m (37°42.267'N, 122°34.65'W). It is operated by the City and County of San Francisco, and discharges 24 million gallons per day of primary treated sewage effluent and stormwater runoff.

- City of Pacifica Outfall: The outfall is located 0.8 km from shore off Pacifica (37°37.917'N, 122°30.500'W) at a depth of 10 m. It discharges 3.2 million gallons per day of secondary treated sewage effluent.

- Northern San Mateo County Outfall: The outfall is located 0.8 km from shore off northern San Mateo County (37°42.800'N, 122°30.833'W) at a depth of 10 m. It discharges 8 million gallons per day of secondary treated sewage effluent.

The Channel Bar ODMDS and three ocean outfalls are at least 45-55 nmi from the alternative sites. Because of this large distance, these activities will not be affected directly by the designation of an ODMDS at any of the alternative sites (see Section 4.4.1.3, Water Quality Modeling). The Channel Bar Site, designated to receive dredged material from the entrance channel to San Francisco Bay, does not receive any dredged material from other parts of the Bay. Thus, disposal volumes and activities at the Channel Bar ODMDS are independent of the amount of material that might be discharged at an offshore ODMDS.

Project-specific, dredged material disposal operations at the Navy Ocean Disposal Site (NODS), corresponding to Alternative Site 5 in this FEIS, were initiated in May 1993 by the Navy under an MPRSA Section 103 permit. The NODS and Alternative Site 5 are located within a portion of the historical chemical munitions dumping area (CMDA). A Final EIS (Navy 1990) and Final Supplemental EIS (Navy 1993) were prepared for this action. A total volume of 1.2 million yd^3 of dredged material from NAS Alameda and NSC Oakland will be discharged at NODS during May 1993 to December 1994 under permit No. 1926OE48 issued by the COE, San Francisco District. This permit contains general and special conditions that pertain to dredging and disposal operations, coordination with the U.S. Coast Guard (USCG), inspections, report submissions, and permit liability. The COE is a cooperating agency on this project.

Three national marine sanctuaries (GOFNMS, CBNMS, and MBNMS) have been designated in the region. The GOFNMS was designated in 1981 (46 FR 7936; January 26, 1981). The boundaries of the GOFNMS extend from Bodega Rock to Rocky Point (near Bolinas) and 19 km beyond the Farallon Islands. The CBNMS was designated in 1990 (55 FR 4994; December 4, 1990) and is located adjacent to and north of the GOFNMS boundary. The MBNMS includes areas of the continental shelf from the Gulf of the Farallones to Cambria (NOAA 1992). The Final Rule for designation of the MBNMS was published on September 18, 1992. Dredged material disposal within the boundaries of any of the NMSs is prohibited by Sanctuary regulations. CBNMS regulations also prohibit discharges outside the boundary which could enter the Sanctuary and impact a Sanctuary resource (NOAA 1989).

A number of other areas delineated in the study region correspond to submarine operating areas, vessel traffic lanes (i.e., navigation channels and a precautionary zone), and historical waste disposal sites (Figure 1.7-1). These areas are not previous NEPA actions or facilities. However, they are legitimate uses of the ocean that may be affected by ODMDS designation (see Chapter 2). Continued use of these areas or, in the case of historical waste disposal sites,

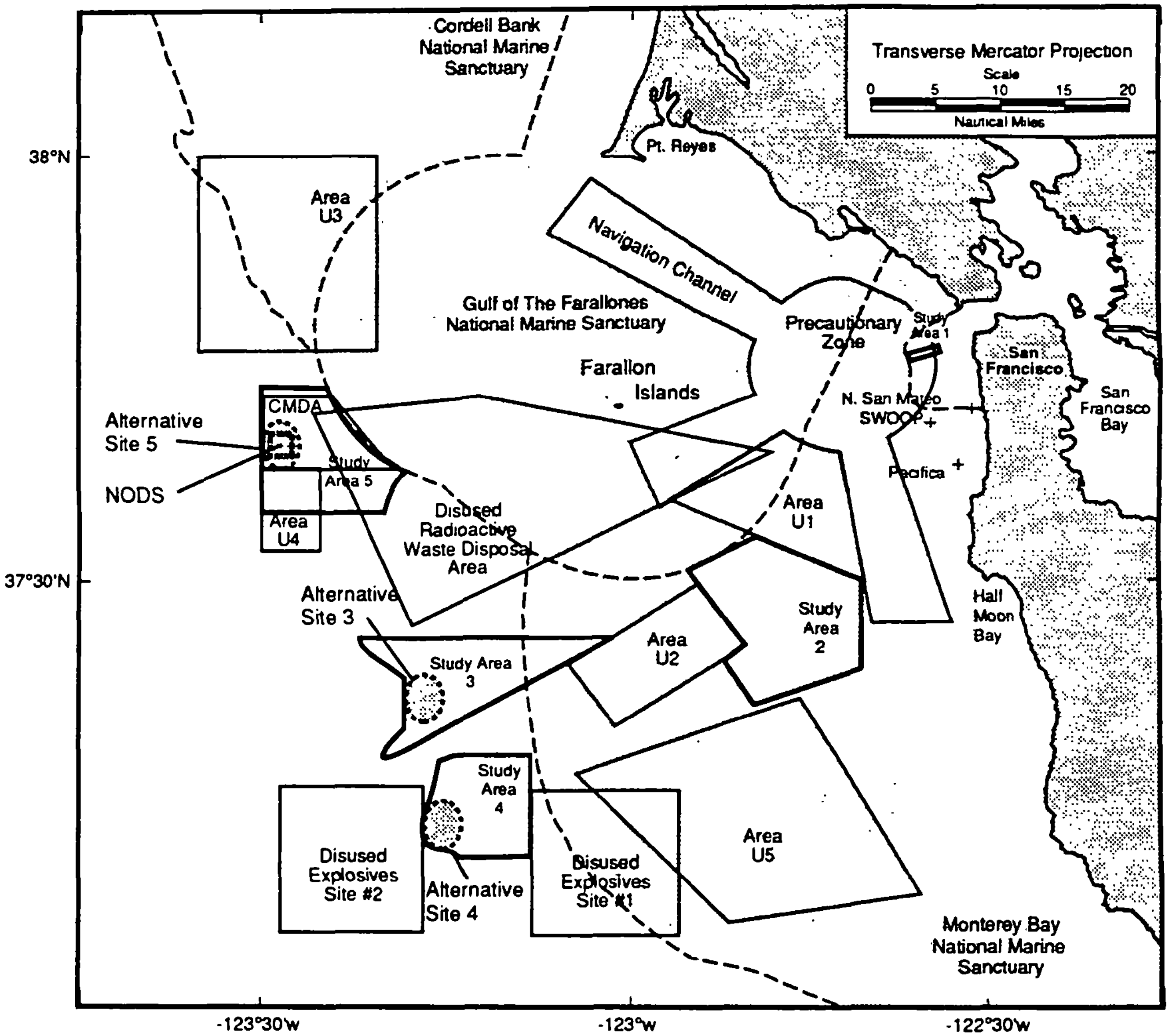

Figure 1.7-1. **Locations of Existing ODMDSs, Ocean Outfalls, National Marine Sanctuaries, Submarine Operating Areas, Navigation Channels and Precautionary Zone, and Historical Waste Disposal Sites in the LTMS Study Region.**

The existing ODMDSs are Study Area 1 (Channel Bar ODMDS) and NODS (corresponds approximately to Alternative Site 5). The terminus of each of the three ocean outfalls is indicated as a "+"; submarine operating areas are designated Areas U1–U5; areas within the National Marine Sanctuaries are shaded, and sanctuary boundaries are indicated by dashed lines.

cumulative environmental impacts associated with these areas could be affected by the designation of an ODMDS. Potential impacts from ODMDS designation, including cumulative impacts with other disposal operations, are discussed in detail in Chapter 4 (Environmental Consequences).

CHAPTER 2

ALTERNATIVES INCLUDING THE PROPOSED ACTION

This chapter discusses five general alternatives for the disposal of dredged material from San Francisco Bay and compares three alternative ocean dredged material disposal sites (ODMDS). Each of the alternative ocean disposal sites is evaluated on the basis of the five general and eleven specific site-selection criteria listed at 40 CFR sections 228.5 and 228.6(a), respectively (Table 1.1-1). Disposal alternatives are described in Section 2.1 and evaluated in Section 2.2.

2.1 Description of Alternatives

Five general alternatives for the disposal of dredged material from San Francisco Bay are available: (1) No-Action; (2) ocean disposal; (3) disposal within the Bay; (4) nonaquatic (i.e., land-based) disposal; and (5) reuse or treatment options, such as landfill cover, beach nourishment, or marsh restoration.

These alternatives are being evaluated as part of the Long-Term Management Strategy (LTMS), an interagency effort led by a State/Federal partnership consisting of the Environmental Protection Agency (EPA), the U.S. Army Corps of Engineers (COE), the San Francisco Bay Regional Water Quality Control Board (SFBRWQCB), and the San Francisco Bay Conservation and Development Commission (BCDC). It is the intent of the LTMS to provide an array of disposal options–including ocean, within the Bay, and nonaquatic sites–to accommodate the volumes and composition of material proposed for dredging over the 50-year planning period (COE 1992a). The LTMS also will develop general guidelines for evaluating the use of individual disposal options for specific projects, as well as promote utilization of dredged material for beneficial uses such as wetlands creation and levee maintenance (COE 1992a). These options are being developed by the LTMS Ocean Studies Work Group, In-Bay Work Group, Nonaquatic/Reuse Work Group, and the Implementation Work Group. Overall management and policy guidance of these groups is provided by an Executive Committee with LTMS coordination and technical direction delegated to a Management Committee (Section 5.2).

Because other options will be evaluated by ongoing LTMS efforts concerning disposal within the Bay, nonaquatic/reuse sites, and implementation, this Environmental Impact Statement (EIS) evaluates only the ocean disposal and No-Action alternatives. Evaluations of non-ocean disposal options are scheduled for completion in 1994.

The process of designating an ODMDS begins by establishing the need for an ocean disposal site. Designation of an ODMDS would not preclude the use of other disposal options or beneficial uses of dredged material. Land-based disposal evaluations are required under 40 CFR sections

227.14 to 227.16 in EPA's Ocean Dumping Criteria for all Marine Protection, Research and Sanctuaries Act (MPRSA) Section 103 permits. These evaluations are considered by the COE and EPA as part of the review of individual applications for use of an ODMDS. If disposal within the Bay or at a nonaquatic/reuse site is feasible, a decision whether an ODMDS is the best disposal option will be made during the National Environmental Policy Act (NEPA) and permit review process according to the existing regulations and other guidelines developed by the LTMS.

2.1.1 No-Action Alternative

The LTMS mission is to develop long-term options that include an array of potential ocean, within the Bay, and nonaquatic disposal sites to accommodate the dredged material volumes and composition projected for the 50-year planning period (COE 1992a). The No-Action Alternative would preclude ocean disposal except under an MPRSA Section 103 permit. Use of an MPRSA Section 103 interim ODMDS is project-dependent and does not provide a long-term management option. Therefore, the No-Action Alternative would not fulfill the LTMS goal of providing a long-term, multi-user ODMDS. In addition, in the absence of a designated ODMDS, or Section 103 interim ODMDS, other disposal options would be required for dredged material, or planned dredging programs would have to be delayed until a suitable disposal option is identified.

2.1.2 Ocean Disposal Alternatives

The process of identifying potential alternative ocean disposal sites involves several steps (EPA 1986a). Once the need for an ocean site has been established, the next step typically is to define a zone of siting feasibility (ZSF) which establishes a broad potential area for locating an ODMDS. The geographic boundary of the ZSF is determined by evaluating operational and economic considerations and jurisdictional limitations. Within the ZSF, historically used disposal sites and sensitive and incompatible use areas then are identified from existing information sources (EPA/COE 1984). Sensitive areas may include marine sanctuaries, breeding, spawning, nursery, feeding, or passage areas of living resources, and significant natural or cultural features of historical importance. Incompatible use areas may include shipping lanes, mineral extraction sites, or geographically limited fisheries or shellfisheries (EPA 1986a). After sensitive or incompatible use areas have been delineated, the remaining portions of the ZSF then may be considered as candidate areas for siting an ODMDS. Candidate sites are evaluated further based on site-specific information, plus other considerations such as disposal management requirements (EPA/COE 1984). Additionally, the Ocean Dumping Regulations (40 CFR 228.5) require that "EPA will, wherever feasible, designate ocean dumping sites beyond the edge of the continental shelf and other such sites that have been historically used."

Potential alternative ocean disposal sites within the LTMS study region were identified from an initial screening process that considered the following: (1) marine sanctuary boundaries; (2) navigation lanes; (3) submarine operating areas; (4) areas of hard bottom; and (5) Pioneer Canyon. As a result of this screening, Study Areas 1, 2, 3, 4, and 5 were delineated by EPA and members of the LTMS Management Committee as potential alternative ocean disposal sites that represented a range of depths and distance from shore and that avoided previously identified incompatible use areas (EPA 1991).

EPA prepared an Ocean Studies Plan (OSP; EPA 1991) that summarized existing information on the environmental conditions of the LTMS study region. The OSP also described methodologies for obtaining additional information and for conducting studies at Study Areas 2, 3, 4, and 5, and Pioneer Canyon, that were needed to support the site designation process. Although the background information available prior to these surveys suggested that areas such as Pioneer Canyon and shelf locations in the vicinity of Study Area 2 might contain potentially unique or sensitive features or resources which should be avoided for ODMDS designation, the OSP included sampling at these locations to fill specific data gaps and document the areas' characteristics for the EIS. EPA-sponsored surveys of Study Areas 2, 3, and 4 and Pioneer Canyon subsequently were conducted from 1990 to 1992. Study Area 5 was surveyed by the Navy and by EPA from 1990 to 1992. Results from these surveys (summarized in Chapter 3) were used to evaluate the individual LTMS study areas, and eventually to select the three alternative sites addressed in this EIS.

Coincidental with the development of the OSP, the COE prepared a draft final ZSF report in 1991 that "...delineate[s] the outer geographical boundaries of operational and economic acceptability within which further environmental, regulatory and socio-economic analysis is performed to achieve a site designation." Based on analyses of the benefit-to-cost ratios of ten representative dredging projects in San Francisco Bay, the COE recommended that the ZSF encompass an area within 53 nmi (100 km) from the Golden Gate Bridge. The ZSF (Figure 2.1-1) includes areas beyond the edge of the continental shelf, all of which would be accessible using existing technology and equipment (COE 1992c). All of the LTMS study areas are within the region defined by the ZSF.

The following sections discuss historically used ODMDSs and the sensitive and incompatible use areas within which dredged material disposal operations would interfere with other activities, uses, or resources within the LTMS study region. These uses and their geographical locations are described below.

2.1.2.1 Historically Used ODMDSs

EPA's ocean site selection criteria [40 CFR Section 228.5(e)] require that sites used historically should be designated as ODMDS wherever possible. Historically used sites within the LTMS study region are discussed below.

The Channel Bar Site (corresponding to LTMS Study Area 1) is the only historically used ODMDS presently designated for disposal of dredged material (see Section 3.1.1, Historical Use of the Study Region). This site received final designation (50 CFR 38524; September 23, 1985), but can be used only for disposal of sandy sediments dredged from the entrance channel to San Francisco Bay. The Farallon Island or 100-Fathom site was given interim designation by EPA in 1977. However, this site is now within the Gulf of the Farallones National Marine

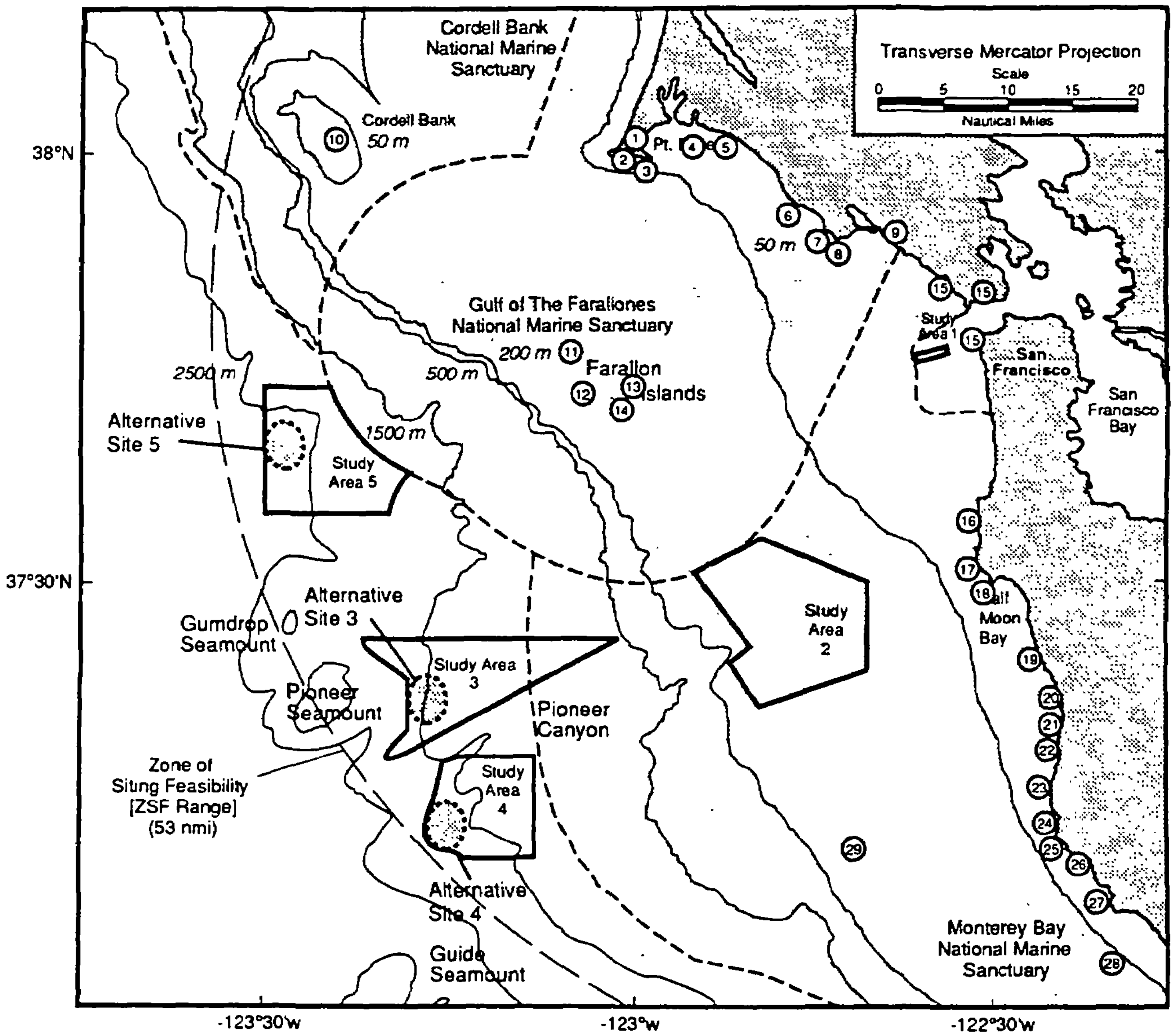

Figure 2.1-1. Locations of National Marine Sanctuaries, Areas of Special Biological Significance, Reserves, and Features of Potential Scientific Importance in the LTMS Study Region.

See Table 2.1-1 for a legend to the numbered circles.
The 50m, 200m, 500m, 1,500m, and 2,500m contours correspond to the 28, 110, 275, 825, and 1,375 fathom contours, respectively.

Table 2.1-1. Areas of Special Biological Significance (ASBSs), Reserves, National Marine Sanctuaries (NMS), and Features of Potential Scientific Significance Shown in Figure 2.1-1.

1.	Point Reyes National Seashore	15.	Golden Gate National Recreation Area
2.	Point Reyes Headlands Reserve	16.	Montara State Beach
3.	Point Reyes Headlands Reserve and ASBS	17.	James Fitzgerald Marine Reserve and ASBS
4.	Drakes Estero	18.	Pillar Point, Half Moon Bay
5.	Estero de Limantour Reserve	19.	Purisima Creek
6.	Double Point ASBS	20.	Lobitos Creek, Tunitas Creek
7.	Duxbury Reef Reserve	21.	San Gregorio State Beach
8.	Duxbury Reef Reserve and Extension ASBS	22.	Pomponio State Beach
9.	Bolinas Lagoon	23.	Pescadero Marsh
10.	Cordell Bank NMS	24.	Pescadero Point
11.	Gulf of the Farallones NMS	25.	Bean Hollow State Beach
12.	Farallon Islands Game Refuge	26.	Pigeon Point
13.	Farallon National Wildlife Refuge	27.	Franklin Point
14.	Farallon Islands ASBS	28.	Año Nuevo State Reserve
		29.	Monterey Bay NMS

Source: KLI 1991.

Sanctuary (GOFNMS), which was established in 1981 (46 CFR 7936; January 26,1981), and disposal of dredged material inside the Sanctuary boundary is prohibited except where necessitated by national defense or in response to an emergency (15 CFR 936.6). Consequently, the interim designation of the 100-Fathom site was canceled in 1983 (48 CFR 5557; February 7, 1983). This site has not been used for dredged material disposal since 1978.

Disposal of dredged material from San Francisco Bay has not occurred routinely at any other ocean site, except for the limited or experimental use of three sites that have not been designated for further use (Section 3.1.1): the COE experimental 100-fathom site, the Bay Area Rapid Transit (BART) site, and Site B1B (Chapter 3, Figure 3.1-1). These sites are considered historical sites because they have been used previously for dredged material disposal. However, all of these sites have been eliminated from further consideration as an ODMDS. The COE experimental 100-fathom site was eliminated because it is within the GOFNMS. The BART site was not considered further because it is located in close proximity to the Golden Gate, nearshore resources, and the Monterey Bay National Marine Sanctuary (MBNMS). Finally, Site B1B has also been eliminated from consideration because it is within the boundaries of the MBNMS.

The Navy obtained a project-specific (MPRSA Section 103) permit for disposal of dredged material at the Navy Ocean Disposal Site (NODS) located within the former chemical munitions dumping area (CMDA). The NODS coincides with LTMS Alternative Site 5. A total volume of 1.2 million yd^3 of material from NAS Alameda and NSC Oakland will be discharged at NODS between May 1993 and December 1994. Therefore, the NODS is considered a historically used ODMDS.

2.1.2.2 Sensitive Areas

EPA's ocean site selection criteria [40 CFR section 228.5(b)] require that impacts to sensitive areas such as sanctuaries, restricted habitats, and areas with high resource values be avoided. Sensitive areas in the LTMS study region are discussed below.

The ocean adjacent to San Francisco Bay contains several national marine sanctuaries (NMS), areas of special biological significance (ASBSs), ecological preserves, and other areas of special scientific importance (Figure 2.1-1 and Table 2.1-1). The GOFNMS boundaries extend from Bodega Rock to Rocky Point (Bolinas) and approximately 19 km seaward of the Farallon Islands. Cordell Bank National Marine Sanctuary (CBNMS), located north of the GOFNMS and 30 km west of Point Reyes peninsula, was designated in 1990 (55 CFR 4994; December 4, 1990). A large area of the California coast from Marin County to Cambria (4,024 nmi^2) has been designated as the MBNMS (57 FR 43310). Routine disposal of dredged material within the boundaries of any of the NMSs is prohibited by Sanctuary regulations. Therefore, the areas within the NMS boundaries are eliminated from further consideration as an ODMDS.

EPA regulations [40 CFR section 228.10(c)(1)(i)] also describe a 12-mile zone around sanctuaries in reference to monitoring of disposal sites. EPA and the National Oceanic and Atmospheric Administration (NOAA) agree that designation of an ODMDS within this zone is not precluded by EPA or sanctuary regulations, or by MPRSA (W. Reilly, EPA, letter to Gov. Pete Wilson dated June 22, 1992).

Several ASBSs occur along the coast between the Point Reyes National Seashore and Año Nuevo Point, within the GOFNMS and the MBNMS (Figure 2.1-1). These locations represent breeding, nursery, haul-out, and feeding areas for marine mammals; over-wintering, breeding, roosting, and migratory passage areas for birds; or geographically limited habitat for large numbers of plant and animal species, including several threatened and endangered species. The need to protect these ASBSs is, in part, justification for including these regions in the GOFNMS and MBNMS. Further, the nearshore zone adjacent to this portion of the coast would not be appropriate for further considerations of ODMDS siting because of potential shoreward transport of dredged material and degradation of water quality at the shoreline.

Physiographic features, such as hard-bottom reefs, submarine canyons, and seamounts, are considered potentially sensitive areas because they could support biological communities which are different from those found on adjacent soft-bottom substrate and which are restricted to the spatial extent of the feature.

The presence of several hard-bottom features, submarine canyons, or seamounts has been identified in locations off the continental shelf (e.g., Nybakken *et al.* 1984; Towill, Inc. 1986; Parr *et al.* 1987; SAIC 1992b). The distribution of potential hard-bottom areas in the vicinity of Study Areas 3, 4, and 5 is shown on Figure 2.1-2. Based on interpretation of U.S. Geological Survey acoustic data (J. Chin pers. comm. 1993), the mapped hard-bottom areas within Study Areas 3 and 4 likely consist primarily of compacted, sandy sediment, whereas localized areas of sea floor to the east of these study areas may include lithified or crystalline rock. Study Area 5 contains relatively few potential hard-bottom sites. Significant hard-bottom features are located at depths of approximately 900 m near the GOFNMS boundary, on and adjacent to Pioneer Seamount, and scattered within Pioneer Canyon south of the GOFNMS (Karl 1992). Other areas with potential hard-bottom features are associated with Gumdrop and Guide Seamounts located to the north and far south of Pioneer Seamount, respectively (Figure 2.1-2). Previous studies conducted in submarine canyons off southern California and within Monterey Canyon revealed the presence of rich or unique biological communities (e.g., Hartman 1963; Embley *et al.* 1990). Therefore, significant hard-bottom features, submarine canyons, and seamounts off San Francisco may represent unique biological habitats or areas of scientific importance. In addition, the difficulty of predicting dredged material dispersion in the vicinity of seamounts and canyons also makes these areas unsuitable for an ODMDS. Nevertheless, because the information previously available for characterizing and evaluating the potential sensitivities of these features or habitats was sparse, EPA conducted surveys within Pioneer Canyon (SAIC 1992b,c) to complete the regional characterization.

Information on potentially sensitive areas within the study region was obtained during studies sponsored by the COE (Nybakken *et al.* 1984; Towill, Inc. 1986; Stevenson and Parr 1987; Parr *et al.* 1987) to evaluate potential ocean disposal sites. The majority of these sites were located on the continental shelf (Figure 2.1-3 and Table 2.1-2). These studies were intended to

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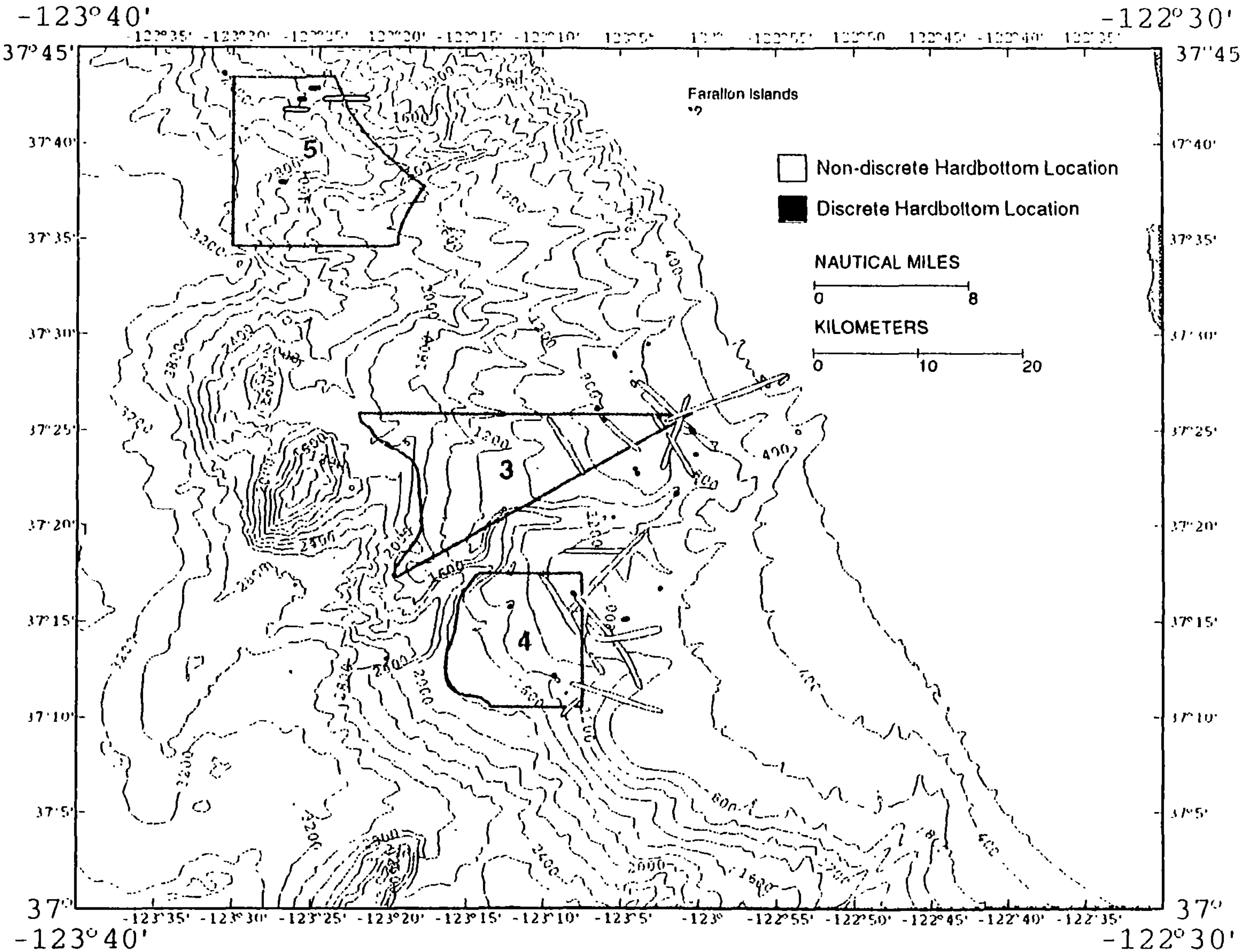

Figure 2.1-2. Distribution of Hard-Bottom Areas in the Vicinity of Study Areas 3, 4, and 5.

Hard-bottom area distributions are based on acoustic data. Discrete hard-bottom areas are defined as features of approximately 500 m or greater in horizontal extent. Non-discrete areas are intervals with patches of individual hard-bottom areas of less than 500 m in extent. Bathymetry is in meters.

Source: Chin (pers. comm. 1993).

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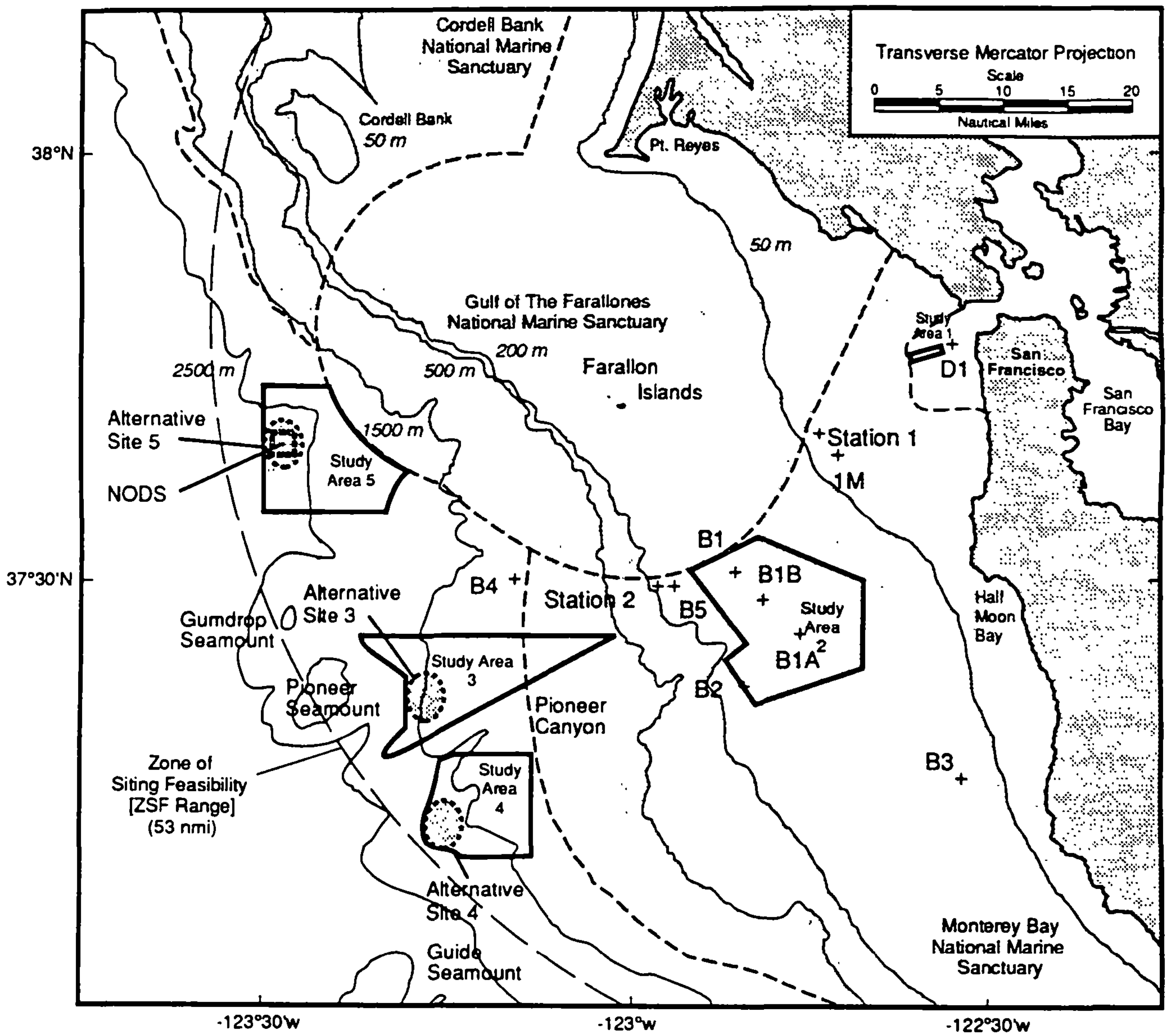

Figure 2.1-3. **Location of the Ocean Disposal Sites Evaluated by the COE and Navy in the Vicinity of the Gulf of the Farallones.**

Refer to Table 2.1-2 for COE site details.

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Table 2.1-2. Potential Ocean Disposal Sites Evaluated by the COE, as Shown in Figure 2.1-5.

	Center Coordinates					
Site	Latitude	Longitude	Depth (m)	Sampling Date	Study Conclusions	Reference
Station 1	37°40.00'N	122°44.00'W	50	March/June, 1983	Productive fishery area for lingcod, flatfish, and Dungeness crab; designation considered inappropriate until other alternatives explored.	Nybakken *et al.* 1984
Station 2	37°29.00'N	122°57.00'W	180	March/April, 1983; September, 1983	Highly productive hard-bottom area that supports rockfish and sablefish fishery; designation considered inappropriate until other alternatives explored.	Nybakken *et al.* 1984
B1	37°31.27'N	122°50.18'W	80-90	January-May, 1986; October, 1986; April, 1987	Fish abundances low to high; site may be important nursery habitat for two fish species.	Towill Inc. 1986; Stevenson and Parr 1987; Parr *et al.* 1988
B2	37°22.77'N	122°50.18'W	110-140	January-May, 1986; October, 1986; April, 1987	Supports high numbers of commercially important fish species and Dungeness crab; may be particularly important habitat for brooding crabs.	Towill Inc. 1986; Stevenson and Parr 1987; Parr *et al.* 1988
B3	37°16.10'N	122°31.00'W	60-80	January-May, 1986; October, 1986	Includes some hard-bottom habitat and supports rich fish and benthic assemblages; also, possible interferences with coastal shipping routes.	Towill Inc. 1986; Stevenson and Parr 1987; Parr *et al.* 1988
B4	37°30.00'N	123°08.50'W	900	January-May, 1986	Located in a large submarine canyon; eliminated from further consideration due to high-relief rock outcroppings.	Towill Inc. 1986

Table 2.1-2. Continued.

Site	Center Coordinates		Depth (m)	Sampling Date	Study Conclusions	Reference
	Latitude	Longitude				
B5	37°29.65'N	122°55.20'W	110-140	January-May, October, 1987, April, 1987	Productive rockfish area, possibly due to presence of mixed hard-bottom habitat, and supports sensitive life stages of Dungeness crabs; considered inappropriate for site designation.	Towill Inc. 1986; Stevenson and Parr 1987; Parr *et al.* 1988
B1A	37°27.00'N	122°44.50'W	80-85	April, 1987	Possible hard substrate downcoast from site; moderate to high fish abundances; site used as nursery area by two commercial fish species.	Parr *et al.* 1988
B1B	37°29.00'N	122°48.00'W	84-88	April/May 1988	Low to high fish abundances; minor to moderate use of site as nursery area. Low crab densities and historically low commercial fish catch.	Parr *et al.* 1988
1M	37°38.70'N	122°42.27'W	42-46	April/May, 1988	Medium to high densities of Dungeness crabs; located in area of intensive commercial crab fishery activity.	Parr *et al.* 1988
D1	37°46.83'N	122°32.66'W	18-24	April/May, 1988	Historical BART site - 1 nmi from shore and 0.5 nmi south of Entrance Channel; site contains medium sand-sized sediments considered incompatible with dredged materials. Contains high densities of juvenile crabs.	Parr *et al.* 1988

Sources: Nybakken *et al.* 1984; Stevenson and Parr 1987; Parr *et al.* 1987.

characterize the physical features (e.g., bathymetry and sediment grain size) and biological habitat (benthic infauna and demersal fishes). Based on the study results, Stations 1 and 2 and Site B4 were considered inappropriate locations for an ODMDS due to the presence of hard-bottom features or rich biological assemblages and fisheries resources (Table 2.1-2). The remaining sites were ranked by Parr *et al.* (1987) for potential disposal site suitability based on the density and diversity of the infaunal and demersal fish assemblages and abundances of Dungeness crabs. Sites B2, B5, and D1 appeared to be used by sensitive life stages of Dungeness crabs, and Site 1M was located in an area of intensive crab fishing. Site B3 was located close to shore and to nearshore kelp beds, as well as being within heavily used vessel traffic areas; this site also contained some hard-bottom habitat. Site B1 was near the GOFNMS boundary, and Site B1A was located near productive rockfishing reefs. Survey data indicated that Site B1B is removed from Dungeness crab and rockfish habitat, and that the site supports low infaunal abundances and diversity. Additionally, historical fish block data for this area suggested that the commercial fish catch was relatively low. Based on this assessment, Site B1B was considered the most suitable of the sites evaluated. This site was selected as the preferred alternative site for disposal of 400,000 yd^3 of dredged material from the Oakland Inner Harbor Deepening Project. However, only 18,000 yd^3 of dredged material was disposed at Site B1B before the project was halted by the State court system.

Although results from these studies indicated significant resource values at many of these stations, there remained substantial controversy regarding the scope and methodology of the studies. Therefore, EPA retained some stations from the previous studies in the surveys of LTMS Study Area 2 to better characterize and document the resources in this area.

2.1.2.3 Incompatible Use Areas

As part of ODMDS designation, incompatible use areas such as regions of heavy commercial or recreational navigation should be avoided [40 CFR 228.5(a)]. Within the LTMS study region, incompatible use areas include vessel traffic lanes and submarine operating areas. The effect of incompatible use areas on selection of the LTMS study areas is discussed below.

The U.S. Coast Guard (USCG) established vessel traffic lanes and a precautionary area within the Gulf of the Farallones (Figure 2.1-4) to promote safe navigation of marine traffic to and from ports within San Francisco Bay. The "General Approach to Site Designation Studies for Ocean Dredged Material Disposal Sites" (EPA/COE 1984) lists navigational lanes as incompatible use areas. Therefore, areas corresponding to the traffic lanes and the precautionary zone were eliminated from consideration (Table 1.1-1).

Submarine operating areas U1, U2, U3, U4, and U5 are used by the U.S. Navy for classified submarine operations and post-overhaul seatrials (Figure 2.1-5). Portions of area U3 are within the CBNMS and the GOFNMS, and the northern boundary of area U4 is contiguous with the southern boundary of the CMDA and overlaps the southern portion of Study Area 5. The Navy confirmed that it was acceptable for EPA to conduct studies within some of the submarine operating areas (E. Lukjanowicz pers. comm. 1992), but the Navy also expressed concern that

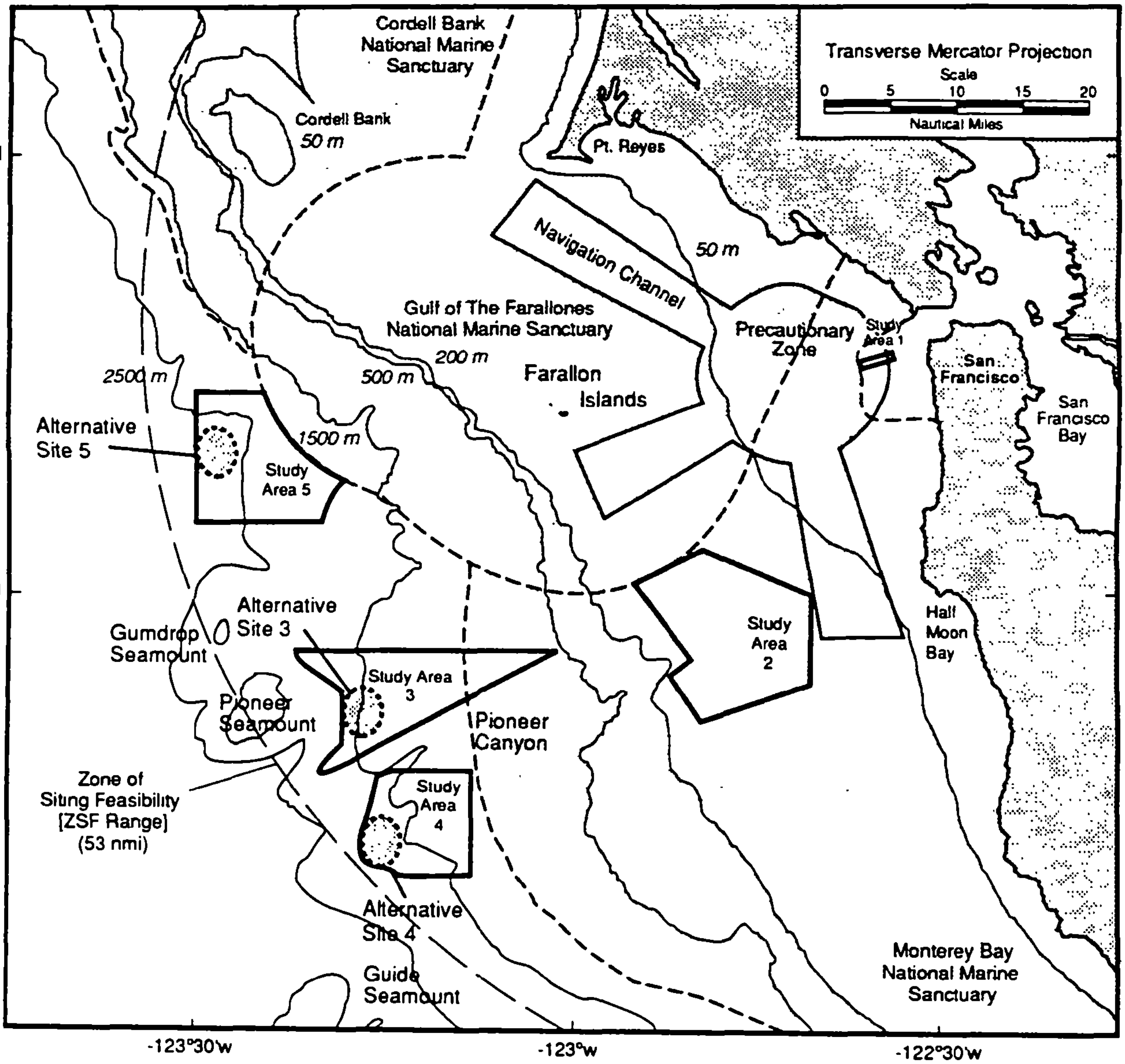

Figure 2.1-4. Location of Navigation Channels and Precautionary Zone in the LTMS Study Region.

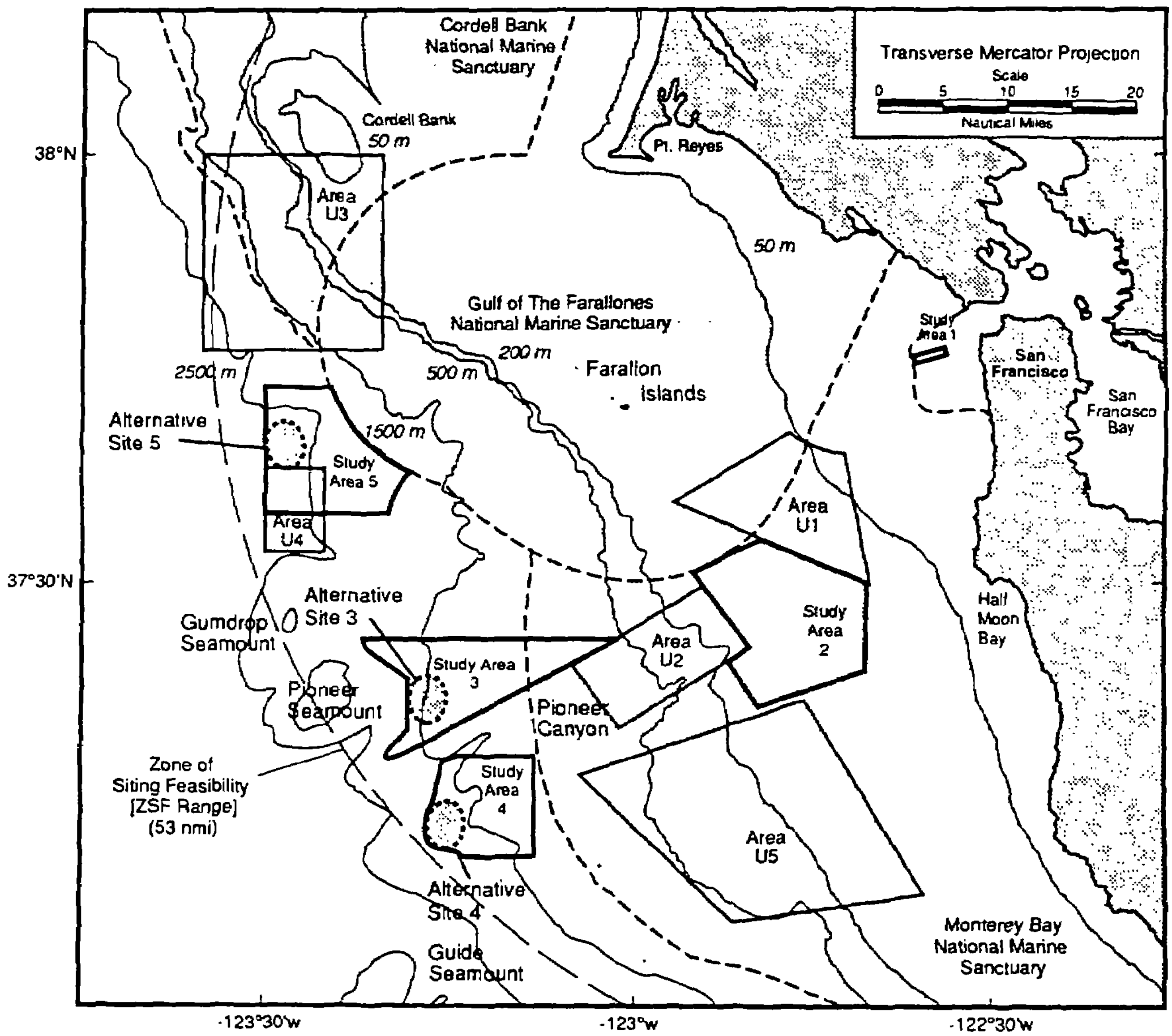

Figure 2.1-5. Location of Submarine Operating Areas (Areas U1–U5) in the LTMS Study Region.

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dredged material disposal within areas U1, U2, and U5 could jeopardize submarine operations or result in collisions between disposal barges and submarines or support vessels. Therefore, areas corresponding to submarine operating areas U1, U2, and U5 were eliminated from consideration.

Based on the location of sensitive and incompatible use areas, and comments received at a Scoping Meeting held on April 11, 1989, EPA and members of the LTMS Management Committee selected Study Areas 1 through 5 (Figure 2.1-1) as potential locations for siting an ODMDS. The LTMS study areas represent appropriate ranges of depths and distances from shore within the ZSF and avoid most of the sensitive and incompatible use areas. Figure 2.1-6 provides a summary overlay of the primary sensitive and incompatible use areas in the LTMS study region. Study Area 1 corresponds to the Channel Bar ODMDS, which is designated for disposal of sandy material from the entrance channel to San Francisco Bay. The previously used Site B1B is located within LTMS Study Area 2, and the CMDA and NODS are within LTMS Study Area 5. Ocean disposal alternatives are described further in Section 2.2.

2.1.3 San Francisco Bay and Nonaquatic Disposal and Reuse Alternatives

The feasibility and environmental consequences of using sites within the Bay, nonaquatic sites, and reuse options for disposal of dredged material are being investigated under the LTMS program by the COE, the SFBRWQCB, and the BCDC, with significant input from other LTMS participants (see Chapter 5). Detailed evaluations of these dredged material disposal options are beyond the scope of this EIS. However, the following summarizes the present status of these options.

2.1.3.1 San Francisco Bay Alternatives

Eleven open water (unconfined) disposal sites in the San Francisco Bay region have been used historically for disposal of sediments dredged from within the Bay. Four of these sites—Carquinez Straits (SF-9), San Pablo Bay (SF-10), Suisun Bay, and Alcatraz (SF-11)—presently are used for dredged material disposal (Table 2.1-3). The Carquinez Straits, San Pablo Bay, and Alcatraz disposal sites are used for most Federal and private maintenance dredging projects; the Alcatraz site also has been used for new work projects in the Bay. The Suisun Bay site is used exclusively for material composed of at least 95% sand dredged from the adjacent Suisun Bay Channel. The sites are located in high current energy areas to promote dispersion and eventual transport of dredged material to the ocean (COE 1990a). The seven other historical disposal sites in the Bay, typically located within one mile of the respective dredging sites, have not been used since 1972 (COE 1990a).

During 1986 to 1992, the San Pablo and Carquinez Straits sites received annual dredged material volumes from 0.008 to 0.98 million yd^3 and from 0.18 to 0.99 million yd^3, respectively (COE 1992a). In accordance with present COE policy, dredged material discharged at these sites is slurried prior to discharge. The annual dredged material disposal volume planned for the Suisun Bay disposal site is 0.2 million yd^3 (COE 1990a). The capacities of these sites are not known.

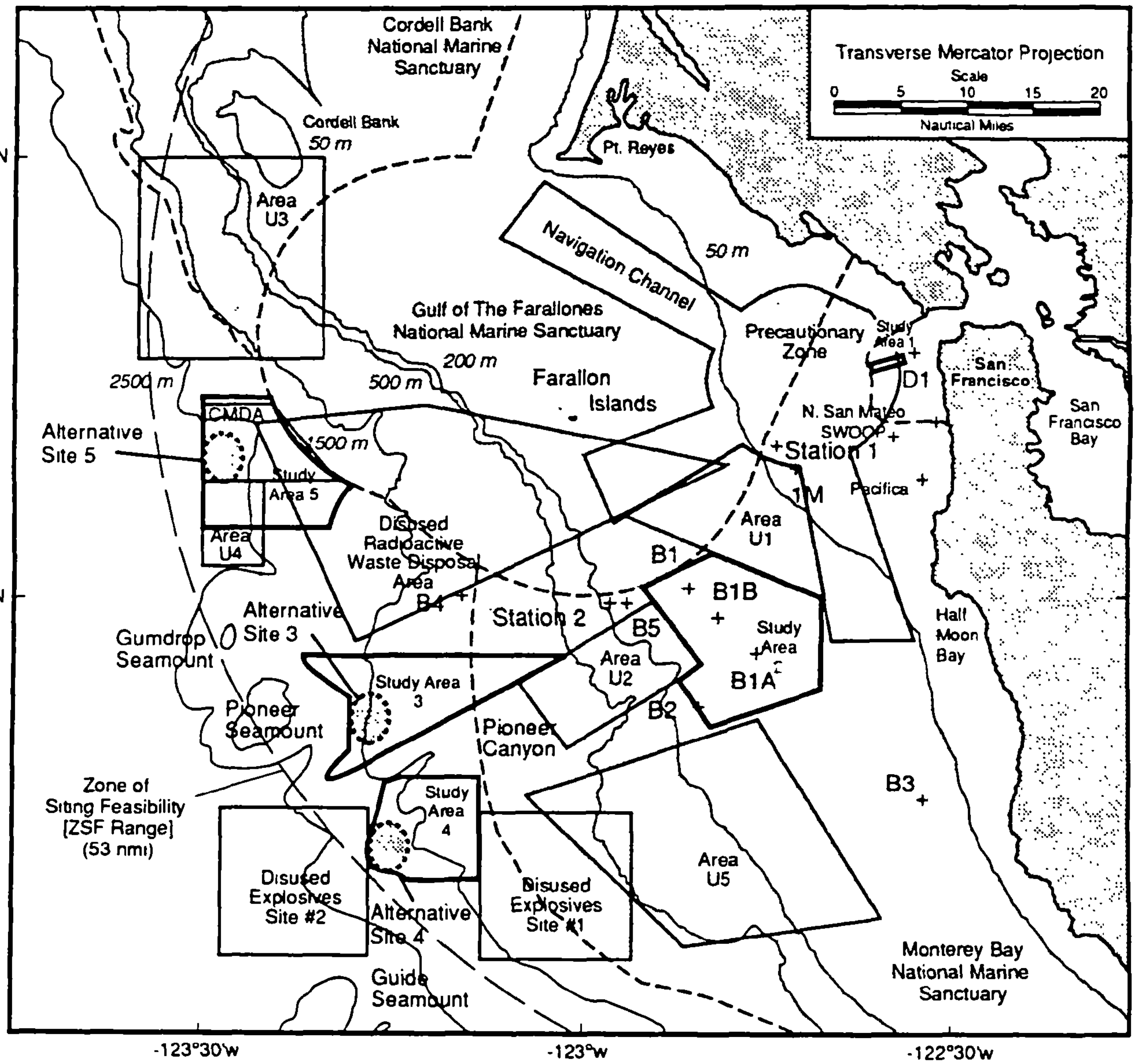

Figure 2.1-6. Locations of Study Areas 2 Through 5 Within the LTMS Study Region as Related to Sensitive and Incompatible Use Areas.

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Table 2.1-3. Designated Open Water Dredged Material Disposal Sites in the San Francisco Bay Region.

Site	Location	Target Disposal Volumes (yd^3)	Site Use Restrictions
Alcatraz	San Francisco Bay; Central Bay	4 million (annual) 0.3 million (monthly; May-September) 0.4 million (monthly; October-April)	Slurried Bay sediments or no more than 0.15 million yd^3 of material dredged with a clamshell dredge may be discharged within any 30-day period.
San Pablo	San Francisco Bay; North Bay	0.5 million (monthly or annual)	Slurried Bay sediments
Carquinez Straits	San Francisco Bay; North Bay	2.0 million (annual) 3.0 million (annual-wet year) 1.0 million (monthly)	Slurried Bay sediments
Suisun Bay	Suisun Bay; North Bay	0.2 million (annual-planning estimate)	Disposal of sandy sediment from adjacent shipping channel

Source: COE 1992a; COE 1990a; COE 1993.

The Alcatraz disposal site has received from 1.2 to 5.0 million yd^3 of dredged material per year since 1986 (COE 1990a, 1992a). Accurate disposal records for periods prior to 1986 are unavailable. Studies conducted at the Alcatraz disposal site in the early 1980s (e.g., SAIC 1987) indicated dispersion of the discharged sediments was lower than predicted, and accumulation and mounding of dredged material within the site was significantly limiting the capacity for long-term use. Consequently, since 1986, the COE has imposed a slurry requirement for material disposed at the site to promote dispersion and to minimize accumulation (COE 1990a). The present capacity of the Alcatraz site to accept slurried material is not known because the factors controlling dispersion are poorly understood (COE 1990a). Periodic removal of a portion of the accumulated materials from the Alcatraz site may be required in the future. Further, recently proposed changes to COE policy on Alcatraz site management, including reducing the maximum 30-day target volumes from 1.0 to 0.4 million yd^3 during October through April and limiting the volumes of material dredged by clamshell dredge to 0.15 million yd^3 within a 30-day period, were published in Public Notice 93-3 (COE 1993). These changes were proposed because "[e]xisting maximum volume targets have been determined inadequate to maintain the site for continued dredged material disposal."

Several resource and regulatory agencies—including the California Department of Fish and Game (CDFG), National Marine Fisheries Service (NMFS), and the SFBRWQCB—have expressed concern about the effects of open water disposal operations on fisheries resources in the Bay; alteration of benthic and shoreline habitats; increased water column turbidity; and remobilization of chemical contaminants associated with resuspended sediments. The BCDC's San Francisco Bay Plan also states that the capacity of existing dredged material disposal sites in the Bay are limited and disposal activities at these sites may have adverse impacts on the Bay's natural resources. The Bay Plan policies allow disposal within the Bay only if use of alternative disposal sites or options is deemed infeasible. In 1990, SFBRWQCB Resolution No. 89-130 was adopted conditionally by the California State Water Resources Control Board (Resolution No. 90-37). Resolution 89-130 included (1) target monthly and annual disposal volume limits for each of the sites within the Bay; and (2) a requirement for the COE to demonstrate "...that there are no significant or irreversible impacts occurring from the disposal of maintenance dredged material in San Francisco Bay." BCDC also has adopted similar volume targets for disposal in the Bay. The target limits for the annual disposal volumes at the San Pablo and Carquinez Straits sites are 0.5 million yd^3 and 2.0 million yd^3, respectively (except that the limit for the Carquinez Strait site during wet weather years is 3.0 million yd^3). The target annual volume for the Alcatraz site is 4.0 million yd^3 (Table 2.1-3). The resolution also states that the RWQCB will encourage land and ocean disposal alternatives whenever feasible. The measures contained in this resolution are implemented by the RWQCB through the issuance or denial of waste discharge requirements, water quality certifications under Section 401 of the Clear Water Act (CWA), or other orders for individual dredging projects that propose disposal volumes which exceed the annual or monthly targets.

The Bay Farm Borrow Area (BFBA) is being investigated by the COE as a potential confined aquatic disposal site. This site is located in the central Bay, immediately west of the northern portion of Bay Farm Island, and it consists of a "borrow pit" that was excavated in the 1950s for material used as fill for the Island and for dike construction and maintenance. The site dimensions are 2,800 m by 1,500 m, with an average potential fill depth of 3 m (i.e., the depth below the adjacent bottom) and an estimated capacity of 16 million yd^3. The environmental characteristics, including the physical and chemical characteristics of the bottom sediments, benthic infaunal abundances, fish abundances, current patterns, and the potential suitability of the BFBA as a confined open-water disposal site presently are being evaluated.

Other sites within the Bay which are potentially suitable for unconfined dredged material disposal were investigated by Nolte and Associates (1987) and PTI (1989). The capacities and dispersive characteristics of most of these sites are not known (COE 1992a). Designation of new sites within the Bay must comply with the requirements of Section 404(b)(1) of the CWA. Siting and use of sites within the Bay are regulated by COE, SFBRWQCB, and the BCDC, and EPA participates in an oversight and review capacity. The State and Regional Water Quality Control Boards are responsible for issuing water quality certifications (COE 1992a).

2.1.3.2 Nonaquatic Disposal and Reuse Alternatives

Existing and potential nonaquatic and reuse sites presently are being evaluated by the LTMS Nonaquatic/Reuse Work Group as candidate dredged material disposal sites. The use of existing nonaquatic disposal sites has declined in recent years due to extensive development, exhausted capacity, and restrictions against filling wetlands (COE 1990a). Of the 78 potential sites originally identified, 11 sites have been characterized as "highly feasible sites." These sites and their potential uses are listed in Table 2.1-4. Note that Redwood Sanitary Landfill is considered a separate site, and Cargill Salt Div-1 is considered two separate sites. The LTMS selected three of these potential disposal sites—Skaggs Island, Cargill Salt Div-1 (East), and Cargill Salt Div-1 (West)—for preliminary engineering feasibility assessments. Preliminary engineering feasibility assessments also have been prepared for the Leonard Ranch, Praxis/Pacheco, and Cargill Salt Div-1 (East) sites, which were identified as "highly feasible" for the development of dredged material rehandling facilities. The assessments are scheduled for completion in June 1993. The primary factors affecting the feasibility of dredged material disposal at nonaquatic sites include groundwater quality, distance from the dredging area, site capacity, local resource concerns, and monitoring requirements (COE 1992a).

Dredged material may have beneficial uses for projects such as marsh restoration, levee maintenance, beach nourishment, and landfill cover. These alternative disposal options are being evaluated independently as part of the LTMS process. However, the suitability of dredged material for use in any project will depend on a variety of engineering, economic, environmental, and regulatory considerations. For example, key factors affecting the feasibility typically include site access and capacity, compatibility of the dredged material with construction or engineering requirements, contaminant levels in dredged material, presence of critical habitat or endangered species, habitat replacement value, and regulatory requirements of local, state, and federal governments (COE 1992a). Specific beneficial or reuse options are summarized briefly below.

Table 2.1-4. Upland Reuse/Disposal Options Classified as "Highly Feasible" by the LTMS Nonaquatic/Reuse Work Group.

Candidate Site	Site Status and Feasibility	Projected Site Capacity (yd³)*	Additional Remarks
Port Sonoma-Marin	Presently used and "highly feasible" for continued use as rehandling facility.	0.06 million/yr throughput (for use at Redwood Sanitary Landfill).[1,2]	0.2 miles from existing barge access channel.
Leonard Ranch	Identified as "highly feasible" for dredged material rehandling project. LTMS preparing feasibility study to construct on-site rehandling facility. COE directed by Congress to study.	Up to 0.80 million/yr throughput (for possible use at Redwood Sanitary Landfill), if entire site used.[1,2]	1 mile from existing barge access channel. Need funding to undertake. Site owned by Sonoma Land Trust.
Praxis/ Pacheco	Identified as "highly feasible" for dredged material confined disposal and/or rehandling project. LTMS prepared a study in January 1993.	0.45 million/yr throughput for rehandling, or 2.5 million for confined disposal.[1,3]	Project constraints due to sewer easement. No project sponsor. Privately-owned; site acquisition and funding required. 3 miles from existing barge access channel.
Sonoma Baylands (330-acre project)	Identified as "highly feasible" for dredged material habitat creation project. Congressional direction to COE to undertake has yet to be approved.	2.5 million for habitat creation.	Need funding to undertake. 0.6 miles from existing barge access channel.
Montezuma Wetlands	Identified as "highly feasible" for dredged material habitat creation, contained disposal, and/or rehandling project; proposals pending for first two uses.	20 million for habitat creation or confined disposal; estimates for annual throughput from the rehandling facility are being developed.	0.1 mile from existing deep-water barge access channel.
Skaggs Island (Navy-owned)	Identified as "highly feasible" for dredged material confined disposal and/or habitat creation project; LTMS conceptual plan issued May 1993.	16.2 million for habitat creation, or 72 million for confined disposal.[3]	3-mile pumping distance across salt ponds. Would require Navy base closure and funding to undertake.
Cargill Salt Div. 1 (East and West)	Identified as "highly feasible" for dredged material confined disposal, rehandling, and/or habitat creation project. LTMS conceptual plans for habitat and confined disposal projects issued May 1993. LTMS reconnaissance level study for rehandling project issued June, 1993.	Up to 15 million/yr throughput for rehandling, or 9 million for confined disposal (at east site).[1,3] 11.4 million for habitat creation (at west site).	Option signed for public acquisition of west site in June 1993. If acquired by public, funding needed if dredged material is used to restore habitat. Adjacent to existing barge access channel.
Cullinan Ranch	Identified as "highly feasible" for dredged material habitat creation project. Possible subject of further LTMS research; FWS conducting preliminary planning.[4]	7.2 million for habitat creation.	FWS, project sponsor, unsure whether it will use dredged material. Need funding to undertake. 0.5 miles from existing barge access channel.
Hamilton AFB: Antenna Field	Identified as "highly feasible" for dredged material habitat creation project.	2.7 million for habitat creation.	Public site ownership; COE and CDFG potential project sponsors. Need funding to undertake. 3 miles from existing barge access channel.

*Capacities are preliminary planning estimates.
[1]Rehandling projection based on assumption that total amount of rehandled material removed annually; subject to change depending upon disposal site size and specific needs of end-user.
[2]Redwood will need up to 14 million yd³ of wet material, if landfill expansion permitted; if not permitted, only 1.6 million yd³ of wet material will be needed by Redwood.
[3]Confined disposal projection based on assumption that multiple disposal events and an average 40% compaction rate for in-place, dry material will occur; subject to change depending upon disposal site size.
[4]Shell Oil Trust will fund initial studies.

Source: LTMS Non-Aquatic/Reuse Work Group, 1992.

Several habitat development and marsh restoration projects have been proposed at sites within the San Francisco Bay area. The six sites/projects ranked as highly feasible by the LTMS Upland/Reuse Work Group are (1) Cargill Salt Div-1 (West); (2) Hamilton Antenna Field; (3) Cullinan Ranch; (4) Sonoma Baylands; (5) Montezuma Wetlands; and (6) Skaggs Island (Table 2.1-4). The capacities of these proposed projects for dredged material range from approximately 2.5 to 20 million yd^3.

The proposed levee rehabilitation/maintenance projects evaluated as dredged material disposal options are located in the Sacramento and San Joaquin River delta area. The primary sites and estimated capacities include Sherman Island (1.6 million yd^3); Twitchell Island (1.0 million yd^3); Jersey Island (1.6 million yd^3); Lower Jones Tract (0.8 million yd^3); Chipps Island (2.0 million yd^3); and Tubbs Island (capacity presently unknown) (COE 1990, 1992a). The primary constraints in using sediments dredged from San Francisco Bay for delta area levees are the potential effects of adding saline waters (associated with the dredged material) to a freshwater environment (COE 1992a).

Some of the sediments dredged from San Francisco Bay may be suitable for landfill cover and construction fill. Nolte and Associates (1987) estimated that 115,000 yd^3 per year of dried (processed) dredged material could be used for construction fill and 15,300 yd^3 per year could be used at sanitary landfill sites. The Redwood Sanitary Landfill near San Pablo Bay was identified by the LTMS Upland/Reuse Work Group as a landfill which could use from 140,000 to 440,000 yd^3 of dredged material annually from 1993 to 1997 if landfill expansion is permitted. Both Port Sonoma-Marin and Leonard Ranch sites have been identified as highly feasible sites for rehandling dredged material intended for Redwood Sanitary Landfill (Table 2.1-4).

Ocean Beach, south of the Golden Gate, has been severely eroded, and California Coastal Commission staff has suggested that this area may be a candidate site for beach nourishment (L. Madalon, COE, pers. comm. 1992). However, it is likely that the majority of sediments from the planned dredging projects would not be consistent in quality or size with the sands that occur on the beaches, and therefore would be inappropriate for nourishment of this or other local beaches. The use of dredged material for beach nourishment will be evaluated by COE on a project-specific basis.

As discussed in Chapter 1 of this EIS, designation of an ODMDS does not preclude further consideration of in-Bay or Nonaquatic/Reuse alternatives for specific projects. The COE and EPA will evaluate other feasible alternatives on a project-specific basis during the MPRSA Section 103 permitting process. In addition, the LTMS Implementation Work Group will address disposal and beneficial reuse options for the San Francisco Bay area.

2.2 Discussion of Alternatives

This section presents a discussion of the alternatives that are not being considered for further analysis (Section 2.2.1), a discussion of how the three proposed ocean disposal site alternatives comply with EPA's general and specific site selection criteria (Sections 2.2.2 and 2.2.3, respectively), and a discussion of the preferred alternative (Section 2.2.4). Detailed information and an evaluation of each candidate disposal site with EPA's general and specific criteria are presented in Chapter 3, Affected Environment, and Chapter 4, Environmental Consequences.

The locations of Alternative Sites 3, 4, and 5 were determined from results of EPA- and Navy-sponsored studies of the regional ocean circulation patterns and surveys of the benthic environments (bottom sediments and bottom-dwelling organisms). The alternative site locations correspond to low-energy depositional zones which contain sediments similar in grain size to those within the Bay (Section 3.2). Disposal in such zones should minimize the dispersion of dredged material and the area of impact. Alternative Sites 3 and 4 are located along the central western and southwestern boundaries of Study Areas 3 and 4, respectively. Alternative Site 5 is located along the central portion of the western boundary of Study Area 5, and corresponds to the location of the NODS (Navy 1993) (Figure 2.1-3).

The size of the alternative sites was determined from the results of dredged material deposition (footprint) modeling (Section 4.2.1.4). The site boundary was intended to encircle the model-predicted 10-mm thick deposit of "mostly clay-silt " material (74% clay and 16% silt) after a one-year dredged material disposal period at Alternative Site 5. The 10-mm thick deposit was boundary used to delineate the site because this thickness represents (1) an amount of material approximately one order of magnitude greater than the minimum thickness that might be measured using existing technology (1 mm) and (2) is approximately one order of magnitude lower than the 100-mm thickness threshold above which impacts, such as smothering of bottom-dwelling organisms, are expected to be significant. Thus, the 100-mm thick deposits would be completely incorporated within each site boundary. Deposition over a one-year period, instead of the 50-year project period, was used as the basis for delineating the site boundaries because natural physical and biological recolonization processes are expected to offset potential effects due to deposition of dredged material at rates less than 10 cm per year. Thus, the present site boundaries are intentionally conservative. Also, because the site boundaries are based on the sediment deposition footprint, the authorized discharge area at the surface will be smaller than the area of the actual disposal site to account for dispersion during settling and to allow material to reach the bottom within the site boundaries. The areas of the model-predicted 10-mm thick deposits at Alternative Sites 3 and 4 are smaller than that at Alternative Site 5. However, to be conservative, the size and configuration of Alternative Sites 3 and 4 are the same as Alternative Site 5. Therefore, each site is an oval shape with dimensions of approximately 3.7 nmi (6.9 km) long and 2.2 nmi (4.1 km) wide, and an area of approximately 6.4 nmi^2 (22 km^2).

2.2.1 *Alternatives Not Considered for Further Analysis*

The No-Action Alternative, Study Area 1, and Study Area 2 will not be considered further as alternatives in this EIS. The LTMS mission is to provide long-term options, including ocean disposal, to accommodate the dredged material volumes and compositions anticipated for the 50-year planning period. The No-Action Alternative would impede the use of ocean disposal as a long-term management option and therefore is an undesirable alternative. Study Area 1, corresponding to the Channel Bar ODMDS, is only designated for disposal of sandy material from the San Francisco Bay entrance channel. The LTMS considered changing the designation of this ODMDS to accept sand from other dredging projects in the Bay, but decided that the amount of potentially suitable material would be too small to warrant redesignating the site. This area was eliminated from further consideration. Study Area 2 originally was included as a candidate location on the continental shelf, and was subjected to considerable study effort by the COE (KLI 1991) and EPA (SAIC 1992b,c). Nevertheless, based on its location within the MBNMS, and because dredged material disposal at a new ODMDS within the Sanctuary is prohibited (NOAA 1992), Study Area 2 also has been eliminated from further consideration as an ODMDS. Because extensive and valuable studies have already been conducted as part of EPA's ocean site designation efforts, the environmental characteristics of Study Area 2 are presented in Chapter 3 of this EIS to provide a basis for comparison with Study Areas 3, 4, and 5.

2.2.2 *Compliance of the Alternative Sites and Study Area 2 with General Criteria for the Selection of Sites*

2.2.2.1 General Criterion 40 CFR 228.5(a)

The dumping of materials into the ocean will be permitted only at sites or in areas selected to minimize the interference of disposal activities with other activities in the marine environment, particularly avoiding areas of existing fisheries or shellfisheries, and regions of commercial or recreational navigation.

Alternative Sites 3, 4, and 5 are in water depths greater than 1,600 m, on the lower continental slope, and are characterized by sparsely distributed fisheries species of potential commercial value, including marginally targeted commercial fisheries species such as rattails (Section 3.4). The use of any of the alternative sites would have minimal effects on existing fisheries or shellfisheries, although vessels towing dredged material barges would pass through sanctuary and fisheries areas. A direct route to Alternative Site 5 (Figure 2.1-1) is of concern because accidents or problems with barges in the vicinity of the Farallon Islands could result in inadvertent releases of dredged material with potential impacts to biological communities. However, the Site Management and Monitoring Plan (SMMP) and site use conditions in MPRSA Section 103 permits will require barges to stay within established navigation lanes and greater than 3 nmi from the Farallon Islands. These conditions would minimize potential impacts of transit.

None of the alternative sites is located within the precautionary zone, navigation lanes, or submarine operating areas (Section 2.1.2.3). Therefore, commercial shipping traffic heading south towards or north from San Francisco should not be affected by use of any of the alternative sites. Dredged material barges transiting directly to Alternative Site 5 would pass along routes potentially used by boats engaged in such activities as bird watching, whale watching, or sailing near the Farallon Islands. However, the SMMP requires dredged material barges to stay within the navigation lanes and at least 3 nmi from the Farallon Islands, thereby minimizing potential interferences with activities or navigation in the vicinity of the Islands.

Because of its location closer to shore and the Golden Gate, the nearshore region including Study Area 2 represents greater potential access for smaller vessels, as well as larger commercial traffic, passing south from or north to San Francisco. Therefore, Study Area 2 likely would be associated with more commercial and recreational boat traffic than Alternative Sites 3, 4, or 5.

2.2.2.2 General Criterion 40 CFR 228.5(b)

Locations and boundaries of the disposal sites will be so chosen that temporary perturbations in water quality or other environmental conditions during initial mixing caused by disposal operations anywhere within the site can be expected to be reduced to normal ambient seawater levels or to undetectable concentrations or effects before reaching any beach, shoreline, marine sanctuary, or known geographically limited fishery or shellfishery.

Alternative Sites 3, 4, and 5 are located outside of any sanctuary boundaries. Results of modeling dispersion of dredged material from the alternative sites (see Sections 4.2 and 4.4) indicate very low probabilities of suspended particles from the disposal being transported into the GOFNMS, CBNMS, or MBNMS. Further, predicted dilution rates would reduce the suspended particle concentrations to within the range of normal, ambient levels near the sanctuary boundaries. Thus, disposal at Alternative Sites 3, 4, or 5 would result in undetectable effects on water quality parameters such as turbidity, dissolved oxygen, or trace contaminant concentrations at sanctuary boundaries. Based on sediment footprint modeling studies for each alternative site (see Sections 4.2 and 4.4), dredged material would not be deposited in detectable thicknesses within any of the sanctuary boundaries.

Alternative Sites 3, 4, and 5 are located at least 25 nmi from the Farallon Islands and approximately 50 nmi from any mainland beach or shoreline (Figure 2.1-1). Therefore, dredged material disposal activities are not likely to cause effects to these resource or amenity areas. Alternative Sites 3, 4, and 5 are not located within or adjacent to a geographically limited fishery or shellfishery.

Study Area 2 is located entirely within the MBNMS (Figure 2.1-1) and therefore could not meet the criterion of avoiding any significant water quality changes within a sanctuary. Also, an important fisheries area exists on the continental shelf off San Francisco and encompasses Study Area 2 and the shoreward portion of Study Area 3.

2.2.2.3 General Criterion 40 CFR 228.5(c)

If at any time during or after disposal site evaluation studies, it is determined that existing disposal sites presently approved on an interim basis for ocean dumping do not meet the criteria for site selection set forth in Sections 228.5 through 228.6, the use of such sites will be terminated as soon as suitable alternate disposal sites can be designated.

The MPRSA site selection process is designed to identify a preferred alternative that minimizes or avoids unacceptable impacts to the physical, biological, and socioeconomic environment. The continued use of a designated disposal site will be evaluated as part of the site management and monitoring program administered jointly by EPA Region IX and the COE, San Francisco District (see Section 4.6).

2.2.2.4 General Criterion 40 CFR 228.5(d)

The sizes of ocean disposal sites will be limited in order to localize for identification and control any immediate adverse impacts and permit the implementation of effective monitoring and surveillance programs to prevent adverse long-range impacts. The size, configuration, and location of any disposal site will be determined as a part of the disposal site evaluation or designation study.

The sizes and configurations of the three alternative sites are based on the results of footprint and water quality modeling studies to identify potential areas of significant sediment accumulation and plume dispersion from dredged material disposal (Sections 4.2 and 4.4). In general, site size will be limited, yet will encompass modeled regions of detectable sediment deposition, based on one year of disposal activity. The site locations are chosen to coincide with low-energy depositional zones, identified by survey results (Section 3.2), where resuspension and dispersion of the deposited dredged material will be minimized and monitoring of long-term effects will be facilitated. Water quality modeling results indicate that disposal within any of the alternative sites would result in probabilities of less than 5% that any class of suspended particles would be transported into a sanctuary (Sections 4.2 and 4.4). Evaluation of the continued acceptability of a designated site will be conducted in accordance with the SMMP.

2.2.2.5 General Criterion 40 CFR 228.5(e)

EPA will, wherever feasible, designate ocean dumping sites beyond the edge of the continental shelf and other such sites that have been historically used.

Alternative Sites 3, 4, and 5 are located on the continental slope, beyond the edge of the continental shelf.

The only study area that has been used for disposal is Study Area 5 (which contains Alternative Site 5). From 1951–54, the general Study Area 5 region, particularly the southeast area, received sealed containers of low-level radioactive wastes from defense-related, commercial, and laboratory activities (Section 3.1). Additionally, from approximately 1958 to the late 1960s, chemical and conventional munitions were disposed in the northern portion of the study area by the U.S. Navy (Section 3.1). It is not known how much of this waste material is present within the boundaries of Alternative Site 5.

Prior to 1993, no dredged material had been disposed at Alternative Site 5. However, between May 1993 and December 1994 the U.S. Navy will discharge approximately 1.2 million yd^3 of dredged material within the NODS, corresponding to the approximate location of Alternative Site 5, under a project-specific MPRSA Section 103 permit (Navy 1993). Thus, Alternative Site 5 also has been used previously as a dredged material disposal site.

Study Area 2 is the only study area located on the continental shelf, in water depths less than approximately 200 m (Figure 2.1-1). The B1B site, located within Study Area 2, was used in 1988 for limited dredged material disposal (approximately 18,000 yd^3) (Section 3.1). Thus, this site could be considered a historically used site. However, it now lies within the MBNMS and, therefore, will not be designated as an ODMDS.

2.2.3 Comparison of the Alternatives to EPA's 11 Specific Criteria for Site Selection 40 CFR 228.6(a)

The characteristics of Alternative Sites 3, 4, and 5 (as well as Study Area 2) with respect to EPA's 11 specific criteria for site selection are compared in Table 2.2-1. These comparisons are used as the basis for selection of the preferred alternative as discussed in Section 2.2.4. Detailed information on the physical, biological, and socioeconomic environment and potential impacts of the proposed action are presented in Chapters 3 and 4.

2.2.4 Selection of the Preferred Alternative

Based on comparisons of the alternative sites to the specific site selection criteria, Alternative Site 5 has been selected by EPA and the LTMS Ocean Studies Work Group as the preferred alternative. This site was selected for the following reasons:

- Bathymetric and sediment surveys indicate Alternative Site 5 is located in a depositional area which, because of existing topographic containment features, is likely to retain dredged material which reaches the sea floor. This is similar to the containment potential at Alternative Site 3 but greater than that at Alternative Site 4;

- No significant impacts to other resources or amenity areas (e.g., marine sanctuaries) are expected to result from designation of Alternative Site 5;

- Existing and potential fisheries resources within Alternative Site 5 are minimal and the site is removed from more important fishing grounds located near Alternative Sites 3 and 4;

- Potential impacts to bottom-dwelling organisms are considered significant at all of the alternative sites, but the magnitude of the impacts varies because of differences in site-specific densities. Abundances and biomass of demersal fishes and megafaunal invertebrates, and the abundances and diversity of infaunal invertebrates, at Alternative Site 5 are lower than those at Alternative Sites 3 and 4. Thus, the relative magnitude of impacts at Alternative Site 5 are expected to be less than those at Alternative Sites 3 and 4.

- Potential impacts to other surface and mid-water dwelling organisms (e.g., seabirds, mammals, and midwater organisms) are expected to be insignificant regardless of which of the alternative sites is used for dredged material disposal;

- Disposal of low-level radioactive wastes and chemical and conventional munitions occurred historically in the vicinity of Alternative Site 5. (Disposal within the site of 1.2 million yd^3 of dredged material will occur during May 1993 through December 1994 as part of the Navy MPRSA Section 103 project). No waste disposal has occurred previously within Alternative Sites 3 or 4.

Table 2.2-1. Comparison of the Three Alternative Ocean Disposal Sites and Study Area 2 Based on the 11 Specific Criteria at 40 CFR 228.6(a).

Criteria	Alternative Site 3 (Study Area 3)	Alternative Site 4 (Study Area 4)	Alternative Site 5 (Study Area 5)	Study Area 2
1. Geographical position, depth of water, bottom topography and distance from coast.	• Lower Continental Slope site, approx. 50 nmi from coast and 47.12 nmi from Golden Gate*; 5 nmi N of Pioneer Canyon, and 5 nmi E of Pioneer Seamount (Figure 2.1-2). • Depths range from approx. 1400 to 1900 m. • Located in a topographic low that is bounded to the west by Pioneer Seamount and to the east by a moderately steep slope. • Sediments comprised mostly of silt-sized sediments; no known hard-bottom features occur within the site.	• Lower Continental Slope site, approx. 50 nmi from coast and 54.95 nmi from Golden Gate*; 10 nmi S of Pioneer Canyon, and 15 nmi SE of Pioneer Seamount (Figure 2.1-2). • Depths range from approx. 1900 to 2100 m. • Moderately sloping bottom that is unbounded (as compared to Alternative Site 3). • Sediments comprised mostly of sand and silt-sized sediments; no known hard-bottom features occur within the site.	• Lower Continental Slope site, approx. 60 nmi from coast and 49.23 nmi from Golden Gate* (Figure 2.1-2). • Depths range from approx. 2500 to 3000 m. • Same as Alternative Site 4. • Sediments comprised mostly of fine grained silts and clays; no known hard-bottom features occur within the site.	• Continental Shelf site, approx. 10–25 nmi from coast and 26 nmi from Golden Gate (Figure 2.1-2). • Depths range from approx. 70 to 90 m. • Gently sloping bottom. • Sediments comprised mostly of sands with some silts; no known hard-bottom features occur within the site.

*Assumes barges would be required to stay within westbound traffic lanes (COE 1992c).

Table 2.2-1. Continued.

Criteria	Alternative Site 3 (Study Area 3)	Alternative Site 4 (Study Area 4)	Alternative Site 5 (Study Area 5)	Study Area 2
2. Location in relation to breeding, spawning, nursery, feeding or passage areas of living resources in adult or juvenile stages.	• Low numbers of demersal fish species and abundances (as compared to Study Area 2).	• Same as Alternative Site 3.	• Lower numbers of demersal species and abundances than those at Alternative Sites 3 and 4.	• Important fisheries area of general shelf region.
	• Moderate numbers of megafaunal invertebrate species and abundances.	• Same as Alternative Site 3.	• Lower overall abundances but higher number of megafaunal invertebrate species than those at Alternative Sites 3 and 4.	• Low abundances of megafaunal invertebrates, although high abundances of juvenile Dungeness crabs have been reported historically in the vicinity.
	• Moderate apparent use by marine birds and mammals.	• Low apparent use by marine birds and mammals (as compared to Alternative Sites 3 and 5).	• High apparent use by marine birds and mammals (as compared to Alternative Sites 3 and 4).	• Same as Alternative Site 5.
	• Moderate abundances of midwater fish species including juvenile rockfishes.	• Same as Alternative Site 3.	• High seasonal abundances of some midwater species including juvenile rockfishes (as compared to Alternative Sites 3 and 4).	• Same as Alternative Site 5.
	• Infauna community very diverse and abundant.	• Same as Alternative Site 3.	• Infauna community with relatively lower diversity and abundance (as compared to Alternative Sites 3 and 4).	• Typical shelf community but very high abundances and moderate diversity.
	• Located approx. 5 nmi from Pioneer Canyon and Pioneer Seamount; both reportedly characterized by hard-bottom communities; currents move away from Canyon.	• Located approx. 10 nmi South of Pioneer Canyon but transport of dredged material would be towards Canyon based on generally northward-flowing currents.	• Located approximately 30 nmi from Pioneer Canyon; currents move away from Canyon.	

Table 2.2-1. Continued.

Criteria	Alternative Site 3 (Study Area 3)	Alternative Site 4 (Study Area 4)	Alternative Site 5 (Study Area 5)	Study Area 2
3. Location in relation to beaches and other amenity areas.	• Located at least 50 nmi from coastal resources and amenity areas (Figure 2.1-1); therefore unlikely to be of concern. • Located approx. 10 and 15 nmi from MBNMS and GOFNMS, respectively, and 30 nmi from the Farallon Islands. Therefore, limited concern based on water quality modeling results (Section 4.4).	• Same as Alternative Site 3. • Located approx. 10 and 30 nmi from MBNMS and GOFNMS, respectively, and 45 nmi from the Farallon Islands. Therefore, limited concern based on water quality modeling results (Section 4.4).	• Located at least 60 nmi from coastal resources and amenity areas (Figure 2.1-1); therefore unlikely to be of concern. • Located approx. 10 and 30 nmi from GOFNMS and the Farallon Islands, respectively. Therefore, limited concern based on water quality modeling results (Section 4.2).	• Located at least 15 nmi from coastal resources and amenity areas (Figure 2.1-1); therefore unlikely to be of concern. • Located within MBNMS, adjacent to the GOFNMS, and approx. 15–30 nmi from the Farallon Islands. Primary concern related to within-sanctuary location.
4. Types and quantities of wastes proposed to be disposed of, and proposed methods of release, including methods of packing the waste, if any.	Composition of dredged material is expected to range between two types: predominantly 'clay-silt' (74% clay, 5% silt, 21% sand) versus 'mostly sand' (76% sand, 21% clay, 3% silt). Site use over a 50-year period could total 400 million yd^3, with approx. 6 million yd^3 per year and between 1,000-6,000 yd^3 per barge trip. Split-hull barges towed by ocean-going tugboats are most likely disposal method.	Same as Alternative Site 3.	Same as Alternative Site 3.	Not applicable.

Table 2.2-1. Continued.

Criteria	Alternative Site 3 (Study Area 3)	Alternative Site 4 (Study Area 4)	Alternative Site 5 (Study Area 5)	Study Area 2
5. Feasibility of surveillance and monitoring.	• USCG has surveillance responsibility; radar not feasible; ODSS-like system feasible. • Monitoring feasible but difficult because of deep water depths and subsequent greater dispersion of dredged material, and limited knowledge of potential impacts to deep-water communities.	• Same as Alternative Site 3. • Same as Alternative Site 3; however, Alternative Site 4's location near Disused Explosives Sites #1 and #2 may represent some additional potential for hazards during monitoring of bottom conditions.	• Same as Alternative Site 3. • Feasibility will be determined partly based on the Section 103 permit activities at NODS. Monitoring feasible but may be more difficult because of greater water depths, somewhat larger footprint, limited knowledge of deep-water communities, and some potential hazards from historical disposal of radioactive waste containers and chemical and conventional munitions.	• USCG has surveillance responsibility; radar or ODSS-like system feasible. • Monitoring would be simplified due to shallow depths, but material would be resuspended and dispersed farther than at deeper sites, making impact assessment more difficult.
6. Dispersal, horizontal, transport and vertical mixing characteristics of the area, including prevailing current direction and velocity, if any.	• Flows primarily to northwest in upper 800-900 m, although periodic reversals in flow occur. Currents below 1,000 m generally weaker than near-surface currents. Near-bottom flows may be enhanced by tidal influences and topography. Sediment resuspension within Site expected to be minimal.	• Similar to Alternative Site 3.	• Similar to Alternative Site 3.	• High energy area; frequent bottom scouring and rapid dispersal of sediments.

Table 2.2-1. Continued.

Criteria	Alternative Site 3 (Study Area 3)	Alternative Site 4 (Study Area 4)	Alternative Site 5 (Study Area 5)	Study Area 2
7. Existence and effects of current and previous discharges and dumping in the area (including cumulative effects).	• No current or previous disposal activities. • The site is within approx. 5 nmi of Disused Explosives Site #2 (Figure 2.1-6); however, there are no known effects.	• No current or previous disposal activities. • Tho sito adjoins Disused Explosives Site #2 and is within approx. 5 nmi of Disused Explosives Site #1 (Figure 2.1-6); however, there are no known effects.	• The Navy is discharging up to 1.2 million yd^3 of dredged material at NODS under an MPRSA Section 103 permit. • No other documented disposal within the site; however disposal of radioactive waste containers was conducted in the general Study Area region from 1951-54. Chemical and conventional munitions were disposed from approx. 1958 to late 1960s at the Chemical Munitions Disposal Area. Potential environmental effects are unknown, but there was no evidence during recent surveys of residual contamination. Therefore, potentials for cumulative impacts are considered unlikely.	• No current disposal activities. • Limited historical dredged material disposal (18,000 yd^3) in 1988; this small volume is unlikely to have caused any significant effects.

Table 2.2-1. Continued.

Criteria	Alternative Site 3 (Study Area 3)	Alternative Site 4 (Study Area 4)	Alternative Site 5 (Study Area 5)	Study Area 2
8. Interference with shipping, fishing, recreation, mineral extraction, desalination, fish and shellfish culture, areas of special scientific importance and other legitimate uses of the ocean.	• Only slight potential for interference with other uses of the ocean, including shipping, fishing, recreation, and areas of special scientific importance (such as the Farallon Islands), is likely. • NMFS has a sablefish study area within Study Area 3 but it is shallower than the alternative site.	• Same as Alternative Site 3.	• Potential interferences with recreational and scientific boat traffic, particularly near the Farallon Islands, will be minimized by requirements that barges remain at least 3 nmi from Islands. Under normal conditions, no interference with areas of special importance is expected; however, accidents resulting in releases of material near the Farallones may be a concern. This will also be mitigated by requiring barges to remain 3 nmi from Islands.	• Relatively greater interference (as compared to other alternative sites) with shipping, fisheries, and recreation due to location on Continental Shelf. No significant interference with other uses of the ocean is expected.

Table 2.2-1. Continued.

Criteria	Alternative Site 3 (Study Area 3)	Alternative Site 4 (Study Area 4)	Alternative Site 5 (Study Area 5)	Study Area 2
9. Existing water quality and ecology of the site as determined by available data or by trend assessment or baseline surveys.	• Good water quality.	• Same as Alternative Site 3.	• Same as Alternative Site 3.	• Good water quality, although turbidity may be high (as compared to the alternative sites) due to influence of San Francisco Bay outflow.
	• Sediments contain background levels or low concentrations of trace metal and organic contaminants.	• Same as Alternative Site 3.	• Same as Alternative Site 3.	• Same as Alternative Site 3.
	• Demersal fish community has low (as compared to Study Area 2) numbers of species and abundances (rattails, thornyhead rockfish, eelpouts).	• Same as Alternative Site 3.	• Demersal fish community has lower numbers of species and abundances (rattails, eelpouts, finescale codling) than Alternative Sites 3 and 4.	• Fish community diverse and abundant (e.g., flatfishes and rockfishes).
	• Moderate number of megafaunal invertebrate species and abundances (sea cucumbers, seastars, brittlestars).	• Same as Alternative Site 3.	• Moderate number of megafaunal invertebrate species but lower overall abundances (sea cucumbers, brittlestars, sea pens) than Alternative Sites 3 and 4	• Megafaunal invertebrates sparse.

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Table 2.2-1. **Continued.**

Criteria	Alternative Site 3 (Study Area 3)	Alternative Site 4 (Study Area 4)	Alternative Site 5 (Study Area 5)	Study Area 2
9. Continued.	• Infaunal invertebrates very diverse and abundant (polychaetes, amphipods, tanaids, isopods). • Moderate apparent use area by marine birds and mammals (as compared to Alternative Site 5 and Study Area 2). • Juvenile rockfishes less abundant seasonally (as compared to Alternative Site 5 and Study Area 2).	• Infaunal invertebrates same as Alternative Site 3, but fewer amphipods. • Low apparent use area by marine birds and mammals (as compared to Alternative Site 3). • Same as Alternative Site 3.	• Infaunal invertebrates lower diversity and abundance (polychaetes, amphipods, isopods, tanaids) compared to Alternative Sites 3 and 4. • Higher apparent use by marine birds and mammals compared to Alternative Sites 3 and 4. • Mid-water organisms, including juvenile rockfishes, abundant seasonally (as compared to Alternative Sites 3 and 4).	• Infaunal invertebrates very high abundances and moderate diversity (polychaetes, amphipods, gastropods). • High use area by marine birds and mammals (as compared to Alternative Sites 3 and 4). • Juvenile rockfishes abundant seasonally (as compared to Alternative Sites 3 and 4).
10. Potentiality for the development of nuisance species at the disposal site.	Unlikely to recruit nuisance species from dredged material due to significant differences in water depth and environment at the disposal site as compared to dredging site; no other disposal site impacts are expected that would result in nuisance species.	Same as Alternative Site 3.	Same as Alternative Site 3.	Same as Alternative Site 3.
11. Existence at or in close proximity to the site of any significant natural or cultural features of historical importance.	There are no known significant natural or cultural features.	Same as Alternative Site 3.	Same as Alternative Site 3.	Same as Alternative Site 3.

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CHAPTER 3

AFFECTED ENVIRONMENT

This chapter describes ocean disposal site characteristics, and the physical, biological, and socioeconomic characteristics of the LTMS study areas and alternative sites (Sections 3.1 through 3.4, respectively). This information provides the basis for evaluating the environmental consequences of the proposed action (Chapter 4) and for evaluating the specific alternatives (Chapter 2). The information regarding disposal site characteristics also addresses elements from several of the general and specific ocean disposal selection criteria (Table 1.1-1).

3.1 Ocean Disposal Site Characteristics

This section addresses historical uses of the LTMS study areas (Section 3.1.1); types and quantities of materials to be disposed of (Section 3.1.2); existence and effects of current and previous disposal operations in the study region (Section 3.1.3); and the feasibility of surveillance and monitoring of alternative sites (Section 3.1.4).

3.1.1 Historical Use of the Study Region [40 CFR 228.5(e)]

3.1.1.1 Dredged Material Disposal

Routine dredged material disposal operations have not occurred within any of the study areas. However, limited dredged material disposal activities have occurred at Site B1B located within Study Area 2 (Figure 3.1-1). Historically, three ocean sites outside of the study areas have received dredged material from San Francisco Bay. These sites include (1) the nearshore Bay Area Rapid Transit (BART) site; (2) the 100-Fathom site; and (3) the COE experimental site (Figure 3.1-1). The Channel Bar Site is used routinely for disposal of dredged material from the entrance to San Francisco Bay, but because of differences in grain size is not designated for disposal of sediments from within the Bay. The historical uses of these sites for dredged material disposal are summarized in Table 3.1-1.

The B1B site, located within Study Area 2, was used between May 12 through 16, 1988 for disposal of 18,000 yd^3 (six hopper barge loads) of sediments from the Port of Oakland Harbor Deepening Project. Disposal operations at this site were enjoined due to a lawsuit and a State Court injunction (COE 1989). Additionally, the B1B site is located within the boundaries of the Monterey Bay National Marine Sanctuary (MBNMS).

The BART site received dredged material, primarily mud-sized sediments, generated during 1966 and 1967 from construction of the Trans-Bay Tube. The site was located inshore from the

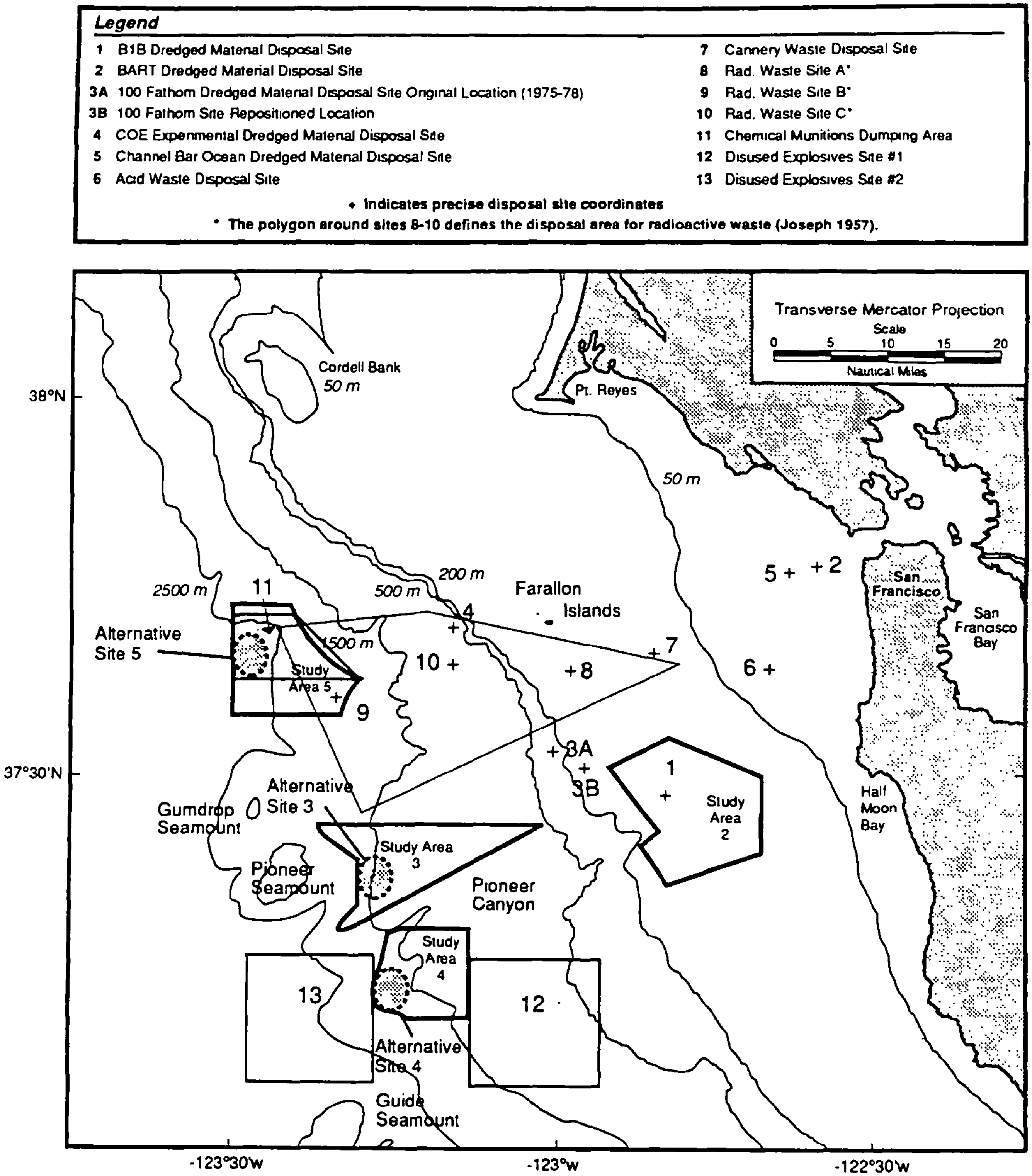

Figure 3.1-1. **Locations of Previously Used Ocean Waste Disposal Sites Within the LTMS Study Region.**
The 50m, 200m, 500m, 1,500m, and 2,500m contours correspond to the 28, 110, 275, 825, and 1,375 fathom contours, respectively.
Sources: IEC 1973; EPA 1975; Dyer 1976; NOAA 1980; MMS 1987; Delgado and Haller 1989; Colombo and Kendig 1990.

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Table 3.1-1. Summary of Dredged Material Disposal Site Locations and Disposal Activities Within the LTMS Study Region.

SITE NAME	DEPTH (m)	DATE & DURATION OF USE	ESTIMATED VOLUME DISPOSED	LATITUDE, LONGITUDE
Channel Bar Site[1,2]	18.3	Maintenance Work (1959-present) New Projects (1972-1976) Total Maintenance (1976-present)	600,000 yd^3/yr 8,800,000 yd^3 9,079,533 yd^3	37°45'N, 122°36'W
BART Site[3]	20.1-25.6	1966-1967	2,300,000 yd^3	37°46.5'N, 122°32.5'W
100 Fathom Original Location[1,4]	183	1975 1977 1978	unknown 20,000 yd^3 60,000 yd^3	37°32'N, 122°59'W
100 Fathom Repositioned Location[4]	183	unknown	unknown	37°31'N, 122°57'W
COE Test Site[5]	183	1974	4,000 yd^3	37°41'N, 123°7.5'W
B1B[4]	69.5-87.8	1988	18,000 yd^3	37°29'N, 122°48'W

Sources:
[1] EPA 1982
[2] T. Bruch (COE), pers. comm. 1992
[3] Ebert and Cordier 1966
[4] COE 1989
[5] COE 1975

Channel Bar Site and 0.9–5.6 km from shore. The quantities of sediments generated from this project were estimated to be 2.3 million yd^3 (Ebert and Cordier 1966). However, this site also is located near the boundaries of the MBNMS.

The 100-Fathom site was used in 1975 for disposal of an unspecified volume of material from Oakland Harbor that was considered too contaminated for disposal within the Bay (COE 1989). An additional 20,000 yd^3 and 60,000 yd^3 of muds from Oakland Inner and Outer Harbors were reportedly discharged at this site in 1977 and 1978, respectively (EPA 1982). The site was then moved five kilometers closer to shore to allow radar surveillance of the disposal operations. However, there is no record that the new site was ever used for dredged material disposal. The site was canceled in 1983 upon establishment of the GOFNMS (48 FR 5558, February 7, 1983).

The COE experimental site was located approximately 20 km northwest of the 100-Fathom site. The experimental site was used in 1974 for a test disposal of 4,000 yd^3 of muddy sediment from San Francisco Bay (COE 1975). The purpose of the test was to provide a qualitative description of the general dispersion of dredged material disposed at the continental shelf break. Post-disposal monitoring determined the amount of dredged material successfully placed at the site. This new location was selected to avoid interactions with previous disposal operations at the 100-Fathom site that could compromise test results. Results from the post-disposal survey are described in COE (1975).

The Channel Bar Site has been used since 1959 for maintenance dredged material from the main San Francisco shipping channel. The original site was located 0.5 nmi south of the main ship channel (EPA 1982). In 1972, the site was moved from its original location to a site 1.0 nmi south of the main ship channel to reduce the possibility that discharged sediments could be transported back into the channel. Present channel maintenance programs generate approximately 900,000 cubic yards (yd^3) of dredged material per year which are disposed of at this site (T. Wakeman, COE, pers. comm. 1992). Estimated maintenance volumes (272,300 yd^3) from fiscal year 1991 were lower than anticipated due to drought conditions (T. Bruch, COE, pers. comm. 1992). In addition to maintenance dredging volumes, an estimated 8.8 million yd^3 from Phase I of the J.F. Baldwin Ship Channel project (D. Myers, COE, pers. comm. 1992) also were placed at the site between 1972 and 1976 (EPA 1982).

The general site selection criterion at 40 CFR 228.5(c) specifies that "EPA will, wherever feasible, designate ocean dumping sites ... that have been used historically." With the exception of the Channel Bar Site, historical use of the other dredged material sites was episodic, and none of them received final designation for continued disposal of dredged material from San Francisco Bay. The Channel Bar Site, the BART site, and the B1B site are near or within the boundaries of the MBNMS. Both of the COE experimental sites and the 100-Fathom site are within the GOFNMS. Designation of a new ODMDS within the boundaries of a National Marine Sanctuary is not allowed. Therefore, none of the five historically used dredged material disposal sites in the LTMS study region remain under consideration as a potential alternative in this FEIS for designation as a permanent site for disposal of dredged material from San Francisco Bay. In recent years, due in part to the absence of an acceptable ocean disposal site, most dredged material disposal has occurred at sites within San Francisco Bay.

3.1.1.2 Other Waste Disposal

Other waste disposal operations have occurred since 1946 at several sites within the Gulf of the Farallones. However, it is difficult to identify and characterize all of the waste materials and the extent of the disposal operations because of the following:

- Lack of regulations at the time of some disposal events;
- Involvement of numerous agencies and organizations in some disposal operations;
- Generally poor record-keeping for many of these activities;
- Security classification of military operations; and
- Problems in monitoring the exact location of some disposal activities.

The types of waste materials disposed of in the vicinity of the Gulf of the Farallones include the following (IEC 1973):

- Acid waste
- Cannery waste
- Low-level radioactive waste
- Conventional and chemical munitions
- Refinery waste
- Vessels and dry dock materials.

These historical waste disposal operations are summarized in Table 3.1-2 and are described below. Estimated locations of disposal site areas are shown in Figure 3.1-1. Anecdotal information (Anon. 1980) suggests that some waste disposal occurred outside of intended sites due to operational problems (e.g., bad weather) or indiscriminate disposal practices. These historical waste disposal operations, including the presence of residual low-level radioactive wastes, chemical munitions, and vessel/dry dock sections within the vicinity of the LTMS study areas, represent a possibility for cumulative environmental effects in combination with proposed dredged material disposal operations.

Table 3.1-2. Summary of Waste Disposal in the LTMS Study Region.

Waste Category	Responsible Agency/Company	Period of Activity	Estimated Annual Quantity	Estimated Total	Latitude, Longitude
Acid waste[1]	USSC	1948 - 1971	10M gal	240M gal	37°38'N, 122°40'W
Cannery waste[1]	OSC	1961 - 1972	22,000 tons	246,000 tons	37°39'N, 122° 50'W
Radioactive waste[1,2]	AEC	1946 - 1965	varied	47,500 containers	See Table 3.1-3
Munitions[1]	USN	1958 - 1969	varied	746 tons	See Table 3.1-4
Dredged material[3]	COE	1976 - Present	900,000 yd^3	9,079,533 yd^3	See Table 3.1-1
Refinery waste[1]	Standard Oil, Shell Oil	1966 - 1972	$\geq$ 45M gal	315M gal	Three generalized locations: approximately 5 miles offshore; 1-3 miles west of the Gulf of the Farallones; and 50-100 miles from shore.
Vessels and drydock materials[4]	See Table 3.1-5	1951-1987	varied	unknown	See Table 3.1-5

USSC = United States Steel Company
OSC = Oakland Scavenger Company
AEC = Atomic Energy Commission
USN = United States Navy
COE = United States Army Corps of Engineers

Sources:
[1]IEC 1973
[2]EPA 1975, Dyer 1976
[3]T. Wakeman, T. Bruch, COE, pers. comm. 1992
[4]P. Cotter, EPA, pers. comm. 1991

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3.1.1.3 Acid Waste

Between 1948 and 1971, the United States Steel Corporation (USSC) annually discharged approximately 10 million gallons of steel pickling waste acids (hydrochloric and sulfuric acids) in an area located approximately 22.5 km southwest of the Golden Gate Bridge, 14.5 km offshore, at a water depth of approximately 40 m (IEC 1973). Exact coordinates for the disposal area are unknown due to incorrect documentation of these disposal activities. However, the site coordinates have been estimated based on reported distances from the Golden Gate Bridge and from shore (IEC 1973) (Table 3.1-2).

3.1.1.4 Cannery Wastes

Cannery wastes generated by six East Bay fruit and vegetable canneries were disposed of 32.2 km offshore of San Francisco at depths of approximately 80 m. These wastes consisted of solid residuals (i.e., fruit and vegetable pulp) from canning processes. Estimated weights of 22,000 tons per year were discharged from 1961 to 1972, at which time concerns over increased costs, monitoring requirements, and environmental issues led to termination of further disposal activities (IEC 1973).

3.1.1.5 Radioactive Waste

Disposal of low-level radioactive waste materials off the coast of San Francisco occurred between 1946 and 1965. Waste materials originated from several agencies and organizations including: Nuclear Engineering Company; Ocean Transport Company; Chevron Research; U.S. Naval Radiation Development Laboratory; Atomic Energy Commission; University of California Radiation Laboratory at Berkeley; and Lawrence Livermore Radiation Laboratory (IEC 1974; U.S. Army 1987; Colombo and Kendig 1990). Waste disposal operations were performed by the U.S. Navy until 1959. After 1959, disposal was conducted by private disposal companies under a license from the Atomic Energy Commission (Colombo and Kendig 1990).

At least three different radioactive waste disposal site locations have been identified. The reported site coordinates and quantities of wastes are listed in Table 3.1-3. Exact coordinates of the actual disposal events are unknown; Joseph (1957) suggested that the disposal area can be defined as an irregular polygon bounded by the coordinates 37° 26'N to 37° 43'N and 122° 48'W to 123° 25'W, representing an area exceeding 650 square kilometers (Figure 3.1-1).

Radioactive Waste Site A was used briefly in 1946 for disposal of three barge-loads (an estimated 150 containers) of material. This site was occupied because the orders supplied to the disposal vessel operators contained a typographical error (IEC 1973). Radioactive Waste Site B was used between late 1946 and 1951 and from 1954 to 1965 (EPA 1975). Radioactive Waste Site C was used between 1951 and 1954. The majority of the wastes (approximately 44,000 containers) was discharged at Site B. The reason(s) for switching to Site C is unknown, although the concurrent use of Site B for the disposal of chemical munitions waste and the greater distance from shore probably were contributing factors (Colombo and Kendig 1990). Isolated disposal

Table 3.1-3. Radioactive Waste Disposal Sites in the Gulf of the Farallones.

SITE	DEPTH (m)	NO. OF WASTE CONTAINERS	DURATION OF USE	LATITUDE, LONGITUDE
Rad. Waste Site A	90	150	1946	37° 38'N, 122° 58'W
Rad. Waste Site B	1,800	44,000	1946-51, 1954-65	37° 37'N, 123° 18'W
Rad. Waste Site C	900	3,600	1951-54	37° 39'N, 123° 09'W

Source: EPA 1975, Dyer 1976

of low-level radioactive wastes also may have occurred closer to shore, due primarily to inclement weather (IEC 1974). Ocean disposal of radioactive wastes was discontinued around 1965 when land disposal sites were licensed to receive the wastes. In 1970, the U.S. terminated all ocean disposal of radioactive waste materials (EPA 1992a).

It is not possible to determine accurately the amounts of low-level radioactive wastes disposed of by these operations because the characteristics of the waste materials and associated radioactivity were poorly documented. Nevertheless, the total quantity of radioactive waste materials disposed of at these sites was estimated at 44,500 to 47,500 containers. The wastes represented a mix of liquid and solid materials, with a wide variety of chemical and physical properties, generated from defense-related, commercial, and medical laboratory activities. The low-level solid wastes included contaminated laboratory equipment and supplies, clothing, rubber gloves, shoes, animal bones, and grease (U.S. Army 1987). Liquid wastes included evaporator concentrates, solvents, and aqueous solutions (Colombo and Kendig 1990). The wastes contained an estimated total activity of 14,500 curies, primarily associated with thorium, uranium, transuranic and other activation-produced radionuclides, and mixed fission products with half-lives greater than one year (Colombo and Kendig 1990).

The radioactive waste materials were packaged prior to disposal, typically by "encapsulation in concrete" within 55-gallon (210 liter) drums or in large (1.5x2x2.5 m), steel-reinforced, concrete "vaults." Beginning in 1951–1952, the waste containers incorporated a wire-rope or steel bar lifting eye. The ends of the wire rope or steel bar were encased in the concrete end caps, and the exposed portions were shaped into an eye or loop that could be used for lifting and handling the drums. This packaging method was useful for distinguishing and dating individual waste containers during subsequent site surveys. Reports from the post-disposal surveys at these disposal sites (e.g., IEC 1974; EPA 1975; Dyer 1976; Colombo and Kendig 1990) and the testimony of recreational divers, who encountered a package in relatively shallow waters (60 to 165 feet) near the Farallon Islands (Anon. 1980) indicate that the condition of the drums and vaults varied. Some containers were intact, whereas others had imploded, ruptured, or split. Thus, presumably some radioactive waste materials were not completely encapsulated because the packaging was compromised.

3.1.1.6 Chemical and Conventional Munitions Waste

Although there are numerous munitions disposal sites surrounding the Farallon Islands and in the Gulf of the Farallones, most aspects of the military's disposal operations remain classified. The U.S. Army has discharged both chemical and conventional munitions at offshore sites since the late 1950s (Table 3.1-4). From 1958 through 1969, the Army and Navy occupied several ocean sites off San Francisco for the purpose of munitions disposal (U.S. Army 1987). One of the sites used for waste munitions was near radioactive waste disposal Site B and within the present Study Area 5. Munitions waste discharges were made at this site through 1968 and 1969, usually by towing barges of one-ton containers and unloading the containers overboard. Two other munitions sites described as containing both explosive and toxic chemical ammunitions (MMS

Table 3.1-4. Summary of Munitions Discharges in the LTMS Study Region.

Operation	Year	Cargo	Total Cargo	Latitude, Longitude
S.S. WILLIAM RALSTON[1]	1958	M70 bombs (mustard) Containers (lewisite)	301,000 1,497	37°40'N, 125°00'W
SEA LION[1,2] (barge)	1958	M47 bombs (mustard) Containers (lewisite) Containers (mustard) Projectiles (mustard)	6 335 11 2	37°40'N, 125°00'W
S.S. JOHN F. SHAFROTH[3]	1964	40 mm ammunition cartridges Unspecified bombs Torpedo warheads Unspecified mines Unspecified projectiles Fuses, detonators Polaris boosters Contaminated "cake-mix"	— — — — — — — 30,000 lb —	37°40'N, 123°25'W
Chemical Munitions Dumping Area (CMDA)[4]	1968-69	Conventional munitions	510 tons[5]	37°41'N, 123°25'W
Explosives[4] Site #1	NI	Explosive and toxic chemical ammunition	—	37°10'N, 123°03'W
Explosives[5] Site #2	NI	Explosive and toxic chemical ammunition	—	37°10'N, 123°23'W

(-) = Unknown quantity
NI = No information

Sources:
[1] U.S. Army 1988
[2] U.S. Army 1987
[3] EPA 1971
[4] NOAA Chart No. 18680 1984
[5] U.S. Navy 1993

1986) are located to the east and west of Study Area 4 (Figure 3.1-1). No additional information about these sites was available.

In 1958, the Army loaded 8,000 tons of aged mustard and lewisite chemical agents aboard the S.S. WILLIAM RALSTON, which then was towed to a site 190 km off San Francisco and scuttled at a depth of about 6,500 m. Five years later, the Army initiated the "CHASE" (Cut Holes And Sink 'Em) program, similar to the earlier sinking of the RALSTON. The CHASE program used obsolete World War II cargo ships to dispose of large amounts of old munitions at offshore sites. The ships were loaded with munitions, towed offshore, then sunk at deepwater sites (EPA 1971). Chemical weapons were disposed of during only four of the twelve CHASE operations, and none of the vessels were scuttled at any of the Gulf of the Farallones munitions disposal sites. However, the S.S. JOHN F. SHAFROTH, containing approximately 236 tons of explosives and ammunition, was scuttled approximately 30 km west of the Farallon Islands, within the boundaries of Study Area 5.

3.1.1.7 Refinery Waste

Standard Oil Company discharged approximately 45 million gallons of refinery waste annually from 1966 to 1972 in the vicinity of the Farallon Islands (IEC 1973). Specific information on the chemical composition of the waste is not available, although it is likely that it consisted of solvents, petroleum by-products, and residual petroleum fractions. Similarly, specific coordinates for the waste disposal site were not identified. The site initially was listed as "at least five miles offshore" (IEC 1973), but then was relocated in 1970 to an area one to three miles beyond (i.e., to the west of) the Gulf of the Farallones. Refinery wastes also were discharged by Shell Oil Company until 1971, although no information on annual discharge volumes or disposal frequency is available. The discharge site was described as an area approximately 81 to 161 km offshore from San Francisco (IEC 1973).

3.1.1.8 Vessel and Dry Dock Sections

From 1951 to 1987, several damaged or derelict vessels and dry dock sections were disposed of in the LTMS study region. A summary of these disposal operations is presented in Table 3.1-5. Discarded items consisted primarily of metal or wooden hulls and associated equipment of the vessels and dry dock sections. As required by EPA Ocean Dumping Regulations issued in 1977 (40 CFR 229.3), the fuel and lube tanks, pipes, pumps, and bilges were emptied and flushed and the other equipment which potentially was capable of resurfacing was removed prior to sinking. Therefore, the environmental consequences of the majority of these vessel disposal operations are expected to be minimal.

In contrast, sinkings of the USS INDEPENDENCE and T/V PUERTO RICAN introduced potentially hazardous materials to the ocean environment. The hull of the USS INDEPENDENCE was characterized as a highly radioactive hulk after serving as a target vessel for the Bikini Atoll atomic bomb testing in 1946 (U.S. Navy 1968). The vessel was sunk in 1951 during further weapons testing at an unspecified location off the coast of California (U.S.

Table 3.1-5. Summary of Vessel and Dry Dock Disposal in the Vicinity of the Gulf of the Farallones.

Date	Vessel/Dry Dock Origin and Responsible Agency/Company	Location	Comments
1951	USS INDEPENDENCE; U.S. Navy.	37°28.4'N; 123°7.6'W (unconfirmed side scan sonar coordinates[2]).	Aircraft carrier whose hull was characterized as highly contaminated from radiation exposures during weapons testing; sunk during further weapons tests.
1980	4 tugboats/towing vessels (M/V SEA KING, M/V SEA PRINCE, M/V SEA ROBIN, M/V SEA CLOUD); Crowley Maritime Corporation.[3]	37°31.0'N; 122°52.0'W (approximately 12.5 miles SE of the Southeast Farallon Light, in approximately 94 m).	Four identical hulls (127' x 29'); vessels taken out of service.
1981	AGGATU; Crowley Maritime Corporation.[3]	37°31.0'N; 122°52.0'W (same location as the site used for disposal of 4 tugboats in 1980).	Rail barge (206' x 99') damaged in "casualty"; the hull was split into 2 sections.
1981	M/V ISLANDER; U.S. Coast Guard.[3]	37°30'N; 122°52.0'W	A vessel in immediate danger of sinking at the San Francisco Coast Guard Base, thus posing a threat to navigation.
1984	T/V PUERTO RICAN; U.S. Coast Guard/Carter and Desmares, Inc.[3]	37°30.6'N; 123°00.7'W	An oil and chemical carrier damaged by an explosion and fire while transporting lubrication oil and bunker oil. The stern section containing bunker oil sank in 450 m.
1985	YFD-19; Todd Shipyards Corporation.[3]	Five sections sunk within area: 37°34.9' - 37°37'N; 123°16.0' - 123°18'W.	Floating dry dock disposed as 77' x 144' sections; weighted with 600 tons of concrete and flooded at locations off the shelf (1,600 m).
1987	LADY ELEANOR; Valley Engineers.[3]	37°23.5'N; 122°53.1'W	Pontoon construction platform with crane (120' x 101' x 100'); scuttled/emergency disposal after capsizing off Half Moon Bay.

Sources: [1]U.S. Navy 1968
[2]Karl 1992
[3]P. Cotter, EPA, pers. comm. 1991

Navy 1968). Recent side-scan sonar investigations in the Gulf of the Farallones have identified a structure believed to be the USS INDEPENDENCE at 37° 28.4'N, 123° 7.6'W (north of Study Area 3 and southeast of Study Area 5); positive verification has not yet been made (Karl 1992). The extent of any potential environmental impacts associated with the sinking of the USS INDEPENDENCE is unknown.

The T/V PUERTO RICAN was transporting 91,984 barrels of lubrication oil and 8,500 barrels of bunker fuel when an explosion and fire damaged the vessel approximately 13 km off the Golden Gate in October 1984. The disabled vessel was towed seaward to minimize potential impacts from leaking fuels to sensitive biological habitats within the GOFNMS. However, the vessel later broke into two sections, and the stern section, containing 8,500 barrels of oil, sank at a location approximately 25 km due south of South Farallon Island in a depth of approximately 450 m. The remains have been surveyed using side-scan sonar; and, as of 1989, oil continued to leak slowly from the vessel (Delgado and Haller 1989). Assessments of the environmental impacts associated with the oil spill were prepared by Herz and Kopec (1985), Robilliard (1985), PRBO (1985), and James Dobbins Associates, Inc. (1986).

3.1.1.9 Summary of Historical Disposal in Relation to the LTMS Study Areas

According to site selection general criteria, EPA will designate ocean dumping sites that have been used historically. A summary of historically used disposal sites indicates that limited dredged material disposal has occurred within Study Area 2 (B1B site), and radioactive and chemical munitions wastes were disposed of in Study Area 5. Study Area 4 lies between two sites previously designated for explosives disposal (Figure 3.1-1); disposal of dredged material within the explosives sites is not desirable. Historically used dredged material disposal sites such as the B1B, COE experimental, and 100-Fathom sites lie within designated National Marine Sanctuary boundaries and therefore cannot be considered for future disposal activities. Similarly, the Channel Bar Site (Study Area 1) is suitable for disposal of sandy materials only, and is not under consideration as an alternative site. Radioactive Waste Sites A, B, and C lie within the boundaries of the GOFNMS.

3.1.2 Types and Quantities of Wastes Proposed To Be Disposed of [40 CFR 228.6(a)(4)]

The proposed ODMDS will be used for disposal of acceptable sediments from projects in the San Francisco Bay area, including maintenance dredging and new construction projects. Presently planned projects are listed in Table 1.2-1. Site use is expected to extend for fifty years, beginning in 1994; the projected 50-year dredging volume would total 400 million yards^3 (COE 1992a). The COE (1992c) estimated that 6 million yards^3 per year could be disposed of at the ODMDS. However, the specific volumes will depend on the characteristics of the dredged materials (evaluated on a project-specific basis), potential disposal restrictions in the site management plan, and the range of alternative disposal options developed by the LTMS (see Chapter 2).

The physical and chemical characteristics of the dredged materials planned for ocean disposal are expected to vary considerably depending on the locations of the dredging operations. The possible range in grain-size characteristics of the dredged material is expected to be broad, and will vary on a project/site-specific basis (Tetra Tech 1992). However, the most prevalent sediment composites planned for disposal are expected to range between two grain size classes: "mostly sand" (76% sand, 21% clay, and 3% silt) and "clay-silt" (74% silt, 5% clay, and 21% sand) (Tetra Tech 1992). Dredged material will not be packaged prior to disposal.

The COE expects that an ODMDS could be used throughout the year, except when wave heights exceed 3 meters and wave periods are 9 seconds or less (approximately 10% of the time, typically from February through May; Tetra Tech 1987). However, seasonal restrictions on dredging activities imposed by biological events such as migration, spawning, and nesting activities may also affect the scheduling of ODMDS use. For example, the California Department of Fish and Game (CDFG) recommends that dredging activities within the Bay be restricted during peak herring spawning periods (December 1 to March 1) (J. Turner, CDFG, pers. comm. 1991). In addition, to ensure high survivorship of Dungeness crab juveniles that utilize the Bay as a nursery ground, CDFG recommends that suction dredging in parts of north San Francisco and San Pablo Bays be prohibited from May 1 to August 1. Mitigation of potential impacts from individual projects will be specified in permit conditions. The goals and objectives of the site management and monitoring plan are summarized in Section 4.6.2. The complete site management and monitoring plan will be prepared in conjunction with, and referenced in, the Final Rule and Coastal Consistency Determination for the site.

3.1.3 Existence and Effects of Current and Previous Discharge and Dumping in the Area [40 CFR 228.6(a)(7)]

As discussed in Section 3.1.1, four locations have been used previously for ocean disposal of sediments from San Francisco Bay. However, use of these ocean sites for dredged material disposal has been intermittent, and the disposal volumes have been relatively small (except for the BART site).

The nature and extent of post-disposal effects at these locations are unknown because no systematic baseline and post-disposal studies have been performed. A brief biological survey of an area adjacent to the BART site was conducted prior to disposal of dredged material from the BART construction project (Ebert and Cordier 1966); however, no post-disposal study was conducted. A series of baseline biological and sediment surveys, and a one-year current meter study were initiated at the B1B site before the disposal of Oakland Harbor dredged material (KLI 1991). However, no post-disposal effects studies were conducted at this site other than a continuation of the current meter study. With the exception of a brief qualitative study of the COE experimental site following a small test discharge of approximately 4,000 yd^3 of dredged material (COE 1975), no studies of the environmental impacts of dredged material disposal have been conducted at any of the offshore sites.

Similarly, studies of the environmental impacts from disposal of other waste materials in the vicinity of the Gulf of the Farallones generally have been limited to reconnaissance surveys of the radioactive waste disposal sites (e.g., EPA 1975, Dyer 1976; Noshkin *et al.* 1978; Dayal *et al.* 1979; Schell and Sugai 1980; Melzian *et al.* 1987; Booth *et al.* 1989; Suchanek and Lagunas-Solar 1991), and investigations of potential effects associated with the sinking of the T/V PUERTO RICAN (Robilliard 1985; PRBO 1985; Herz and Kopec 1985). Thus, the specific effects from these previous waste discharges are poorly known, although NOAA and EPA are presently evaluating environmental impacts from disposal of low-level radioactive waste material in the Gulf of the Farallones.

3.1.4 Feasibility of Surveillance and Monitoring [40 CFR 228.5(d) and 228.6(a)(5)]

3.1.4.1 Surveillance

The United States Coast Guard, EPA, and the COE are responsible for surveillance and enforcement of ocean disposal activities. This includes navigational surveillance and deterrence of unauthorized disposal.

The Coast Guard's marine radar, Offshore Vessel Movement Reporting System, has an operational range of approximately 45 km (27 nmi) from Point Bonita (i.e., the approximate distance to the Farallon Islands). Vessel visibility on the radar screen is affected by the size of the contact, vessel aspect, and weather. Thus, under conditions where distances are greater than 45 km or inclement weather prevails, vessels may not be visible continuously using the radar surveillance system. Portions of Study Area 2 and all of Study Areas 3 through 5 are greater than 45 km from Point Bonita. For these reasons, other methods of navigational surveillance, such as Ocean Dumping Surveillance System (ODSS)-like black boxes, overflights, navigation/operation log audits, or checks by on-board ship riders would be necessary for surveillance at Alternative Sites 3 through 5.

3.1.4.2 Monitoring

The EPA and the COE are responsible for the development of a site management and monitoring plans for the ODMDS. The purposes of monitoring an offshore disposal site are to:

- Document compliance with all permit requirements;
- Confirm predictions of dredged material dispersion and resuspension; and
- Evaluate the ecological impacts and consequences of dredged material disposal.

Elements of a disposal site monitoring program may include evaluation of: sediment chemistry, demersal fisheries, benthic organisms, bathymetric conditions, bioaccumulation potential, and oceanographic conditions. A site monitoring plan designed to detect and minimize adverse impacts through appropriate management options will be prepared in conjunction with, and referenced in, the Final Rule and the Coastal Consistency Determination. The goals and objectives of the monitoring plan are summarized in Section 4.6-2.

Assuming appropriate sampling equipment and survey vessels are available, as well as contingencies associated with inclement weather and sea conditions, it is expected that monitoring of environmental effects associated with dredged material disposal operations can be performed at any of the alternative sites. However, depending on specific monitoring requirements, some sites may be more difficult to monitor, due to greater depths or residual contamination from historical waste disposal. Impacts to benthic communities at deeper sites may be more difficult to assess because less information about benthic community structure and disturbance response is available.

3.2 Physical Environment

This section addresses the physical characteristics of the affected environment: meteorology and air quality (Section 3.2.1); physical oceanography (Section 3.2.2); water column characteristics (Section 3.2.3); geology (Section 3.2.4); and sediment characteristics (Section 3.2.5). These characteristics are addressed in the general and site-specific criteria applied to evaluations of project alternatives Section 2.2.

3.2.1 Meteorology and Air Quality

The primary meteorological and air quality parameters relevant to ODMDS designation are the regional climate, winds, and air quality in the vicinity of the alternative sites.

The coastal environment off San Francisco has a maritime climate characterized by a general lack of weather extremes (Williams *et al.* 1980), with cool summers and mild, wet winters. The area has experienced drought conditions for at least five years through 1991, which has reduced the frequency and amount of seasonal rainfall. Weather conditions are most stable in summer and autumn, with moderate but persistent winds diminishing to calmer conditions through the mid-autumn period. Variable weather conditions occur during winter when series of storms produce strong winds and high seas in the Gulf of the Farallones. Spring has fewer frontal rainstorms and less extreme conditions, but it usually is the windiest period of the year. Typical meteorological conditions for the coastal area off San Francisco are summarized in Table 3.2-1.

Fog occurs off the coast throughout the year, but it is most persistent during summer. Upwelling in the waters off San Francisco tends to cool the relatively warm, moist air masses moving eastward and results in the formation of fog off the coast. The presence of fog often reduces visibility; for example, the visibility at Southeast Farallon Island is less than 3 km 24% of the time in July, compared to 11% of the time in January (Williams *et al.* 1980).

Winds are an important influence on water column characteristics and currents over the continental shelf and upper continental slope (Winant *et al.* 1987). For example, the strong north to northwest winds in spring and early summer promote offshore-directed flow of surface waters and upwelling of cool, saline, nutrient-rich waters along the coast. Relaxation periods of weak or calm winds can result in reversals in the surface currents (Halliwell and Allen 1987). The wind field in the region exhibits a seasonal cycle. Summer winds are driven by the pressure gradients of the North Pacific subtropical high pressure and southwestern U.S. thermal low pressure systems (Halliwell and Allen 1987). Coastal atmospheric boundary layer processes modify the wind patterns within 100–200 km of the coast such that wind fluctuations are strongly polarized in directions parallel to the coastline. The cross-shelf component of the winds in the region is weak (Chelton *et al.* 1987). The mean summer winds have an equatorward alongshore component that is relatively strong (approximately 20 knots) along the California coast (Halliwell and Allen 1987). The strongest equatorward winds occur in April and May (Chelton *et al.* 1987). Winds exhibit greater spatial and temporal variability in the winter than in the summer (Halliwell

Table 3.2-1. Meteorological Conditions for the Coastal Area off San Francisco.

Weather Elements	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Wind ≥ 34 knots (%)	1.5	2.5	1.9	2.4	2.5	1.9	0.8	≤ 0.5	1.1	1.7	1.4	2.7	1.7
Wave Height ≥ 10 feet (%)	15.6	13.1	16.4	22.2	18.3	8.7	7.9	4.9	6.2	10.7	14.9	16.0	12.5
Precipitation (%)	9.9	6.9	7.6	4.5	3.2	3.5	3.2	2.7	2.4	2.9	5.4	8.0	4.9
Temperature ≥ 29°C (%)	0	0	0	0	0	0	0	0	0	0	0	0	0
Mean Temperature (°C)	11.7	11.9	11.8	12.0	12.9	14.0	14.8	15.6	16.0	15.4	14.2	13.0	13.7
Temperature ≤ 0°C (%)	0	0	0	0	0	0	0	0	0	0	0	0	0
Mean Relative Humidity (%)	82	82	80	81	82	86	87	88	86	84	83	81	84
Sky Overcast or Obscured (%)	33.2	29.4	28.2	28.9	32.5	37.3	54.3	45.1	34.0	29.2	27.7	28.3	34.5
Mean Cloud Cover (eighths)	4.9	4.6	4.7	4.5	4.7	4.6	5.4	4.9	4.3	3.3	4.5	4.5	4.6
Prevailing Wind Direction	NNW	NNW	NW	NNW	NNW	NW	NNW	NW	NNW	NNW	NNW	NNW	NNW

Boundaries: Between 36°N and 38°N, and from 126°W eastward to coast. These data are based on observations made by ships in passage, and biased towards good weather observations.
Source: U.S. Coast Pilot #7, 1976.

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and Allen 1987). The greater variability in the winter winds is due to the passage of atmospheric cyclones and anticyclones moving onshore from over the Pacific Ocean. Storm-driven winds occur approximately 2% of the time with average velocities of approximately 14 m/sec (35 knots; Table 3.2-1).

Wind measurements in 1991 from four National Data Buoy Center (NDBC) buoys off central California, including Bodega Bay (38.2°N, 123.3°W), Gulf of the Farallones (37.8°N, 122.7°W), Halfmoon Bay (37.4°N, 122.7°W), and Monterey Bay (36.8°N, 122.4°W) were analyzed by Ramp *et al.* (1992). The surface wind vectors for 1991 (Figure 3.2-1) indicated distinct seasonal patterns. From January through early April, the winds were variable in both speed and direction. During the summer months, upwelling-favorable, northwest winds of 10 to 15 m/sec predominated. Winds during autumn were still mainly equatorward, but weaker than those during summer. Some wind reversals occurred, but they usually were weak and lasted only one day. After the beginning of November, winter conditions were similar to those in the beginning of the year, with strong, frequent reversals (Noble *et al.* 1992).

The large-scale wind patterns were similar at the four buoy locations; however, some small-scale differences were apparent that reflect potentially important variations in the mesoscale forcing to the coastal ocean. In particular, the winds measured in the Gulf of the Farallones tended to be weaker and directed more in an eastward direction than the winds to the north and south (Ramp *et al.* 1992). These differences have implications for the location and intensity of upwelling and the subsequent advection of upwelled water along the coast (Schwing *et al.* 1991; see Section 3.2.2).

The air quality in most of central California is considered good. Annual summaries of air pollutants at selected stations in the central San Francisco Bay Area and listings of the corresponding National and California standards are presented in Table 3.2-2. During 1988–1991, concentrations of ozone, carbon monoxide (CO), nitrogen dioxide (NO_2), and sulfur dioxide (SO_2) typically were below the National and California standards, whereas, concentrations of particulate matter (PM) in San Francisco exceeded the California standard up to 15 days per year. Air pollutants were not monitored in the vicinity of the Gulf of the Farallones (M. Basso, BAAQMD, pers. comm. 1992). However, because the offshore regions including Study Areas 2, 3, 4 and 5 are upwind from the urbanized areas of San Francisco Bay (Holzworth 1959), the study areas are expected to have relatively lower concentrations of air pollutants than those measured at stations around the central parts of the Bay.

3.2.2 Physical Oceanography 40 CFR 228.6(a)(6)

Physical oceanographic parameters that are important for evaluation of an ODMDS designation are regional and site-specific current patterns, waves, and tides, and the effects of these forces on the transport and dispersion of dredged material. In particular, site-specific current measurements in the vicinity of the alternative sites are used to evaluate the predicted dispersion in the water column, and initial deposition on the sea floor, of dredged material discharged at these sites (Sections 4.2 and 4.4). In this section, the regional current patterns are characterized

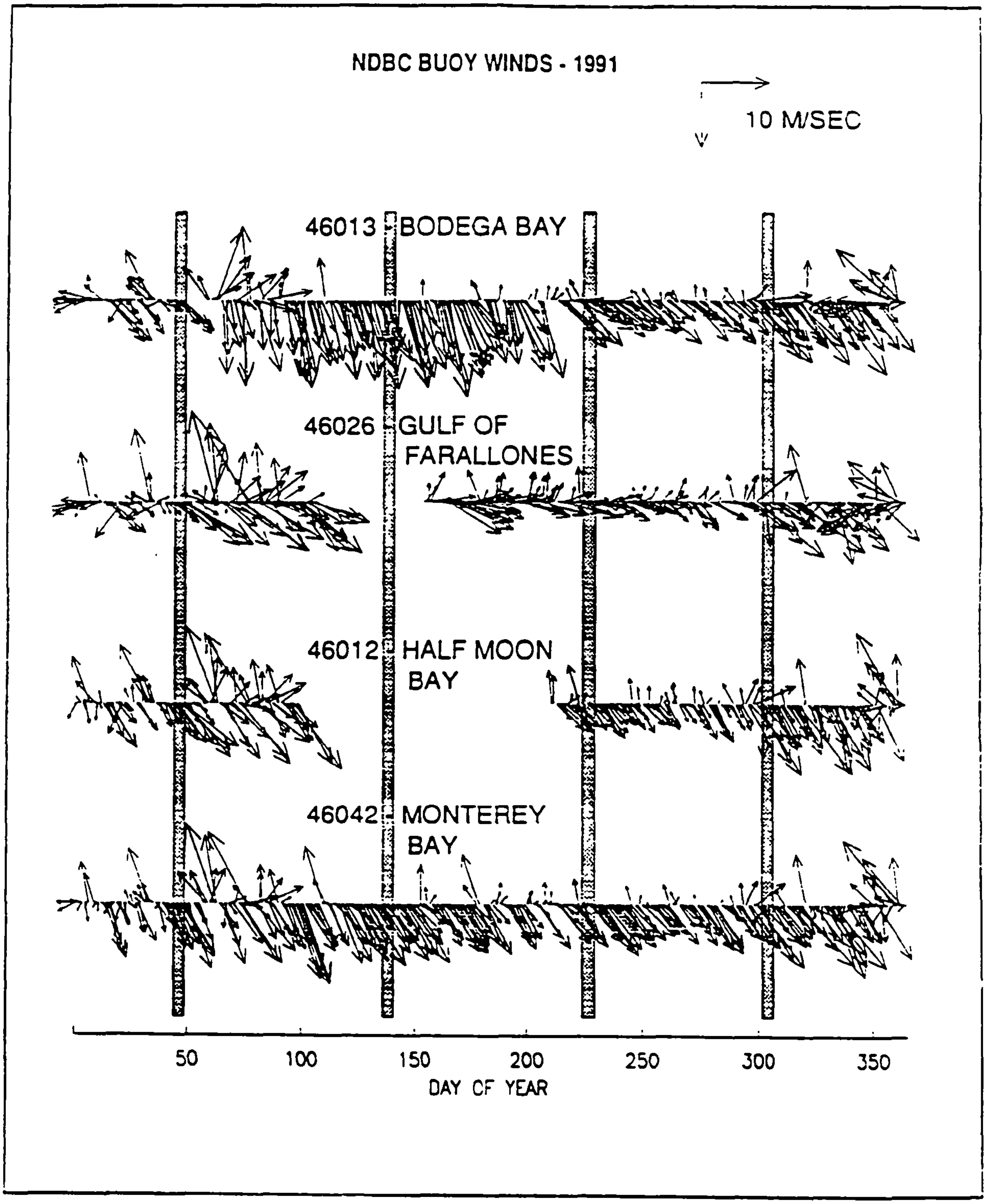

Figure 3.2-1. Surface Wind Vectors at Four NDBC Buoys in the Vicinity of the Gulf of the Farallones During 1991.
Source: Ramp *et al.* 1992.

Table 3.2-2. **A. Annual Air Pollutant Summary for Central San Francisco Bay Stations During 1988–1991; and B. California and National Standards for Individual Pollutants.**

The units and standards for pollutants are described in the Explanatory Notes.

A. Annual Air Pollutant Summary													
	OZONE				CO		NO_2		SO_2		PM_{10}		
Year/Station	Max. Hr.	National Std.	California Std.	3-Yr. Avg.	Max. 8-Hr.	Days National Std.	Max. Hr.	Days California Std.	Max 24-Hr.	Days California Std.	Annual Mean	Days National Std.	California Std.
1991													
San Francisco	5	0	0	0.0	6.5	0	10	0	13	0	29.6	0	15
San Rafael	8	0	0	0.0	5.6	0	9	0	-	-	26.4	0	10
Richmond	5	0	0	0.0	4.6	0	8	0	16	0	24.4	0	9
Oakland	6	0	0	0.0	6.8	0	-	-	-	-	-	-	-
1990													
San Francisco	6	0	0	0.0	5.6	0	11	0	11	0	27.7	1	12
San Rafael	6	0	0	0.0	5.0	0	7	0	-	-	22.5	0	4
Richmond	6	0	0	0.0	4.0	0	8	0	12	0	22.9	0	5
Oakland	6	0	0	0.0	6.1	0	-	0	-	-	-	-	-
1989													
San Francisco	8	0	0	0.0	7.0	0	12	0	15	0	31.8	0	13
San Rafael	8	0	0	0.0	4.0	0	10	0	-	-	27.3	0	8
Richmond	10	0	1	0.0	4.1	0	11	0	14	0	-	-	5
Oakland	8	0	0	0.0	7.5	0	-	-	-	-	-	-	-

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Table 3.2-2. Continued.

A. Annual Air Pollutant Summary													
	OZONE				CO		NO_2		SO_2		PM_{10}		
Year/Station	Max. Hr.	National Std.	California Std.	3-Yr. Avg.	Max. 8-Hr.	Days National Std.	Max. Hr.	Days California Std.	Max 24-Hr.	Days California Std.	Annual Mean	Days National Std.	California Std.
1988													
San Francisco	9	0	0	0.0	12.8	1	12	0	12	0	29.7	0	7
San Rafael	10	0	1	0.0	5.0	0	9	0	7	0	27.6	0	2
Richmond	10	0	2	0.0	5.0	0	11	0	7	0	-	-	-
Oakland	10	0	1	0.0	6.0	0	-	-	-	-	-	-	-

Table 3.2-2. Continued.

B. California and National Standards			
Pollutant	Averaging Time	California Standard	National Standard
Ozone	1 hour (hr)	9 pphm	12 pphm
CO	8 hours	9 ppm	9 ppm
	1 hour	20 ppm	35 ppm
NO_2	Annual Avg.	-	5.3 pphm
	1 hour	25 pphm	-
SO_2	Annual Avg.	-	30 ppb
	24 hours	50 ppb	140 ppb
PM	Annual Avg.	30 $\mu g/m^3$	50 $\mu g/m^3$
	24 hours	50 $\mu g/m^3$	150 $\mu g/m$

Explanatory Notes

The units for the maximums and means in the summary table are in parts per hundred million (pphm) for ozone and nitrogen dioxide, parts per million (ppm) for carbon monoxide, parts per billion (ppb) for sulfur dioxide, and micrograms per cubic meter ($\mu g/m^3$) for suspended particulate matter (PM_{10}). "Days" columns give the number of days per year on which an air quality standard was exceeded: National for CO; California for NO_2 and SO_2; and both for Ozone and PM_{10}. The California and National standards vary sharply for ozone and PM_{10}; the California standards are 25% more stringent on ozone and 67% more stringent on 24-hour suspended particulate matter (PM_{10}).

Generally, the particulate measurements are taken on the National systematic 6-day schedule. The 6-day occurrences are reported for days exceeding the California 24-hour standards.

Source: BAAQMD 1988, 1989, 1990, 1991

from historical data, followed by a summary of the results from recent, EPA-sponsored studies of the currents within the LTMS study region.

3.2.2.1 Regional Current Patterns

The LTMS study areas are located within the California Current system, an eastern boundary current that forms the eastern portion of the North Pacific subtropical gyre. The seasonal patterns in the large-scale surface (upper 250 m) currents generally are divided into two seasons: an upwelling period from March to August; and the winter or Davidson Current period from October to February. September is a transition month and may be more like one season or the other depending on the year being studied. The spring and summer upwelling season is characterized by fluctuating flows with a net southward component. During October through November and February through March, nearshore flows over the shelf and upper slope south of Cape Mendocino move northward against weak, northerly, prevailing winds. At the same time, the southward flow of the California Current weakens and moves offshore. Winter is a period of storms that can produce large, storm-generated surface waves and strong fluctuating currents that can last for 2 to 10 days. During any particular month, the flow pattern may differ significantly from the seasonal mean conditions. Much of this variability is attributable to small-scale features (e.g., eddies and filaments) with short time scales and interannual variability with large spatial and temporal scales (Chelton *et al.* 1987).

The California Current is a broad surface flow approximately 100 to 1,000 km from shore. This current is driven primarily by wind stress over the North Pacific Ocean, and it transports cold, low salinity, subarctic waters. The typical mean flow in the upper few hundred meters is equatorward (i.e., towards the southeast) at speeds less than 10 cm/sec. Satellite-tracked drifter observations (Brink *et al.* 1991) show slow, equatorward movement of surface waters that is superimposed on an energetic mesoscale eddy field, displacing the flow 200 to 400 km to the east and west as it moves slowly towards the south.

Within the California Current system are two poleward flows: the Coastal Countercurrent and the California Undercurrent (Hickey 1979; Chelton 1984; Neshyba *et al.* 1989). The Coastal Countercurrent flows northward over the continental shelf, inshore from the California Current. The countercurrent typically is only 10 to 20 km wide, with velocities less than 30 cm/sec (Kosro 1987). It is broader and stronger in the winter (October through early March), when it occasionally covers the entire continental shelf and is referred to as the Davidson Current; however, it remains strongest nearshore (Huyer *et al.* 1978). The Coastal Countercurrent has been observed both north and south of the study region. Observations north of the Gulf of the Farallones were made by the Coastal Ocean Dynamics Experiment (CODE; Beardsley and Lentz 1987) during 1981–1982 along a relatively straight stretch of coast between Point Arena and Point Reyes, California. During the upwelling season, the countercurrent appeared whenever equatorward, upwelling-favorable winds relaxed and disappeared when the winds were unusually strong (Send *et al.* 1987; Winant *et al.* 1987).

The California Undercurrent is a strong poleward flow over the slope. This current has been observed off southern California (Lynn and Simpson 1990), Point Conception and Point Sur (Chelton *et al.* 1988; Tisch *et al.* 1992), Northern California (Freitag and Halpern 1981), Oregon (Huyer *et al.* 1984; Huyer and Smith 1985), Washington (Hickey 1979), and Vancouver Island, British Columbia (Freeland *et al.* 1984). The position, strength, and core velocity of the undercurrent vary spatially and at different times of the year, although a maximum poleward velocity of around 30 cm/sec typically occurs between 150 to 300 m depth in slope waters 500 to 1,000 m deep.

All the currents described above are mean flows that are fairly steady over periods of many months. However, the characteristics of the mean flows are subject to considerable interannual variability. El Niño/Southern Oscillation (ENSO) events can alter the mean current field on a year-to-year basis; evidence from the tropical Pacific indicates that 1991–1992 was an ENSO year. ENSO events can cause anomalous atmospheric conditions and anomalous oceanic conditions in the northeast Pacific. Weakened equatorward or poleward winds may cause weakened upwelling and onshore transport, which leads to warmer than usual water temperatures. The ENSO events also can produce very low frequency wave motions at low latitudes which then propagate poleward into the northern hemisphere along the continental shelf and slope. Huyer and Smith (1985) showed that the northward flow over the continental shelf was twice as strong during the El Niño winter of 1982–83 than during the preceding and subsequent "normal" years.

A basic feature of the circulation along the entire central coast is coastal upwelling, which causes continental shelf water to exchange with slope water. An "upwelling front" forms between the upwelled water and the warmer, less dense water further offshore. North of Cape Blanco, Oregon, the upwelling front is fairly straight along the coast, but to the south, large meanders develop and form "cold filaments" of recently upwelled water that can extend more than 200 km offshore. Filaments are observed most commonly near coastal promontories such as Cape Mendocino, Point Arena, Point Reyes, and Point Sur. The Point Arena filament was observed in six different surveys during July and August 1988 (Huyer *et al.* 1991). Offshore velocities along the northern side of the filament approached 100 cm/sec (2 knots), which is far greater than the large scale mean flow towards the south. The Point Reyes filament is less studied and less well understood, but it is expected that large cross-shore transport is associated with the Point Reyes feature as well, which potentially can affect suspended particle transport in the vicinity of the alternative sites. Because the filaments are associated with upwelling, they are not commonly seen during winter.

Mixed semidiurnal tides occur on the west coast in the vicinity of San Francisco. The strongest tidal current component is either the principal lunar or the luni-solar diurnal tide, which have periods of 12.4 hours and 23.9 hours, respectively. Diurnal tides are strongest on the shelf in the Gulf of the Farallones (Noble and Gelfenbaum 1990), with tidal amplitudes between 6 and 9 cm/sec. Lunar tidal currents are strongest on the slope adjacent to the Gulf of the Farallones, with amplitudes from 2.3 to 4.4 cm/sec near Study Area 5 (Noble and Kinoshita 1992). Semidiurnal and diurnal tides together account for 35 to 60% of the total variability in the current records on the shelf, and from 15 to 33% of the variability on the slope. These tidal currents may promote the resuspension of material deposited on the seabed and dispersion of material suspended in the water column.

Wave observations at a buoy 7 nmi southwest of the Golden Gate Bridge (37.62°N; 122.95°W) are summarized by wave period and wave height in Table 3.2-3. Bottom current motions associated with large, storm waves can affect scouring and resuspension of sediments, particularly on the continental shelf. Also, severe wave conditions (e.g., heights greater than 3 m with periods less than 11.7 seconds or wave heights greater than 5 m) can limit or restrict dredged material barge transit to the alternative sites (Section 3.1.2; Tetra Tech 1987).

3.2.2.2 Study Region-Specific Currents

Beginning in 1991, EPA sponsored a one-year study of the circulation in the Gulf of the Farallones and over the adjacent continental slope to develop a better understanding of the physical processes and support predictive modeling of the deposition and fate of dredged material at the LTMS study areas (see Section 4.4). The following, modified from Noble *et al.* (1992), summarizes the information relative to the study area locations.

The EPA study included a main line of moorings, which contained Stations A through D, to monitor the changes with water depth in the physical oceanographic parameters (Figure 3.2-2). Changes in water depth typically cause the largest spatial gradients in the circulation and sediment transport pathways. Station A was on the shelf in 92 m of water, Station B was on the upper slope in 400 m between Study Areas 2 and 3, and Stations C and D were on the mid- and lower-slope at depths of 800 m and 1,400 m adjacent to the southern boundary of Study Area 3. Stations E and F represented a secondary mooring line in the array. Station E was located along the eastern edge of Study Area 5, and Station F was shoreward of Study Area 5. Data from these moorings were used to determine how the circulation patterns changed with distance along the isobaths. Each mooring in the array had between three to six instruments that measured current speed, direction, and temperature at specific locations in the water column (Noble *et al.* 1992).

3.2.2.3 Outer Shelf (Study Area 2) Currents

Currents over the outer shelf were measured at Station A, located within Study Area 2 (Figure 3.2-3). Evaluations of currents at Site A are obscured by gaps in the data, but the available data suggest a vertically coherent flow during the first half of the year. Fluctuations in the alongshore component were quite similar and nearly uniform in magnitude with depth, weakening only slightly towards the bottom. There was a tendency for the along-isobath flow at mid-depth to veer toward the coast. The average mid-depth, cross-shelf flow had a mean speed of 2.4 cm/sec. However, shoreward flow was not observed near the surface or 12 m above the sea floor (approximately 80 m depth).

Tidal currents were the other strong component of the currents measured over the shelf. The principal diurnal tides and the principal semidiurnal tides each can have speeds of 8 to 9 cm/sec (Kinoshita *et al.* 1992). Hence, the tidal and lower frequency (subtidal) currents can combine

Table 3.2-3. Wave Observations (Percent Occurrence) Based on U.S. Army Corp of Engineers (COE) Wave Data at Station 20 (Dates Unspecified), Located Approximately 7 nm southwest of the Golden Gate Bridge, San Francisco, California. Bold numbers represent percentage of total observations exceeding criteria (1) wave heights exceed three meters (9.8 ft.) and wave periods are less than 11.7 seconds; and (2) wave height exceeds 5 meters (16.4 ft.) regardless of wave period.

Wave Height (m)	Wave Period (seconds) 4.4-6.0	6.1-8.0	8.1-9.5	9.6-10.5	10.6-11.7	11.8-13.3	13.4-15.3	15.4-18.1	18.2-22.2
0-0.9	0.16	0.49	0.52	0.03	0.01	0.01	0.00	0.00	0.00
1.0-1.9	1.73	3.97	8.56	5.35	2.68	0.72	0.04	0.06	0.00
2.0-2.9	2.04	2.71	4.76	7.14	11.01	7.84	1.26	0.10	0.02
3.0-3.9	**0.05**	**0.96**	**1.15**	**1.07**	**3.89**	11.14	4.84	0.35	0.00
4.0-4.9	0.00	**0.17**	**0.46**	**0.32**	**0.58**	3.35	5.48	0.56	0.00
5.0-5.9	0.00	0.00	**0.09**	**0.13**	**0.21**	**0.39**	**1.81**	**0.80**	0.00
6.0-6.9	0.00	0.00	0.00	**0.01**	**0.03**	**0.03**	**0.29**	**0.44**	0.00
7.0-7.9	0.00	0.00	0.00	0.00	0.00	0.00	**0.04**	**0.09**	0.00
8.0-8.9	0.00	0.00	0.00	0.00	0.00	0.00	0.00	**0.04**	0.00
9.0-9.9	0.00	0.00	0.00	0.00	0.00	0.00	0.00	**0.01**	0.00
10.0+	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
TOTAL%	3.97	8.31	15.54	14.06	18.41	23.48	13.76	2.46	0.02

Source: Modified from COE (1987).

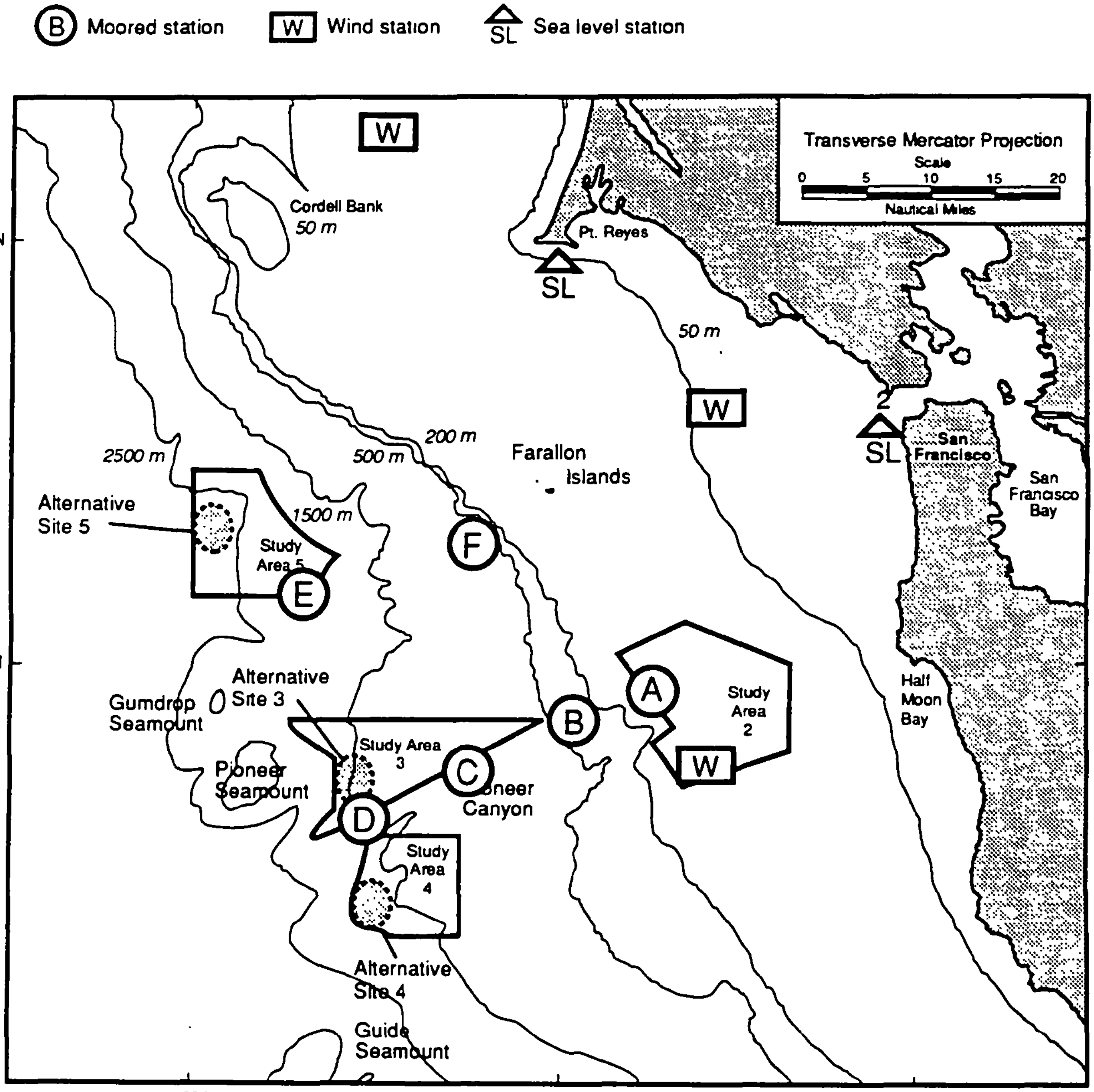

Figure 3.2-2. **Locations of Current Meter Stations A Through F.**
Source: Noble *et al.* 1992.

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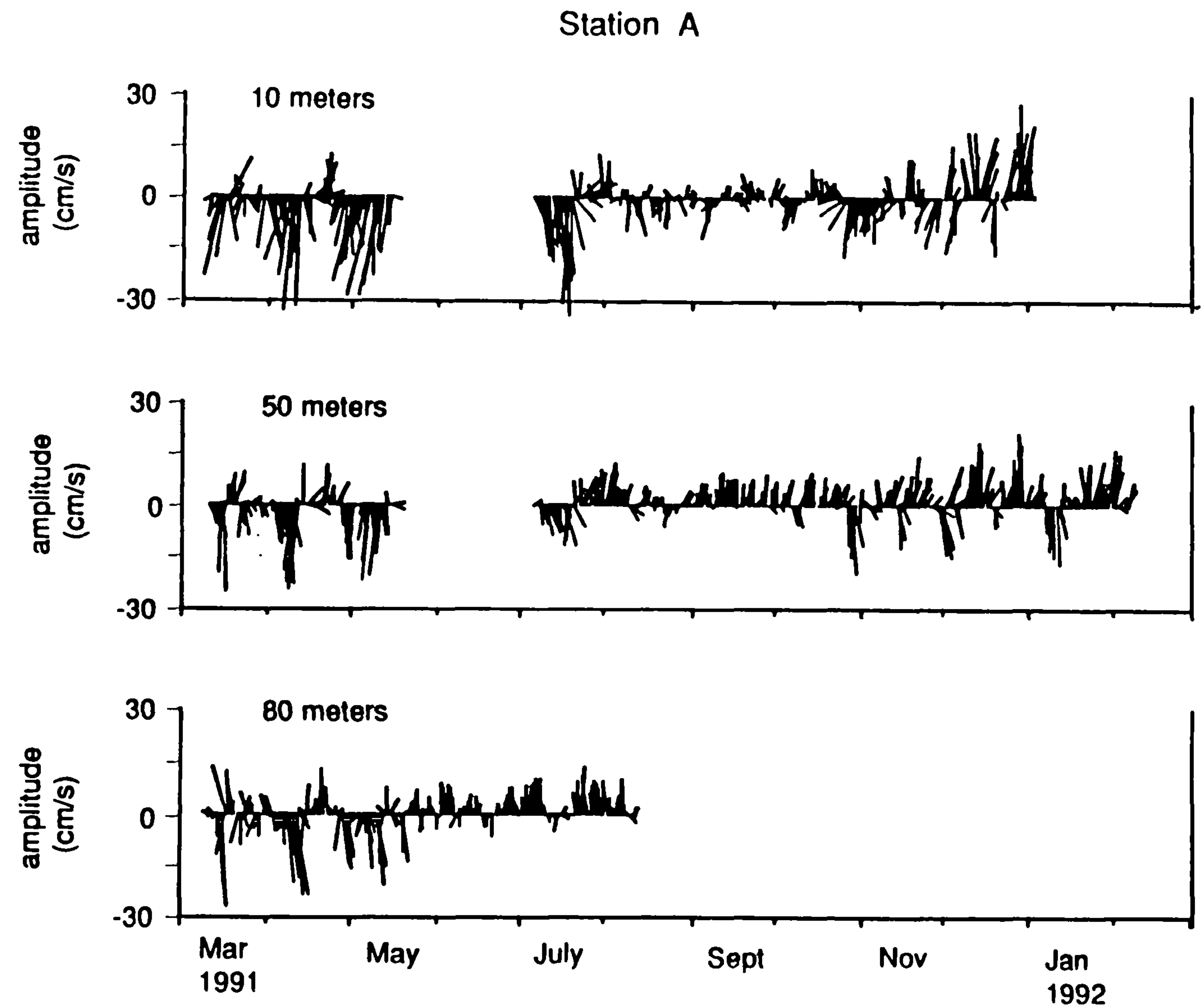

Figure 3.2-3. Subtidal Currents at Station A.
Each line represents the magnitude and orientation of the current vector. A line pointing toward the top of the page represents poleward flow along the shelf. Currents flowing toward the coast point to the right.
Source: Noble *et al.* 1992.

to generate strong currents. Maximum current speeds over the shelf ranged between 40 to 60 cm/sec, and the maximum speed near the seabed was 47 cm/sec. These currents would be strong enough to move fine sand (see Section 3.2.4.2).

3.2.2.4 Slope (Study Areas 3 through 5) Currents

Slope currents in the region of the Gulf of the Farallones during 1991 and 1992 can be grouped by depth ranges. Near-surface currents are those above 75 m depth. Mid-depth currents are between 75 and 800 m and at least 50 m above the seabed. Deep currents are below 800 m and at least 50 m above the seabed, and near-bottom currents are 10 to 15 m above the seabed. The currents within these different depth ranges share similar characteristics, and the coupling among currents is much stronger within discrete depth ranges than the coupling between currents in separate depth ranges.

3.2.2.5 Near-Surface Currents Over the Slope

Near-surface currents over the slope are well studied only at Station C. Spring currents at this station were characterized by a strong equatorward event during April which reached a depth of at least 250 m. This event likely was due to an anticyclonic (clockwise) eddy or a southward flowing upwelling filament, and not attributable to wind. Similar equatorward events also were observed at this time at Stations D and E to depths exceeding 800 m. The strength and duration of the event at 250 m depth was about the same at Stations C and D.

At times, the flow at Station C at 10 m depth was poleward at speeds greater than 30 cm/sec. A portion of this flow likely represented a surfacing of the California Undercurrent which is common during autumn and winter (Section 3.2.2.1). The near-surface diurnal and semidiurnal tidal currents have velocities up to 5 or 6 cm/sec (Kinoshita *et al.* 1992), which are not sufficient to reverse the dominant flow direction of the near-surface currents. The tidal currents can act to disperse materials suspended in the near-surface water; however, being rotational in nature, they would not cause large changes in the fate of those materials in the water column or in the region of deposition (Noble *et al.* 1992).

3.2.2.6 Mid-Depth Currents Over the Slope

A wedge-shaped region, generally including Study Areas 3, 4, and 5, can be described where mid-depth currents along the isobaths are strongly correlated both horizontally and vertically (Figure 3.2-4). The California Undercurrent traditionally has been observed in this region. The offshore boundary of this flow field extended seaward of the study region and was not well delineated.

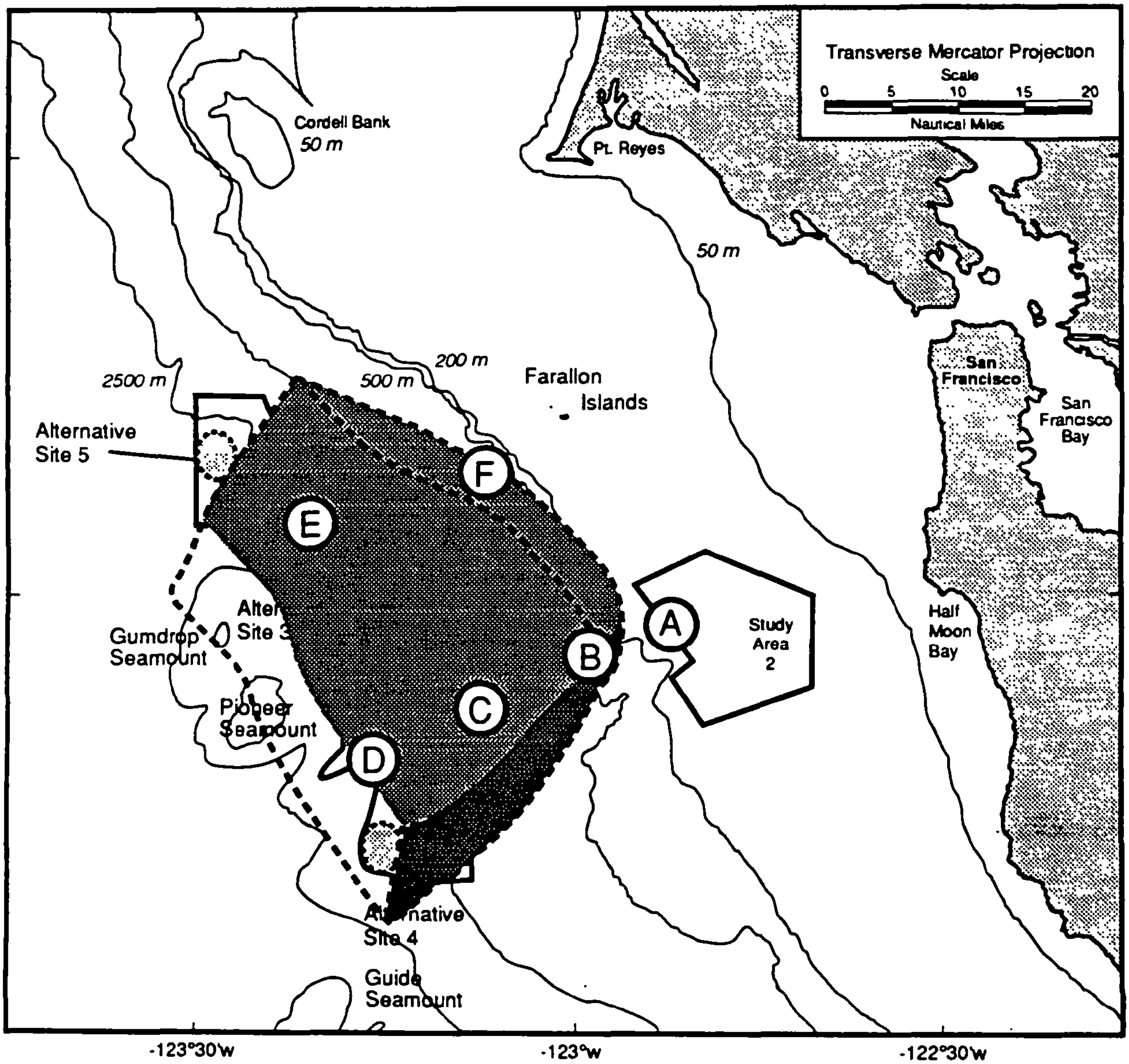

Figure 3.2-4. **Schematic Representation of the Three-Dimensional Structure of the "Wedge-Shaped" Region of Coherent Mid-Depth Flow Over the Slope.**
Source: Noble *et al.* 1992.

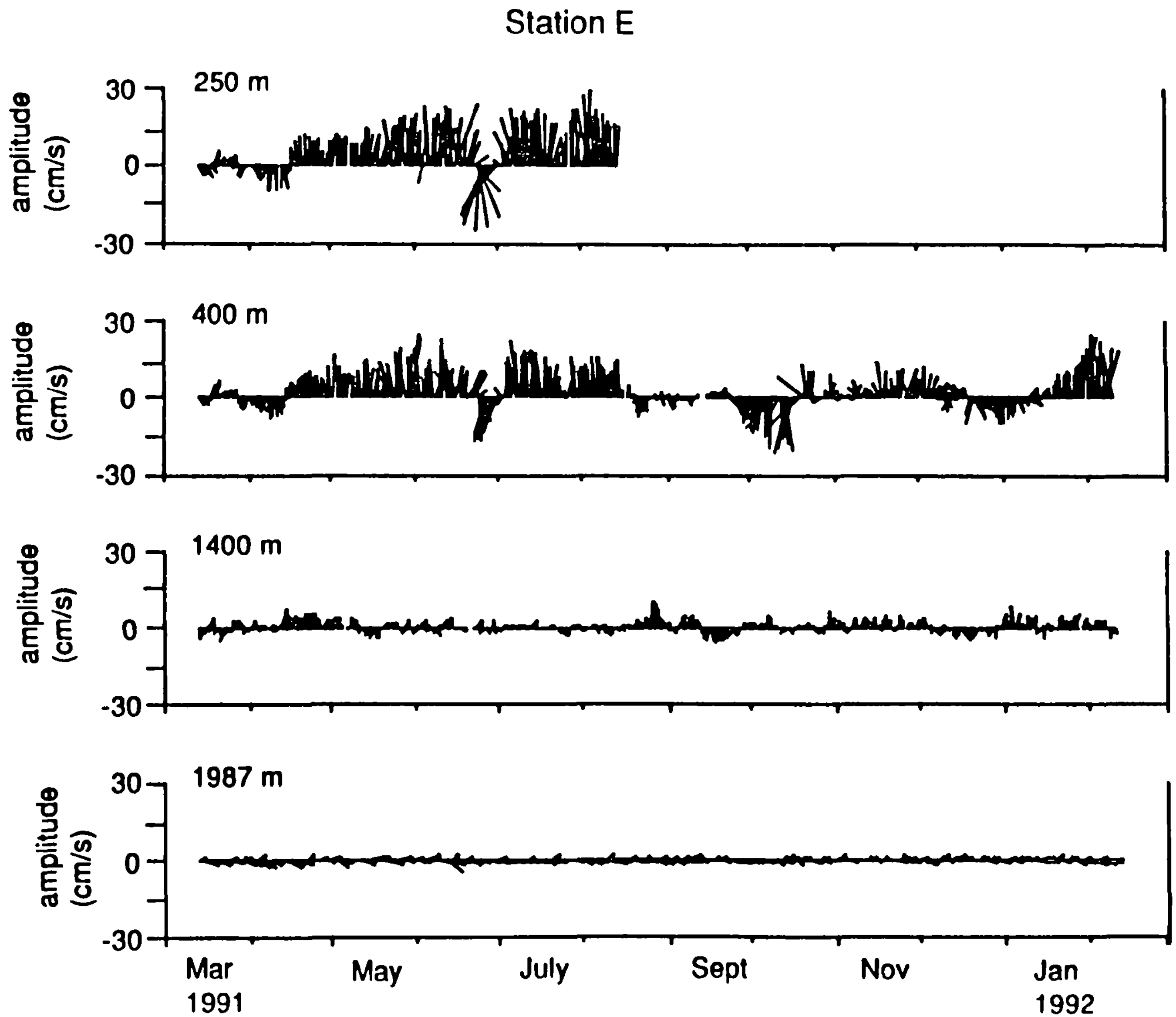

Figure 3.2-5. **Subtidal Currents at Station E.**
Each line represents the magnitude and orientation of the current vector. A line pointing toward the top of the page represents poleward flow along the shelf. Currents flowing toward the coast point to the right.
Source: Nobel *et al.* 1992.

The persistent patterns in mid-depth currents that flow throughout the wedge-shaped region were not observed at Station F, located shoreward of Study Area 5. Currents at Station F were weak and disorganized, with a much higher variability than currents observed over the continental slope at locations elsewhere along the California coast. Current speeds in 150 m at Station F were slower than the equivalent currents at Station B, even though both flow toward the northwest in the spring and early summer, and the poleward currents at Station F do not extend to 250 m. These characteristics suggest that Station F was just east of the inshore boundary of the correlated, wedge-shaped flow field observed at the other stations on the slope.

The most prominent feature of the mid-depth currents over the slope is a burst of strong poleward flow lasting from mid-April to September. Similar bursts of poleward flow have been observed in three-year records over the slope off Point Sur (Ramp *et al.* 1991). Such burst events are not seasonal. Hence, it is not clear if the poleward bursts observed in the EPA data records are part of a seasonal cycle or if they appear randomly at different times in other years.

Both the persistent poleward flow and the strong vertical correlations in the alongslope currents weakened as the year progressed. The amplitude of the mid-depth flow was reduced at all stations, and the direction became more erratic from mid-August through mid-November. A partial return to the strong poleward flow occurred after mid-November.

The daily, mid-depth, tidal currents have combined amplitudes less than 5 cm/sec (Kinoshita *et al.* 1992). The semidiurnal, mid-depth, tidal currents are slightly stronger, with a combined amplitude that can reach 10 cm/sec, but which generally are less than 8 cm/sec. Hence, neither of these tidal constituents can significantly alter the lower frequency current regime described above. The main effect of the tidal components is to increase the cross-slope flow and dispersion of material suspended in the water column across isobaths.

3.2.2.7 Deep Currents Over the Slope

Current measurements in water depths of 1,420 m at Station E suggest that deep currents over the slope are weak and variable (Figure 3.2-5). The deep currents are parallel to bottom contours, but the velocities tend to be less than 10 cm/sec. The mean current speed is 1 cm/sec toward the northwest (Kinoshita *et al.* 1992). The tidal currents have amplitudes less than 4 cm/sec, which are somewhat smaller than those at shallower depths. Because the lower frequency currents also are small, the tidal currents can act to reverse both the net along- and cross-slope flow (Kinoshita *et al.* 1992).

3.2.2.8 Near-bed Currents Over the Slope

Characteristics of currents within 20 m of the seabed cannot be predicted reliably from measurements made in the overlying water column. Near-bed currents also were different at each of the stations, A–F. For example, near-bed currents at Station B appear unrelated to near-bed currents at Station C even though currents in the overlying water column share similar characteristics. Near-bed currents flow along the isobaths, but their amplitudes are much smaller than flows in the overlying water column at most stations on the slope. Bottom currents at Stations B (400 m) and C (800 m) range from 10 to 15 cm/sec, whereas currents at 250 m depths at these stations reach speeds of 30 cm/sec or more. These differences occur because near-bed currents are more strongly controlled by topographic features than currents higher in the water column.

In contrast to the overlying flow, the near-bed currents at Stations B and D have no definite seasonal or temporal patterns. The mean current directions at Stations B and D are weakly equatorward, at speeds of 0.7 and 0.2 cm/sec, respectively (Kinoshita *et al.* 1992). In addition, particular flow events in the near-bed currents last only a few days, which is much shorter than the duration of events in the overlying water column. Near-bed flow at Station C was poleward for most of the observation period, although current flow to the southeast was observed during a few short periods. Near-bed currents at Station E were small but had a steady flow to the northeast up a small unnamed submarine canyon, and across the local isobaths. This shoreward, near-bed flow at Station E may be caused by interactions between the tidal current and local topography (Noble *et al.* 1992).

One of the most notable features of the tidal currents over the slope was the increase in amplitude of both the diurnal and semidiurnal tidal constituents towards the bottom at some locations (Kinoshita *et al.* 1992). Amplification of diurnal and semidiurnal tides can result in tidal currents which are two to three times stronger at the bottom than in overlying waters. This difference may promote resuspension and transport of larger grain sized sediment than would otherwise occur in the absence of "bottom trapping". Enhancement of tides by topographic features also can result in unusually strong mean flows which can result in unidirectional sediment transport. This may occur at Station E, where a steady up-canyon flow was observed. However, amplification of bottom tidal currents was not observed at Station F, possibly due to the relatively steep bottom slope that does not allow this condition to occur. Bottom trapping of the tidal currents has been observed previously over the continental shelf off Point Sur (Sielbeck 1991).

3.2.2.9 Summary of Observed Currents

The circulation over the continental shelf and slope near the Farallon Islands was not strongly coupled. Over the continental shelf and inshore of the Farallon Islands, the observed flow was coupled closely with the local surface wind stress. The flow was equatorward when the wind was equatorward, and poleward when the wind was slack or poleward. The flow also may be affected by outflow from the San Francisco Bay. This aspect of the flow has not been studied previously; hence, the magnitude of the effect is unknown. On average, the mean surface circulation from the shelf break seaward is likely equatorward during the upwelling season, with a velocity less than 10 cm/sec. Surface currents were variable in the other seasons, with speeds and directions changing partially in response to variable surface wind stresses.

Over the continental slope, at depths between 100 and 1,000 m, the flow likely is poleward due to the presence of the California Undercurrent. These currents probably flow poleward throughout the year, but their velocities vary due to conditions not yet fully understood. Strong, persistent bursts (greater than 40 cm/sec) can occur during all seasons for periods of four months or more. The basic flow patterns will be perturbed occasionally by the Point Reyes coastal upwelling jet, which, based on satellite observations of sea surface temperature, sometimes swings southward and crosses the northern corner of the region, and also by mesoscale eddies that move into the area. The frequency of such events is unknown, but at least one such event per year is likely. The upwelling process, which moves water in the upper layers from the slope to the shelf, is weaker here than at other sites on the California coast. The tidal currents over the continental shelf are strongly diurnal and are relatively more important than tidal currents near the continental slope (Noble and Kinoshita 1992). Because wave-induced currents generated during winter storms can reach depths of 100 m or more, fine grained material likely will be resuspended over most areas of the shelf (Noble *et al.* 1992). The general absence of fine-grained sediments, and the presence of sand ripples throughout Study Area 2 (SAIC 1992c; see Section 3.2.4.2) support these indications of strong current-sediment interactions. The mean currents will carry suspended materials mainly along the isobaths. The jets, eddies, and tidal currents will disperse the suspended materials across isobaths.

3.2.3 Water Column Characteristics 40 CFR 228.6(a)(9)

Water column characteristics include temperature, salinity, hydrogen ion concentration (pH), turbidity/light transmittance, dissolved oxygen, and concentrations of major nutrients, trace metals, and trace organic contaminants.

3.2.3.1 Temperature-Salinity Properties

Recent hydrographic and current measurements indicate that the outer shelf and slope regions of the Gulf of the Farallones are a dynamic area (Ramp *et al.* 1992). Current and water mass variability occurs on time scales from days to months, corresponding to meteorological and mesoscale events and seasonal patterns. Surface waters show a great deal of variability in temperature-salinity (T-S) properties. For example, during recent EPA-sponsored surveys (Ramp *et al.* 1992), near-surface waters represented a mixture of three primary water types: (1) recently upwelled water from a source primarily to the north of Point Reyes; (2) offshore water from the large-scale California Current system; and (3) outflow from San Francisco Bay. The characteristics and importance of each water type in the Gulf vary seasonally and on shorter (i.e., event-related) time scales.

Water discharged from San Francisco Bay into the Gulf of the Farallones has a higher temperature and lower salinity, and therefore lower density, than water in the Gulf. The long-term average salinity at S.E. Farallon Island is 33.4 ppt, whereas, at Fort Point on the south side of the Golden Gate, the average salinity is 29.9 ppt (Peterson *et al.* 1989). Historically, salinities at both locations are lowest during winter and spring when the Delta outflow is highest. Due to its lower density than ambient waters, the outflow from San Francisco Bay is confined in the Gulf of the Farallones to the surface layer.

In the vicinity of the alternative sites, a typical temperature-versus-depth profile during summer consists of an isothermal surface layer that is tens of meters thick. Beneath the surface mixed layer is a region of rapidly changing temperatures referred to as the thermocline. Below the thermocline, the water temperature changes gradually with depth, becoming nearly isothermal again. The depth of the surface mixed layer and the degree of vertical temperature and salinity (density) stratification in the Gulf of the Farallones varies depending on the characteristics and extent of mixing of the various water masses.

Water temperatures below 4.0°C with salinities greater than 34.5 parts per thousand (ppt) are associated with Pacific Common Water, which has a stable T-S relationship throughout the North Pacific. Contrasting T-S properties associated with Subarctic Intermediate Water (found offshore in the California Current) and Equatorial Water (over the continental slope in the California Undercurrent) are found at temperatures between 4.8 and 7.0°C. Subarctic waters also are evident, and although the horizontal scale of this intrusion of Subarctic water was not resolved, it is indicative of the active mixing which must occur in the region at these depths.

Considerable seasonal variability in surface water temperatures and salinites reflect large-scale current patterns, outflow from the Bay, and the presence of mesoscale features. Figure 3.2-6 shows satellite images of surface water temperatures during winter (February 1991) and spring (May 1991) and illustrates the variability in surface temperatures. The presence of numerous mesoscale features in both the water mass distribution and currents demonstrates that there was no overall persistent pattern among the study areas. However, it was apparent that the outflow from San Francisco Bay was confined to the inner continental shelf and did not influence the water column at the study areas (Ramp *et al.* 1992).

3.2.3.2 Hydrogen Ion Concentration (pH)

The pH of seawater within the LTMS study areas was not measured during the recent EPA surveys, but is expected to be within the range of 7.8 to 8.3 measured previously in other areas of the Gulf of the Farallones (e.g., Nybakken *et al.* 1984; IEC 1982). Seawater pH values likely are similar at all of the LTMS study areas, although some minor spatial differences may be related to localized effects from primary production by plankton.

3.2.3.3 Turbidity

Water turbidity or light transmittance properties on the continental shelf near the Golden Gate are affected by seasonal and tidal flows of turbid waters from San Francisco Bay. The location and aerial extent of the outflow plume in the nearshore surface waters off San Francisco change seasonally. During recent hydrographic surveys of the region (Ramp *et al.* 1992), outflow from San Francisco Bay was observed to the north of the Golden Gate during August, directly off the Golden Gate during November, and to the south and farther offshore during February 1991. The distribution of the outflow plume may have been influenced by prevailing nearshore wind stress. None of the observed plumes extended very far offshore, likely due to limited freshwater runoff associated with drought conditions. However, previous studies noted a plume of turbid water

Color figures follow.

Figure 3.2-6.

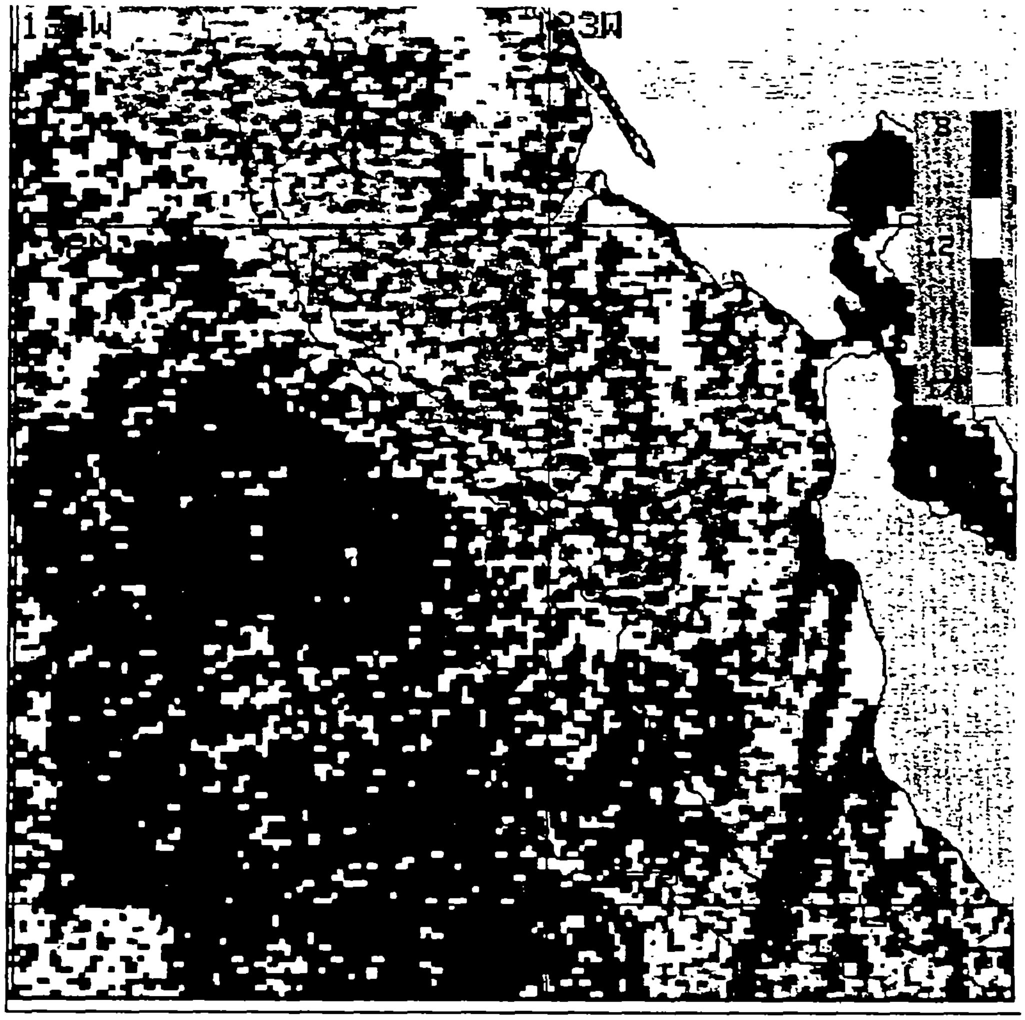

Figure 3.2-6. Satellite Images of Sea Surface Temperatures Within the LTMS Study Region During February 16, 1991.

Temperature ranges are indicated by different colors; red to white represents the warmest water; dark blue represents the coldest.

Source: Noble *et al.* 1992.

Figure 3.2-6. **Satellite Images of Sea Surface Temperatures Within the LTMS Study Region During May 15, 1991.**

Temperature ranges are indicated by different colors; red to white represents the warmest water; dark blue represents the coldest.

Source: Noble *et al.* 1992.

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Figure 3.2-6. Continued.

extending approximately 46 km offshore during peak spring flows from the Bay (Carlson and McCulloch 1974). The relative spatial extent of the plume is reduced in summer when flows from the Bay are minimal.

In waters over the continental shelf off Point Reyes to Point Arena (i.e., the CODE study region), Drake and Cacchione (1987) measured light transmittance values of 65–90 percent transmittance per meter (%/m) throughout the water column. Depth-related patterns in light transmittance suggested the presence of a subsurface lens and bottom layers of turbid (nepheloid) waters. The development of these subsurface lenses may be associated with previously upwelled waters containing high plankton concentrations that sink during periods of relaxation of upwelling-favorable winds. Turbid waters containing high plankton concentrations occur along the front between low density surface water offshore and recently upwelled water over the continental shelf. The location of the front may then move in an onshore or offshore direction in response to local alongshore winds.

Within the LTMS study areas, turbidity probably is affected by seasonal changes in suspended particle concentrations related to primary productivity, surface current patterns and the presence of fronts, and the extent of bottom sediment resuspension on the shelf or at the shelf break. Light transmissivity measurements made at Study Area 5 in September 1991 showed values of 88–90 %/m throughout the water column; there was no evidence of a turbid nepheloid layer in any of the sampled water layers (SAIC 1992a). Similarly, Nybakken *et al.* (1984) measured 80–90 %/m light transmittance throughout the water column at a shelf-edge location (Station 2; see Figure 2.1-3), whereas, lower values of 10–80 %/m were measured at a site over the continental shelf. The low transmittance levels at the continental shelf site may be related to resuspension of sediments near the bottom and inorganic suspended particles or phytoplankton within the near-surface mixed layer (Nybakken *et al.* 1984).

Few measurements of suspended solids concentrations have been made within the region, and no measurements of total suspended solids (TSS) were performed within the LTMS study areas during the EPA surveys. However, IEC (1982) measured TSS concentrations of 0.08 to 2.5 mg/l in waters near the shelf-break (the 100-Fathom disposal site) in April 1980, and Gordon (1980) measured TSS concentrations of 0.3 to 2.9 mg/l within the surface 25 m at two continental shelf sites in the Gulf of the Farallones during March and August 1979. Nearshore areas affected by the plume from San Francisco Bay are expected to have significantly higher water column concentrations of TSS and associated higher turbidity levels than waters further from shore.

3.2.3.4 Dissolved Oxygen

Dissolved oxygen concentrations are important because depressed oxygen levels can affect the diversity and abundances of marine organisms. In upwelling areas, such as the central California coastal zone region, organic material associated with high primary production settles through the water column and consumes oxygen via microbial respiration as it sinks. The depletion of dissolved oxygen at depths of about 500 to 900 m can produce an oxygen minimum zone (OMZ) (Broenkow and Green 1981). Intersection of the OMZ with the sea floor potentially can affect the distribution of oxygen-sensitive taxa. Whereas the cores of some OMZ are faunally depauperate (Rhoads *et al.* 1991), the edges of the OMZ are known to be highly productive, especially with respect to bacteria (Mullins *et al.* 1985; Rhoads *et al.* 1991).

Composite profiles of dissolved oxygen (DO) concentrations measured in July and September 1991 within Study Areas 3 and 5 are shown in Figure 3.2-7. The DO concentrations in surface waters are approximately 8 mg/l. Concentrations decline through the mixed layer, and reach minimum values of about 0.5 mg/l at a depth of 800 m. Below 800 m, DO concentrations increase to over 3 mg/l at depths greater than 2,000 m. This DO concentration/depth pattern is similar to those reported for other portions of the central California continental margin (e.g., Thompson *et al.* 1985). Nybakken *et al.* (1984) measured dissolved oxygen concentrations of approximately 5.1–8.6 mg/l over the continental shelf and shelf edge in the Gulf of the Farallones; surface waters were supersaturated with oxygen, while bottom waters were at about 45% saturated. Similarly, dissolved oxygen concentrations averaged over a period of 18 years for CalCOFI Station 60052 (37°51.8N; 123°03.8W; offshore from Point Reyes and north of the Farallon Islands) over the continental shelf ranged from 8.7–10.1 mg/l at the surface to 5.3–7.3 mg/l at 50 m. The higher concentrations typically were measured in January and lower concentrations occurred in October.

3.2.3.5 Nutrients

Nutrient concentrations in marine ecosystems are influenced by seasonal current patterns, upwelling, and biological uptake by marine plants (e.g., phytoplankton). Outflow of water from San Francisco Bay may represent an additional source of nutrients to nearshore waters. Typically, nutrient concentrations increase with depth due to surface depletion by phytoplankton and settling of detritus followed by subsurface remineralization and release of nutrients. However, upwelling of deeper waters transports nutrients into the surface mixed layers.

Measurements from CalCOFI surveys in the vicinity of the Gulf of the Farallones indicate that phosphate concentrations in surface waters (10 m depth) typically range from 0.25 to 2.0 micromoles per liter (μM/liter). Concentrations increase with depth below the surface mixed layer; concentrations up to about 4 μM/liter occur at depths greater than 1,000 m. Nitrate concentrations in surface (10 m) and mid-depth (100 m) waters range from < 1 to 20 μM/liter and from 10 to 30 μM/liter, respectively. Silicate concentrations in surface and mid-depth waters range from 1 to 40 μM/liter and from 20 to 50 μM/liter, respectively. Profiles of nitrate, phosphate, and silicate concentrations measured at CalCOFI Station 60060 (37°36.8'N, 123°36.5'W; southwest from the Farallon Islands and Study Area 5) over the continental slope during July 1984 are shown in Figure 3.2-8.

No measurements of nutrient concentrations were performed during the EPA surveys of the LTMS study areas. Differences in nutrient concentrations between Study Areas 3 through 5 are expected to be minimal, especially within the subsurface layers, although localized upwelling events and small-scale variability in phytoplankton productivity may result in some short-term spatial differences within surface waters. As mentioned, nutrient concentrations within the shelf

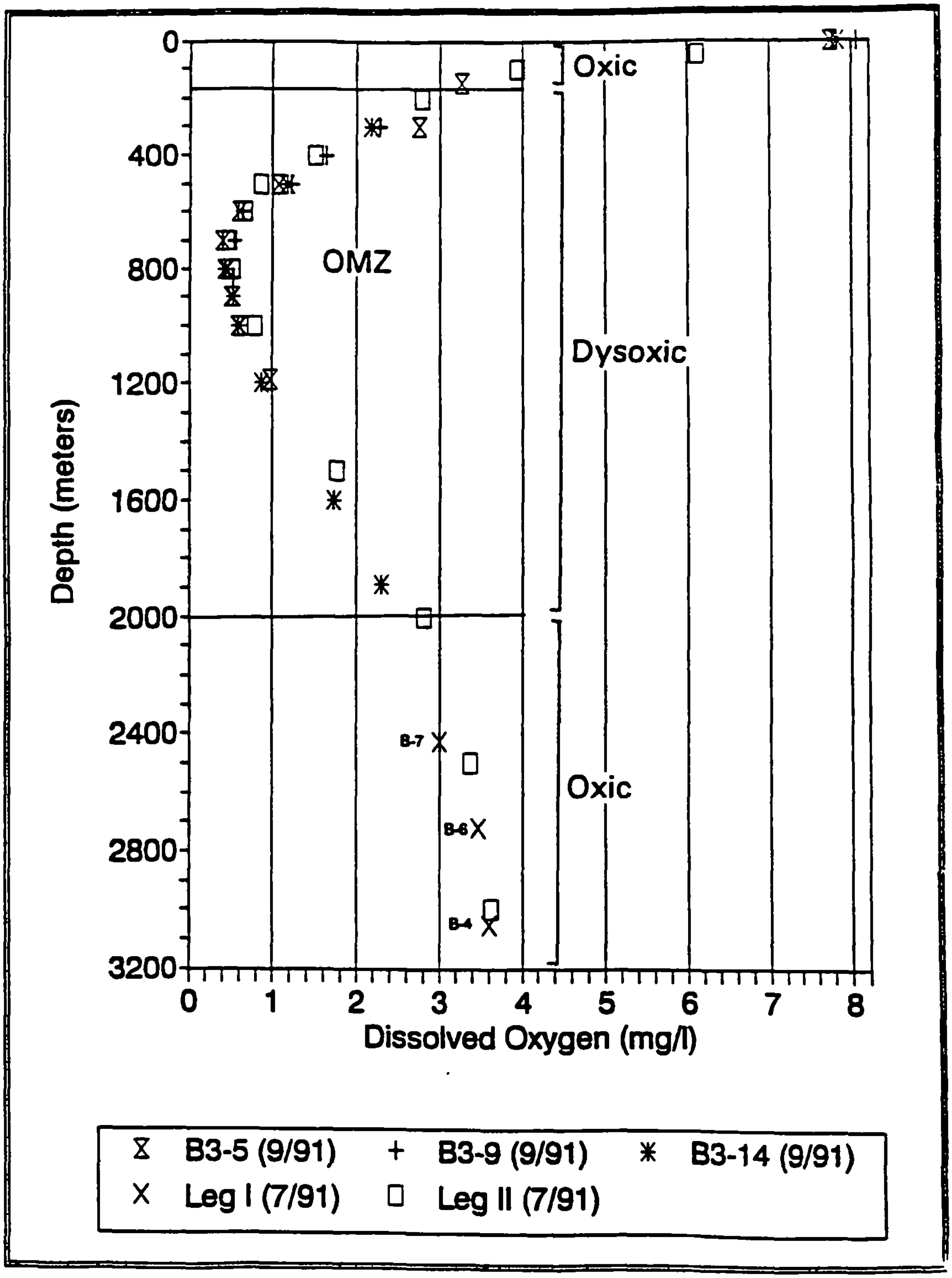

Figure 3.2-7. A Composite Profile of Dissolved Oxygen Concentration in the Water Column Over the Continental Slope off San Francisco and the Gulf of the Farallones.

Data were collected at Study Area 5 in July 1991 and at Study Area 3 in September 1991. Oxygen concentrations in the oxic zones are > 2.8 mg/l and in the dysoxic zone range from 0.28–2.8 mg/l.

Source: SAIC 1992c.

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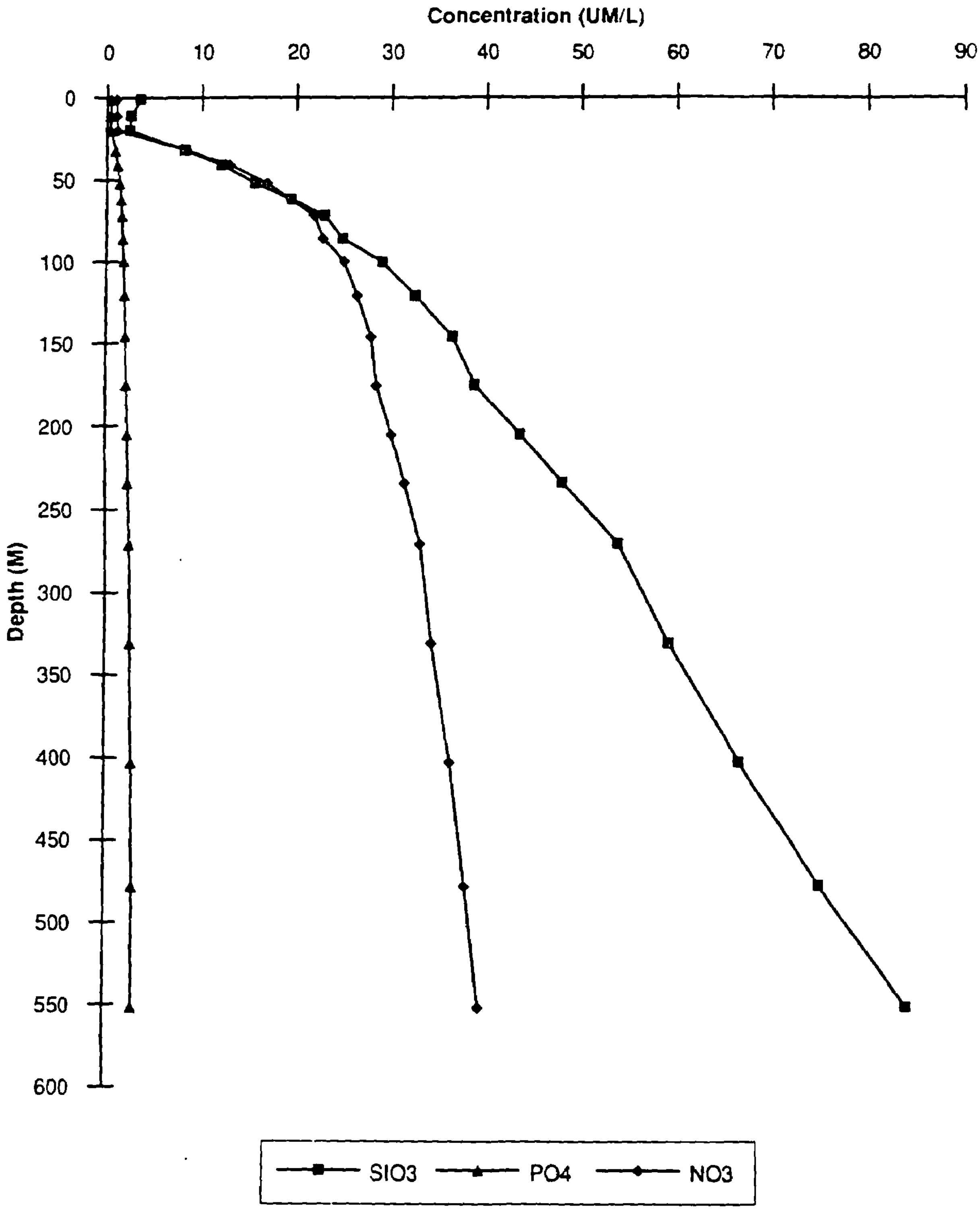

Figure 3.2-8. Vertical Profiles of Silicate, Phosphate, and Nitrate Concentrations at CalCOFI Station 60060 (37°36.8'N, 123°36.5'W) in July 1984.
Source: CalCOFI Database (1991).

region, including Study Area 2, are expected to be influenced to a greater extent by the Point Reyes upwelling filament and outflow from San Francisco Bay than are Study Areas 3 through 5.

3.2.3.6 Trace Metals

Trace metal concentrations in seawater within the LTMS study areas were not measured during the EPA and Navy surveys. However, data from previous measurements of seawater trace metal concentrations in the vicinity of the Gulf of the Farallones are presented in Table 3.2-4. Concentrations of individual trace metals in the surface waters of the Gulf of the Farallones are characterized by pronounced spatial and temporal variability (Nybakken *et al.* 1984). These differences are expected to reflect upwelling patterns, transport and mixing of outflow from San Francisco Bay, resuspension of bottom sediments by currents and wave action, and atmospheric deposition of anthropogenic metals (e.g., lead from gasoline additives). Large differences between Study Areas 3, 4, and 5 in the seawater trace metal concentrations would not be expected. Relatively higher concentrations of selected metals may occur within Study Area 2, depending on Bay outflow and current conditions.

The NOAA National Status and Trends (NS&T) Program and California "Mussel Watch" Program measured contaminant concentrations in tissues of intertidal mussels (*Mytilus* spp.) as an indicator of water quality trends. Waters near the Farallon Islands typically contain low concentrations of most trace metals as compared to sites along the California coast located near urban areas or discrete sources of pollutants. However, the Farallon Islands mussels historically contained high lead concentrations relative to concentrations in mussels from several central California locations. The source of the lead is unknown; however, the location of the Farallon Islands upwind from potential combustion sources would minimize atmospheric deposition sources (Farrington *et al.* 1983; Goldberg and Martin 1983). Elevated concentrations of some elements (including cadmium in mussels at the Farallon Islands) probably are related to upwelling of subsurface waters that are relatively enriched with these elements (Farrington *et al.* 1983; Bruland *et al.* 1991).

3.2.3.7 Hydrocarbons

Petroleum and synthetic (anthropogenic) hydrocarbon concentrations in waters within the LTMS study areas were not measured during the EPA and Navy surveys. However, concentrations are expected to reflect current transport and mixing with outflow from San Francisco Bay, atmospheric deposition, particularly of combustion-derived compounds, and episodic inputs from oil/petroleum product spills (e.g., the T/V PUERTO RICAN) or vessel discharges. Nevertheless, appreciable differences in hydrocarbon concentrations between Study Areas 3, 4, and 5 would not be expected. Slightly higher concentrations of hydrocarbons may occur within Study Area 2, depending on Bay outflow and current patterns.

Nybakken *et al.* (1984) reported very low concentrations of petroleum hydrocarbons (140–280 ng/liter) in outer continental shelf waters (Station 2; see Figure 2.1-5). Similarly, deLappe *et al.* (1980) reported that the polynuclear aromatic hydrocarbons (PAHs) phenanthrene and pyrene in

Table 3.2-4. **Trace Metal Concentrations in Seawater in the Vicinity of the Gulf of the Farallones.**

Study Area (Source)	Depth (m)	Concentration (mg/Liter)							
		Cd	Cu	Fe	Mn	Ni	Pb	Zn	Hg
Continental Shelf and Shelf Edge (Nybakken *et al.* 1984)	10	0.02	0.14–0.15	0.51–1.4	< 0.005–0.01	0.42–0.53	< 0.6	0.52–0.53	
	20	0.01–0.04	< 0.005–0.07	0.59–1.1	0.21–0.51	0.17–0.23	< 0.6	< 0.005–0.18	
	40	0.03–0.05	0.03–0.27	1.5–2.7	< 0.005–1.5	0.29–0.48	< 0.6	0.33–2.1	
	100	0.02–0.04	0.07–0.13	0.17–0.59	0.01–0.10	0.23–0.39	< 0.6	< 0.005–0.27	
Continental Shelf (Gordon 1980)[1]	2	0.047	0.16		0.41	0.24	0.15	0.21	
	6	0.030	0.16		0.99	0.34	0.028	0.12	
	20	0.046	0.14		0.39	0.21	0.049	0.095	
	25	0.045	0.10		0.60	0.33	0.020	0.17	
100-Fathom Site (IEC 1982)[1]	55	0.060–0.61					0.22–0.38		0.018–0.019

Table 3.2-4. Continued.

Study Area (Source)	Depth (m)	Concentration (mg/Liter)							
		Cd	Cu	Fe	Mn	Ni	Pb	Zn	Hg
Continental Slope (Bruland 1980)	25	0.0066	0.084			0.217		0.016	
	50	0.0064	0.085			0.207		0.014	
	100	0.037	0.082			0.263		0.054	
	250	0.082	0.081			0.358		0.160	
	750	0.115	0.119			0.522		0.363	
	1,500	0.107	0.135			0.620		0.507	
	3,000	0.100	0.221			0.627		0.574	

[1]Dissolved and particulate fraction concentration

waters near the Farallon Islands were below analytical detection limits. Organochlorine compounds measured by IEC (1982) in seawater collected at the 100-Fathom site were nondetectable. However, Nybakken *et al.* (1984) measured concentrations of total (dissolved and particulate) polychlorinated biphenyls (PCBs) of 24–105 ng/liter, dichloro-diphenyldichloroethylene (DDE) of 4.6–27 ng/liter, and trace amounts (less than 500 ng/liter) of chlordane, hexachlorocyclohexane, dieldrin, and toxaphene in waters over the continental shelf and shelf edge.

3.2.4 Regional Geology

The regional geology characterization includes bottom topography, presence and location of large geologic structures such as submarine canyons and seamounts, and sediment transport pathways.

3.2.4.1 Topography

The LTMS study region is located in the physiographic province called the Farallones Escarpment. Within this province are two geomorphic areas: a northern segment where the escarpment is about 35 km wide with a slope of six degrees and more, and a southern segment where the width of the escarpment is about 75 km wide with a slope of about two degrees (Karl 1992). The approximate boundary between the northern and southern geomorphic areas is 37°30'N, which also separates Study Areas 2, 3, and 4 to the south from Study Area 5 to the north.

In 1990, the United States Geological Survey (USGS) conducted a geological, geophysical, and geotechnical study of the 3,400 km^2 LTMS study region ranging in depths from 200 to 3,200 m. Regional geologic data were used to evaluate bottom stability and sediment transport, as well as other physical and benthic processes, and to identify areas of sediment erosion, bypass, and accumulation (Karl 1992). The regional geological setting as determined from the USGS survey is described below.

The northern segment of the escarpment has the most rugged topographic relief. This relatively narrow part of the escarpment is transected by numerous gullies and canyons that dissect the slope from the shelf-slope break to the lower slope and/or basin floor. These topographic features are oriented roughly perpendicular to the regional trend (generally northwest-to-southeast) of the Farallones Escarpment. A canyon within Study Area 5 represents one of these slope features. Between the gullies and canyons are steep intercanyon ridges that consist of barren rock outcrops of consolidated or hardened strata and crystalline basalt (Chin *et al.* 1992). Within the gullies and canyons, unconsolidated muds have accumulated to thicknesses up to 5 m. Although the northern area has a rugged topography and relatively steep slopes, few examples of massive down-slope movement could be detected from either sidescan or subbottom acoustic records. If slump structures exist in this area, they are of small spatial dimensions and represent only thin intervals of sediment (Chin *et al.* 1992).

The southern segment of the escarpment is wider than the northern segment with a mean slope of about one-third that of the northern area. The major topographic features consist of Pioneer Canyon and Pioneer, Guide, and Mulburry Seamounts at the base of the slope. Pioneer Canyon is located between Study Areas 3 and 4, and Pioneer Seamount is immediately west of Study Area 3. Sidescan sonar records show that these features consist of volcanic basement rock covered with hemipelagic (i.e., predominantly from oceanic or planktonic origins with little terrigenous material) sediment.

The topography within both Study Area 3 and Study Area 4 is relatively featureless (Karl 1992). Study Area 3 is located to the north of Pioneer Canyon on a gently sloping, featureless plain that is covered by a thin and variable sediment layer. Study Area 4 is located south of Pioneer Canyon on a gently sloping area where the sediment cover is sparse and patchy. Outcrops of volcanic rock are present within both study areas and in Pioneer Canyon. Subbottom acoustic profiles show a thin, discontinuous layer of unconsolidated sediment covering older sedimentary strata or crystalline bedrock. Soft sediment is 5 to 15 m thick over the southern escarpment. The thin layer of soft sediment makes it difficult to observe small-scale acoustic features that are diagnostic of slumping, soft sediment deformation, and faulting.

Geotechnical analysis of sediment cores collected in both the north and south escarpment areas showed that the upper 3 m of the sediment column appear to be physically stable under conditions of static gravitational loading. A stability model predicted that the equilibrium thickness for sediments deposited on a slope of one to five degrees should be 5 to 15 m thick (Edwards *et al.* 1992). Subbottom profiling results from the USGS survey confirm this prediction, as sediment cover falls within this thickness range. However, the surficial sediment cover becomes marginally stable under conditions of seismic loading as modeled from extreme earthquake events. These slope stability predictions only apply to existing slope sediment, and extrapolation or extension of these conclusions to dredged material that may be rapidly loaded onto the ambient bottom are not warranted (Edwards *et al.* 1992).

3.2.4.2 Sediment Transport

Interactions of strong bottom currents and surface waves can generate bottom shear stresses that are sufficient to suspend and initiate bedload transport of bottom sediments over the continental shelf (Cacchione *et al.* 1987; Grant *et al.* 1984). Mass sediment movement in the form of turbidity currents and submarine avalanches also may occur on the slope in response to downwelling, internal waves, or earthquakes. Some downslope and offshore movement of sediments may be indicated by results from recent EPA surveys showing onshore to offshore gradients in sediment grain size, sediment organic content, and concentrations of some trace sediment chemical parameters (SAIC 1992a,c).

Study Area 2

Of the four areas investigated during the EPA and Navy surveys, Study Area 2 has the greatest potential for resuspension and transport of sediment. The bottom sediments within Study Area 2 are extensively rippled (Figure 3.2-9) indicating active bedload transport of sand. At the shelf-slope transition (180 to 200 m) south of Pioneer Canyon, a coarser sand zone (Figure 3.2-10) lies within a depth zone coincident with the pycnocline (water density stratification layer) (Vercoutere *et al.* 1987). This may represent an area where shoaling internal waves intersect and scour the bottom. The surface component of the California Current and Undercurrent also can affect bottom stresses in this zone, resulting in downslope movement of shelf sands. No low kinetic energy regions were identified within Study Area 2. (The low kinetic energy area indicated in Figure 3.2-9 likely is an artifact of high biological activity obscuring sand ripples; SAIC 1992c). Thus, dredged material discharged at this shelf location would not be expected to remain in place for any prolonged period of time.

Study Areas 3 and 4

Study Areas 3 and 4 share several attributes related to sediment transport. Mapped distributions of rippled and scoured bottoms within the shallower depths of Study Area 3 and regions shoreward of Study Area 4 (Figure 3.2-9) appear to be affected episodically by bottom scour related to occasional "benthic storms" (SAIC 1992c). Between these strong flow events, the bottom may experience low kinetic energy periods when fine-grained sediments and organic "fluff" layers can accumulate until they are resuspended and transported by the next storm event. The periodicity of these benthic storms is unknown. These conclusions are based on sediment patterns observed within depth zones of approximately 200 to 500 m that lie within areas affected by the nearshore California Undercurrent. This current has a mean velocity of about 5 to 10 cm/sec (Vercoutere *et al.* 1987). However, "bursts" within this current regime of up to 40 cm/sec have been measured (see Section 3.2.2). Near-bottom flow velocities of 5 to 10 cm/sec are too weak to erode and transport large quantities of fine-grained sediments, whereas velocities over 25 cm/sec are capable of initiating bed erosion (Rhoads and Boyer 1982).

Within the depth range of 600 to 800 m, where the slope flattens from 8 to 4%, the mud (silt and clay) content of the sediment increases from 12 to 55%. This is called the "mud line" or the mud transition (Vercoutere *et al.* 1987) that generally separates nondepositional or erosional bottoms above this depth range from more depositional regimes below this depth range. However, as noted above, the depositional regimes below 600 to 800 m also may experience episodic scouring.

Depositional, low kinetic sites corresponding to Alternative Sites 3 and 4 are located in Study Areas 3 and 4 (designated as Sites "B" and "C," respectively, in Figure 3.2-10) below depths of approximately 1,400 m. These are the only study area sites that consist of muddy sediments with biogenic features such as fecal mounds, feeding pits, and pelletal layers at the sediment-water interface. The presence of these delicate structures is strong evidence that sediment transport is not taking place. Thus, dredged material deposited within these two areas likely will remain

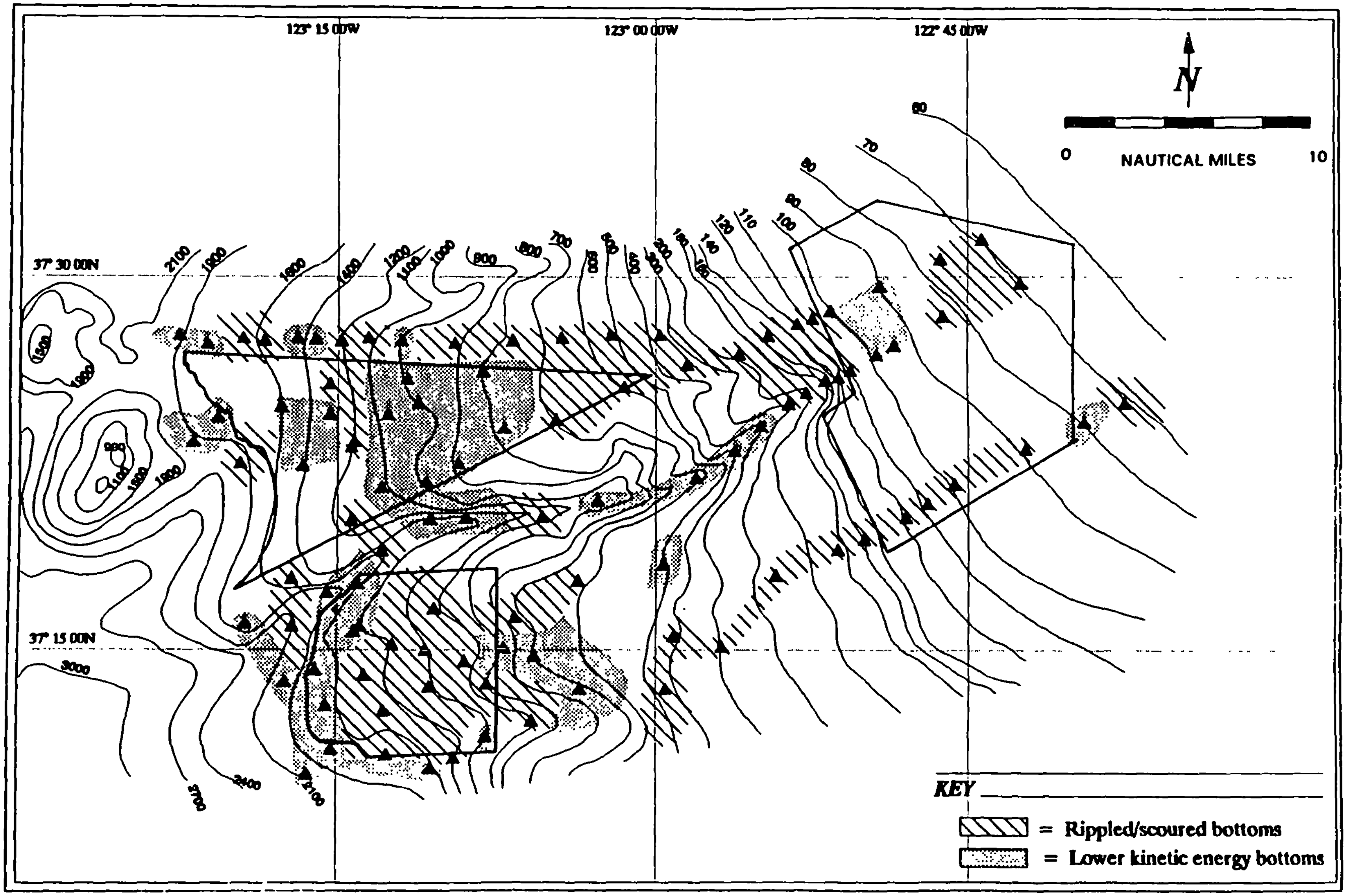

Figure 3.2-9. **Mapped Distribution of Ripples and Scour Lag Deposits (High Kinetic Energy Bottoms) and Sediments Dominated by Biogenic Features (Low Kinetic Energy Bottoms).**
Source: SAIC 1992c.

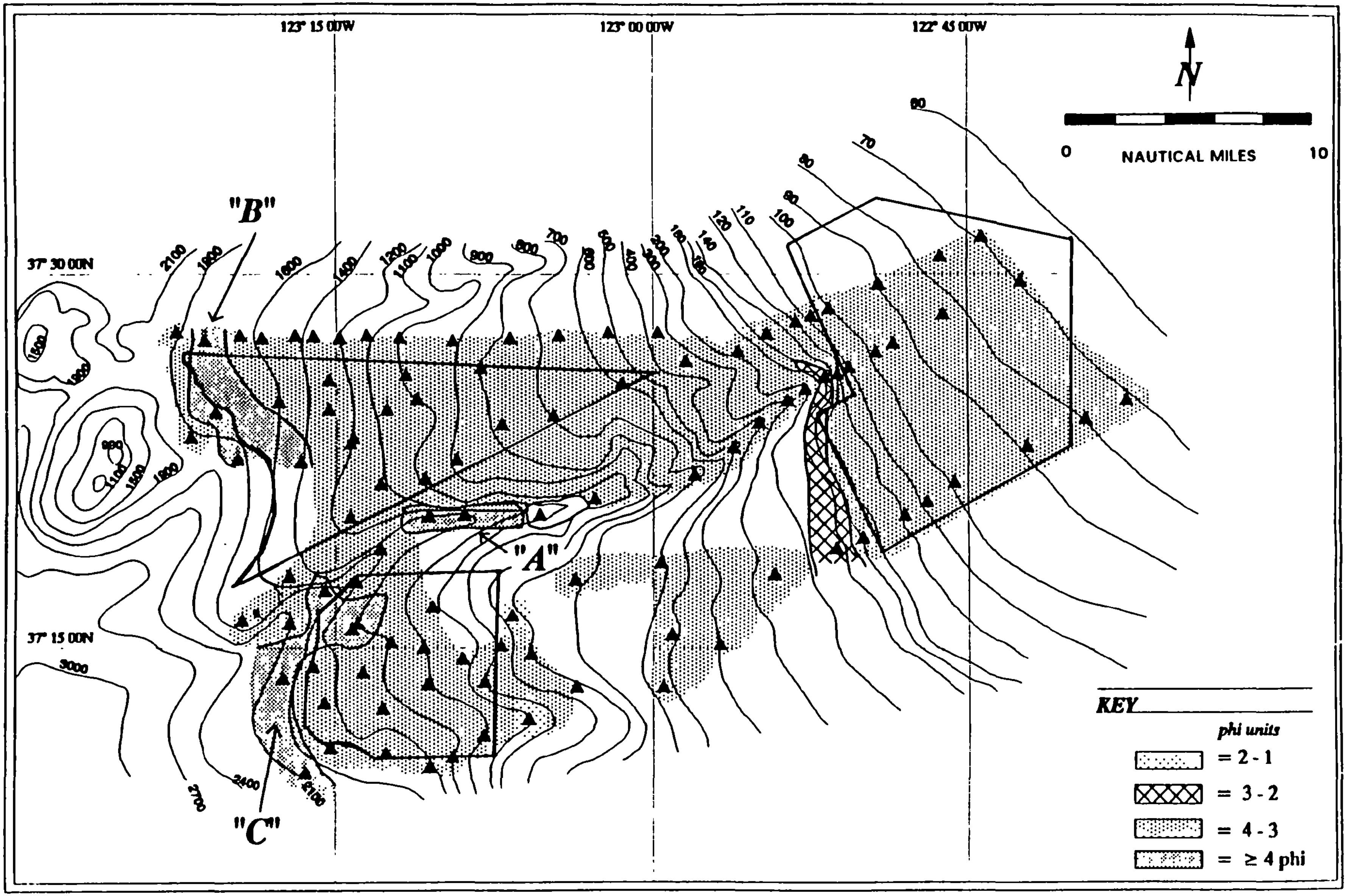

Figure 3.2-10. Mapped Distribution of Major Modal Grain Size (phi units).
Areas A, B, and C identify silt-clay depositional sites.
Source: SAIC 1992c.

undisturbed for relatively longer periods of time than material discharged into the shallower portions of Study Areas 3 and 4 or within Study Area 2.

Pioneer Canyon

The Pioneer Canyon sediments have less evidence of rippling and scouring than the adjacent portions of Study Areas 3 and 4 (Figure 3.2-9). Because Pioneer Canyon is incised into the Farallones escarpment, it apparently is less affected by the California Undercurrent than areas at comparable depths in Study Areas 3 and 4. The major transport direction is along the axis of the canyon. A "pool" of mud has been mapped extending from 1,100 m to deeper than 1,400 m. This low kinetic energy area is designated as Site "A" in Figure 3.2-10.

Study Area 5

Study Area 5 contains a geological environment where sediments entering the escarpment from the continental shelf are flushed through numerous canyons. However, sediments probably do not accumulate over the long term until they reach the continental rise, west of Study Area 5. The floors of gullies and canyons contain unconsolidated sediment, but these deposits may be only temporary repositories. No unequivocal evidence of mass sediment movement within the study area was found (SAIC 1992a). All evidence of slumping is limited to steep slopes and walls of submarine canyons. The intercanyon ridges and sides of gullies and canyons are largely experiencing erosion. However, a low kinetic energy (depositional) area occurs at depths between 2,200 to 3,000 m in the trough axis and extends to the western portion of the study area (Figure 3.2-11). The depositional area (corresponding to part of Alternative Site 5) within Study Area 5 is at a greater depth than depositional areas (corresponding to Alternative Sites 3 and 4, respectively) within Study Areas 3 and 4.

3.2.5 Sediment Characteristics

Sediment characteristics considered for an ODMDS designation include grain size, mineralogy, organic content, and chemical contaminant concentrations. In the Gulf of the Farallones, many of these parameters show depth-related trends (e.g., SAIC 1992a,c; Booth *et al.* 1989) which reflect the sources of sediments and particulate matter, transport pathways, and erosional/depositional characteristics of the specific locations within the region.

3.2.5.1 <u>Grain Size</u>

Sediment grain size generally decreases with increasing depth, from predominantly sand-sized sediments on the continental shelf to fine-grained muds on the continental slope (Figure 3.2-12). The sand-to-sandy mud transition occurs at depths of 600 to 800 m (SAIC 1992c). Above this transition depth, waves and the California Undercurrent can scour the bottom, preferentially removing the finer-grained sediments. At depths below this range the scouring effects are attenuated and fine-grained sediments have longer residence times on the bottom (Vercoutere *et al.* 1987). However, some localized areas of relatively coarser and relatively finer grained

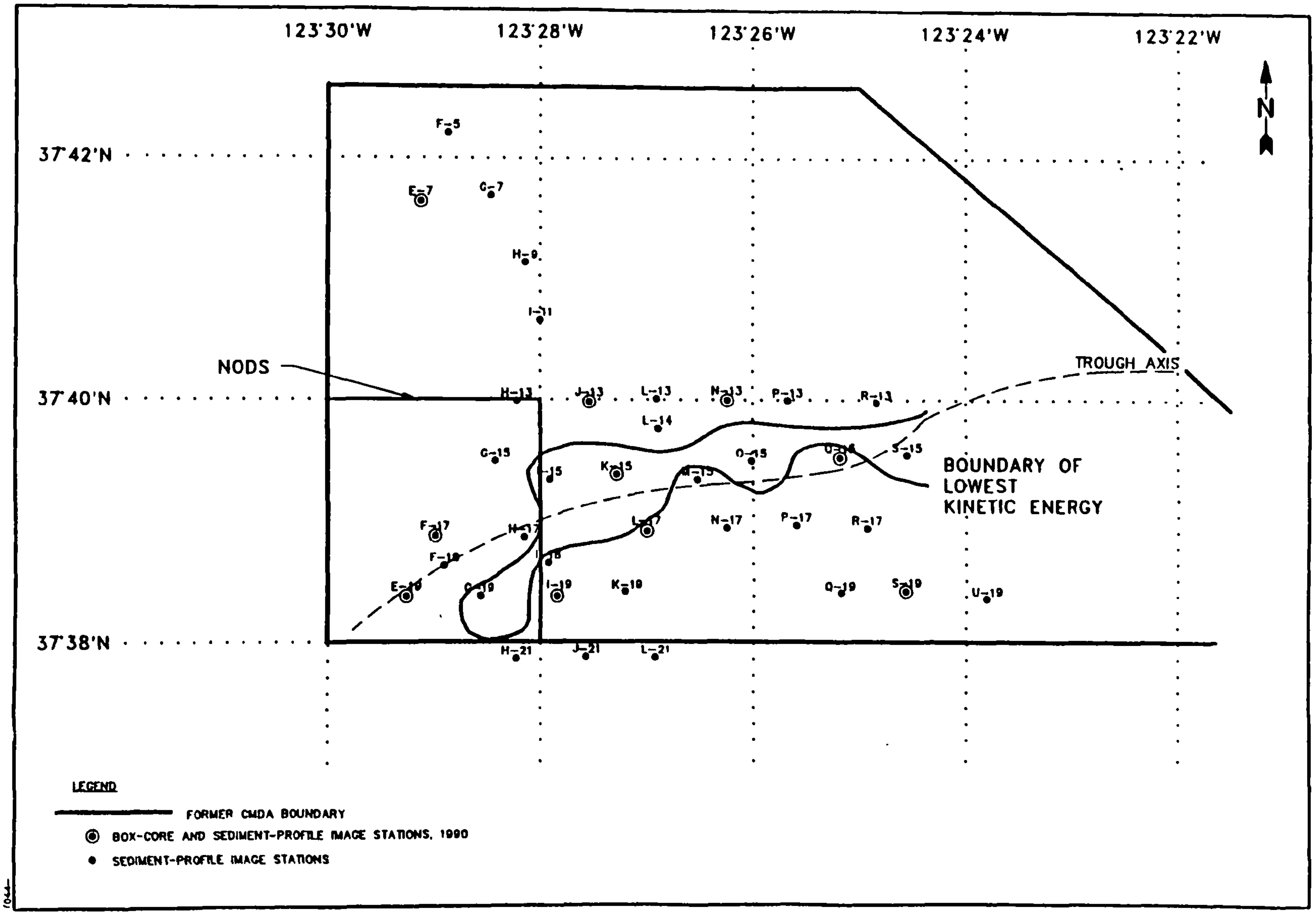

Figure 3.2-11. Low Kinetic Energy Zones in LTMS Study Area 5.
Source: SAIC 1992a.

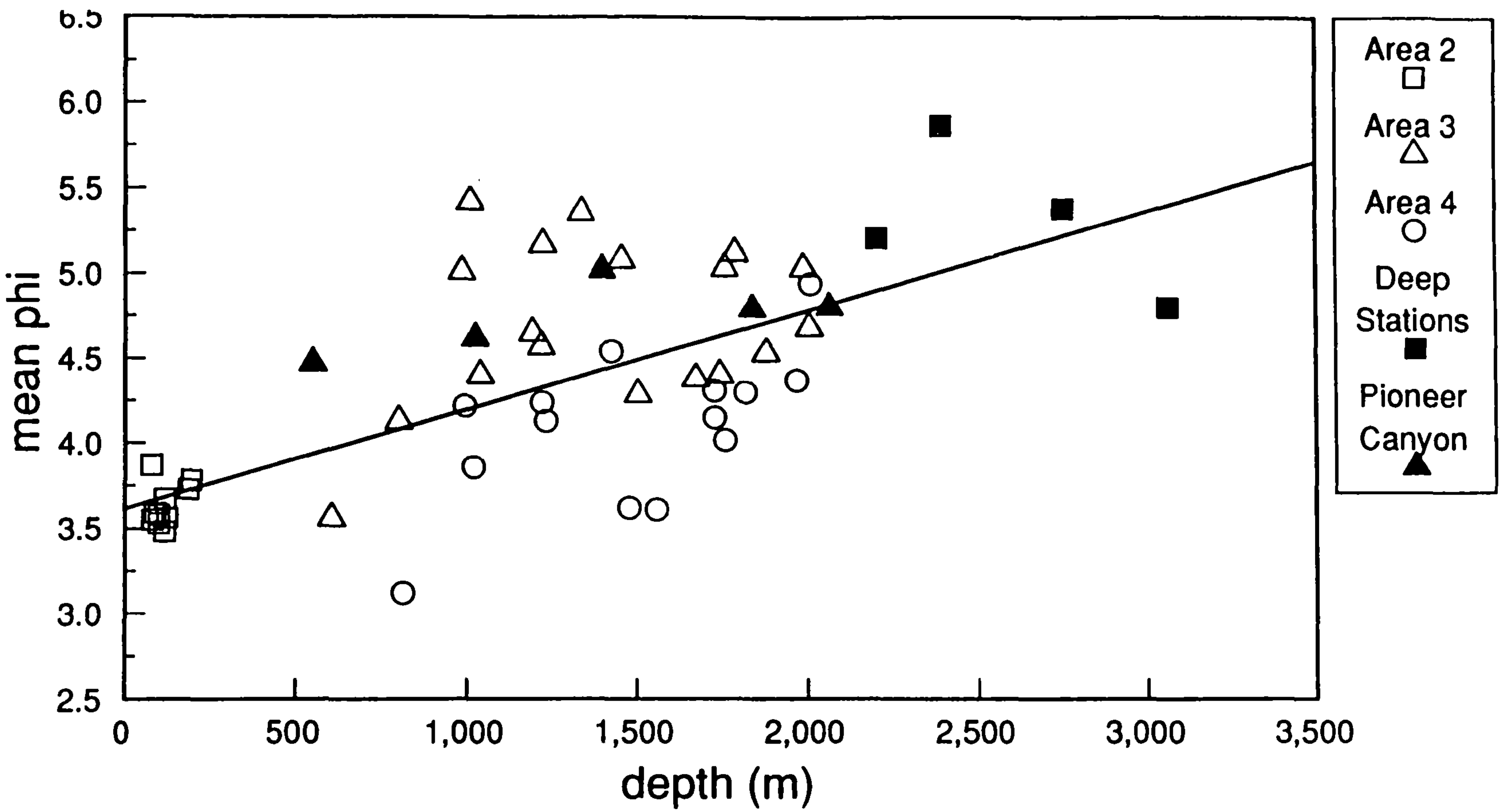

Figure 3.2-12. **Patterns in Sediment Grain Size (mean phi) with Depth Within the LTMS Study Region.**
Symbols indicate the origins of the composite samples.
Source: SAIC 1992c.

sediments were observed in Study Areas 3 through 5 which reflect small-scale differences in the kinetic energy or erosional/depositional characteristics of the specific location. Additionally, the Farallon Islands may contribute a local source of relatively coarser sediments to adjacent areas (Hanna 1952).

The results of sediment grain size and organic content measurements from the EPA surveys are listed in Table 3.2-5. Grain size characteristics are summarized for each of the LTMS study areas in the following sections. The mineralogical and organic content of sediments in the study areas are summarized in Sections 3.2.5.2 and 3.2.5.3, respectively. Trace metal, hydrocarbon, and radionuclide characteristics are discussed in Sections 3.2.5.4 through 3.2.5.6, respectively.

Study Area 2

Sediment grain size measurements from the EPA surveys show that sediments in Study Area 2 are primarily sandy (89%) with some silt (10%; Figure 3.2-13), a low organic carbon content (0.4%), and low carbonate concentration relative to sediments in Study Areas 3, 4, and 5. Study Area 2 sediments are relatively coarse with a mean phi (negative $\log_2$ of particle grain size in mm) of 3.6 and a range of 3.5 to 3.9 phi (SAIC 1992c). Study Area 2 sediments are compact with a high total solids (TS) content (72%), which is related to the large sand fraction. Similar sediment grain size distributions were reported from previous surveys of the continental shelf area by Kinnetics (Parr *et al.* 1987), IEC (1982), and Nybakken *et al.* (1984). Temporal and spatial variability in grain size are expected due to seasonal and annual differences in current velocities, wave conditions, and variations in the input of fine-grained sediments associated with outflow from San Francisco Bay (Parr *et al.* 1987).

Sand waves and ripples that likely extend throughout most of the area indicate that this is a high energy sedimentary regime (Figure 3.2-9). Study Area 2 bottom sediments also are mixed vertically through bioturbation by infaunal organisms. However, in spite of the high mixing by currents and bioturbation, the sediments appear to have a high oxygen demand as no apparent redox potential discontinuity (RPD) depth was observed at most stations located below a depth of 80 m (SAIC 1992c). The high oxygen demand is likely related to a high flux of organic material which is produced in the surface water layer and subsequently sinks as large organic particles to the bottom.

Study Area 3

Sediments in Study Area 3 range from sandy sediments at the eastern edge below the shelf break to silty sediments at the deeper western end. The average sediment composition throughout the study area consists of 44% sand and 50% silt (Table 3.2-5). Organic matter concentrations are quite low in the eastern part of Study Area 3, but are higher in sediments in the deeper western end where finer-grained sediments are more prevalent. Variations in sediment composition from the northern to the southern parts of the study area also are apparent. Sediments along the northern edge are sandy, rippled, and contain lower organic carbon concentrations than the siltier sediments that occur to the south along the same isobath. A sand outcrop occurs at about 1,400

Table 3.2-5. Descriptive Statistics for Sediment Parameters from Study Areas 2, 3, 4, and 5.

Mean, minimum, maximum, range of values (difference between maximum and minimum), and number of samples are shown for the study areas, deep stations (DS) west of Study Area 4, and Pioneer Canyon. All concentrations are on a dry-weight basis. Percentage of Total Solids (TS), as well as various other sediment types, is presented.

Area	Depth (m)	% TS	Avg. Phi	% Gravel	% Sand	% Silt	% Clay	% Carbonate	% C	% N	C/N
All Areas											
Mean	1499	52.4	4.54	0.2	47.10	47.0	5.7	1.5	1.85	0.23	9.26
Minimum	78	32.1	3.12	0	2.1	7.0	0.3	0.2	0.37	0.04	8.48
Maximum	3060	74.9	5.87	6.4	92.2	90.4	14.8	6.1	3.86	0.49	11.01
Range	2982	42.9	2.75	6.4	90.1	83.4	14.5	5.9	3.49	0.45	2.54
No. Samples	64	64	63	63	63	63	63	64	63	63	63
Study Area 2											
Mean	120	72.2	3.63	0.1	88.6	10.3	1.0	0.3	0.43	0.05	9.50
Minimum	78	68.6	3.48	0	80.7	7.0	0.3	0.2	0.37	0.04	8.48
Maximum	196	74.9	3.87	0.4	92.2	18.4	2.8	0.7	0.55	0.07	11.01
Range	118	6.3	0.39	0.4	11.5	11.4	2.5	0.5	0.18	0.03	2.53
No. Samples	10	10	10	10	10	10	10	10	10	10	10
Study Area 3											
Mean	1356	54.7	4.67	0	44.0	49.8	6.2	1.9	1.72	0.21	9.31
Minimum	550	32.1	3.56	0	15.6	20.7	0.8	0.4	0.57	0.07	8.91
Maximum	2005	67.8	5.42	0.2	78.5	80.7	14.1	6.1	3.23	0.40	9.65
Range	1455	35.8	1.86	0.2	62.9	60.0	13.3	5.7	2.66	0.33	0.74
No. Samples	19	19	19	19	19	19	19	10	18	18	18
Study Area 4											
Mean	1421	58.1	4.10	0	62.5	33.4	4.1	1.9	1.33	0.16	9.35
Minimum	545	44.4	3.12	0	31.1	13.8	0.7	0.6	0.66	0.07	9.00
Maximum	2010	72.1	4.94	0.3	84.0	60.5	9.6	4.4	2.58	0.33	9.79
Range	1465	27.7	1.82	0.3	52.9	46.7	8.9	3.8	1.92	0.26	0.79
No. Samples	15	15	14	14	14	14	14	15	15	15	15

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Table 3.2-5. Continued.

Area	Depth (m)	% TS	Avg. Phi	% Gravel	% Sand	% Silt	% Clay	% Carbonate	% C	% N	C/N
Study Area 5*											
Mean	2759	30.9	5.33	1.2	13.0	76.1	9.9	1.4	3.50	0.45	9.07
Minimum	2385	21.7	3.95	0.3	2.1	48.5	7.6	1.2	2.70	0.34	8.85
Maximum	3085	43.9	5.78	6.4	37.1	90.3	15.2	1.6	3.86	0.49	9.25
Range	700	22.2	1.83	6.1	35.0	41.8	7.6	0.4	1.16	0.15	0.40
No. Samples	11	11	11	11	11	11	11	11	11	11	11
DS**											
Mean	2604	37.9	5.32	0	16.1	75.4	8.6	1.1	3.13	0.41	8.91
Minimum	2205	35.3	4.80	0	2.1	51.7	2.3	0.9	2.63	0.34	8.75
Maximum	3060	39.5	5.87	0	41.3	90.4	14.8	1.3	3.77	0.48	9.06
Range	855	4.2	1.07	0	39.2	38.7	12.5	0.4	1.14	0.14	0.31
No. Samples	4	4	4	4	4	4	4	4	4	4	4
Pioneer Canyon***											
Mean	1376	45.3	4.74	0.1	32.8	60.8	6.3	1.6	2.06	0.26	9.03
Minimum	550	35.0	4.47	0	19.3	47.0	3.1	0.5	0.98	0.12	8.76
Maximum	2065	60.7	5.02	0.3	47.7	69.2	11.5	2.3	2.81	0.36	9.34
Range	1515	25.7	0.55	0.3	28.4	22.2	8.4	1.8	1.83	0.24	0.58
No. Samples	5	5	5	5	5	5	5	5	5	5	5

Sources:

* Stations 1-10, 20 (SAIC 1992a).
** Four deep stations west of Study Area 4 (SAIC 1992a,c).
*** Pioneer Canyon (SAIC 1992a,c).

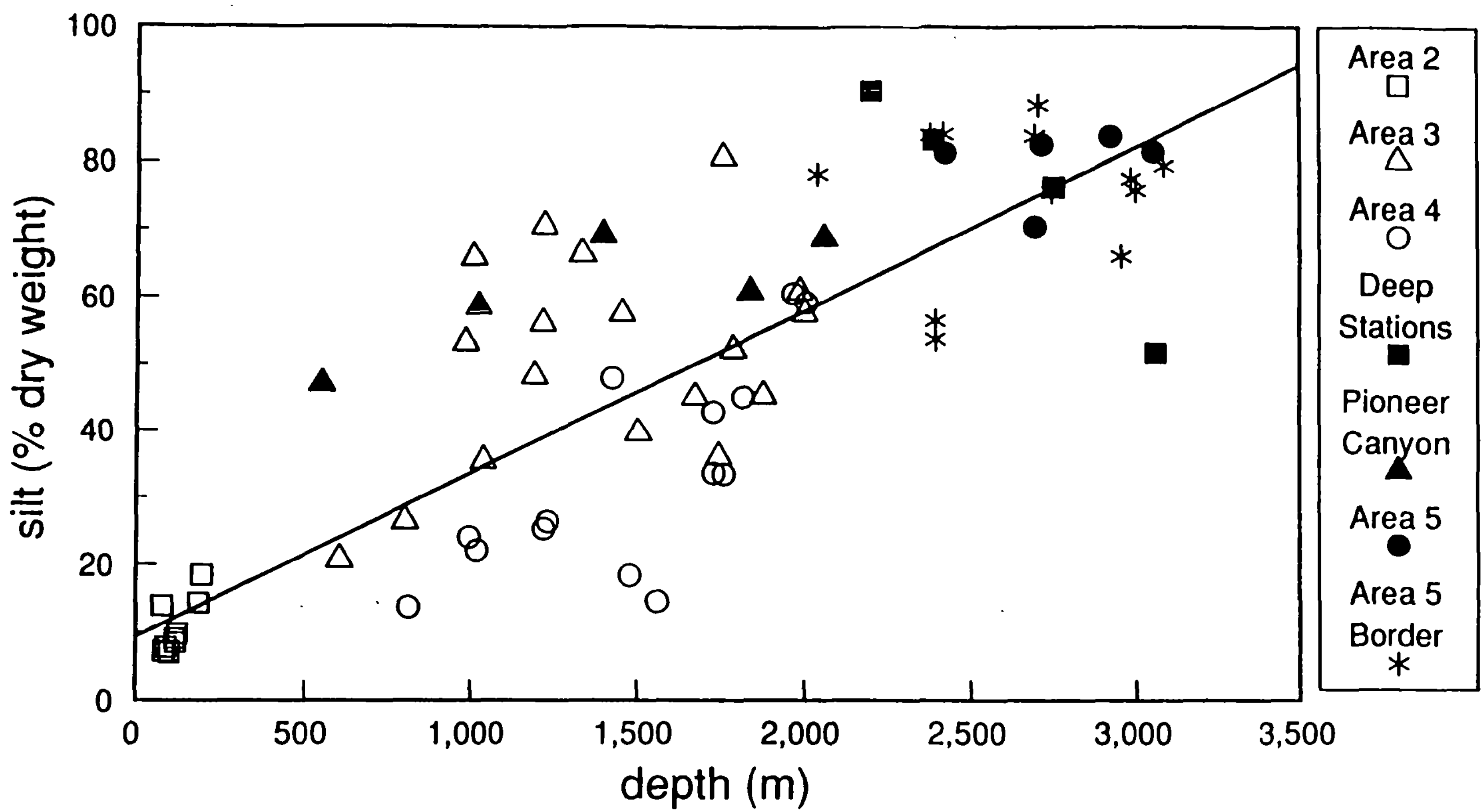

Figure 3.2-13. **Patterns in Sediment Silt Content with Depth Within the LTMS Study Region.**
Symbols indicate the origins of the composite samples.
Source: SAIC 1992c.

m depth, and probably continues to the southeast through the center of Study Area 4, crossing Study Area 4 from the northwest to the southeast. The sediment characteristics within Study Area 3 indicate that the average kinetic energy may be intermediate between that noted for shelf depths within Study Area 2 and that indicated for the deeper sites west of Study Area 4 and Pioneer Canyon (SAIC 1992c).

Study Area 4

Overall, Study Area 4 had the second coarsest sediments (Table 3.2-5), with an average 62.5% sand and relatively low silt (33.4%) and organic carbon (1.3%) content. Study Area 4 ranked between Study Areas 2 and 3 in average kinetic energy based on grain size (SAIC 1992c). Fine-grained sediments and organic matter generally increased as with increased depth. A sandy outcrop at about 1,400 m, extending from the southeast to the northwest portion of the study area, may be laterally correlated with a similar outcrop seen in Study Area 3. Below 1,400 m, a low kinetic energy bottom exists with sediment properties characteristic of a depositional zone (Figure 3.2-9).

Study Area 5

Sediments within this study area were the finest of all the study areas, including those collected from deep sites west of Study Area 4 (Table 3.2-5). In addition, Study Area 5 sediments had higher percentages of carbon and nitrogen than sediments from the other areas. Although the high mean phi value corresponds to fine-grained sediments, some gravel sized material occurred on a knoll just south of Study Area 5 that showed other features typical of erosional areas including a high percentage of total solids and low carbon and nitrogen concentrations. In general, the gully area surveyed by SAIC (1992a) in the northern Farallones Escarpment shares many features, although on a smaller scale, with Pioneer Canyon. The characteristics of both features indicate that the axes of the depressions are collecting fine-grained sediments and organic matter. Results from the USGS surveys of the area suggested that sediments accumulating in the axes of the gullies may be temporary, and that the long-term depositional sites for sediments may be the basin floor to the west of these features (Karl 1992). Earthquakes and/or density currents periodically may initiate movement of accumulated sediment in a downslope direction.

3.2.5.2 Mineralogy

The clay mineralogy of the continental shelf sediments off California was described by Griggs and Hein (1980). Booth *et al.* (1989) reported trends with depth in mineralogical patterns; in general, the quantity of clay minerals increased while the nonclay minerals—primarily feldspar, quartz, and heavy minerals (amphibole)—decreased with depth. Smectite is the predominant clay mineral in the continental shelf sediments, with lesser amounts of chlorite, kaolinite, and illite. Booth *et al.* (1989) suggested that there is a similarity between the clay mineral assemblage from the low-level radioactive waste sites (i.e., Study Area 5) and that of the Russian River sediments (north of San Francisco Bay). This observation strongly suggests that sediment input to the Gulf slope regions is from areas to the north.

Vercoutere *et al.* (1987) described the mineralogical attributes of sediments in a portion of Study Areas 2, 3, and 4 at depths less than 1,200 m. However, mineralogical data for the low kinetic energy depositional areas at depths below 1,400 m (including depositional Sites "A" in Pioneer Canyon, "B" in Study Area 3, and "C" in Study Area 4) were not included in their study. Sediment characteristics at depths corresponding to the core of the OMZ (500 to 900 m) appear to be different from those of the upper and lower edges of the OMZ. The upper boundary has abundant glauconite and foraminiferal carbonate, whereas the lower boundary has abundant fecal pellets, high mica content, high foraminiferal carbonate, low concentrations of quartz and feldspar, and no glauconite. The core of the OMZ has an increased content of mica, lower carbonate, and a higher relative percentage of quartz and feldspar; glauconite and fecal pellets are only minor components (Vercoutere *et al.* 1987).

Sediments within Study Area 5 contained high organic carbon concentrations (2.7 to 3.8% dry wt.), reflecting high productivity of the overlying water (SAIC 1992a). This high surface productivity also is reflected in biogenic carbonate which is contributed mainly by coccolithophores (1 to 2% by wt.); no foraminifera were observed. Biogenic opal also is present in the form of diatom frustules. The bulk of the minerals is contributed by clay (phyllosilicate) minerals, dominated by illite and chlorite. Smectite and kaolinite are present but less common. Clays range from 24 to 73% of the total minerals present. Quartz is the next most abundant mineral (20 to 36% of total minerals), and feldspar ranges from 6 to 52% of total minerals (SAIC 1992a).

3.2.5.3 Sediment Organic Content

Concentrations of organic carbon and organic nitrogen in sediments from the study areas are presented in Table 3.2.5. In general, the concentrations of organic carbon and nitrogen increase with increasing depth (Figure 3.2-14) and with decreasing grain size (i.e., higher phi, Figure 3.2-12). As discussed above for the individual study areas, these trends also are correlated with regional trends in the fine fractions of sediments. Trends in the organic content of the sediments may influence the spatial trends of concentrations of trace metals and trace organic contaminants (Sections 3.2.5.4 and 3.2.5.5). Positive correlations between inventories of metals, organic matter, and grain size are well known (Forstner and Wittman 1983).

3.2.5.4 Sediment Trace Metals

Concentrations of the selected sediment trace metals measured during the EPA and Navy surveys of Study Areas 2, 3, 4, and 5, and Pioneer Canyon (SAIC 1992a,c) are summarized in Table 3.2-6. For comparison, data for sediments from San Francisco Bay and NS&T Program sites, for deep-sea sediments (primarily clay and carbonate sediments), and for local bedrock are presented in Table 3.2-7. The local bedrock of the Franciscan Complex, which consists of basalts and shales, is a likely source of sediments to the offshore region (Yamamoto 1987; Murray *et al.* 1991) and, therefore, represents the natural or background concentrations of sediment metals.

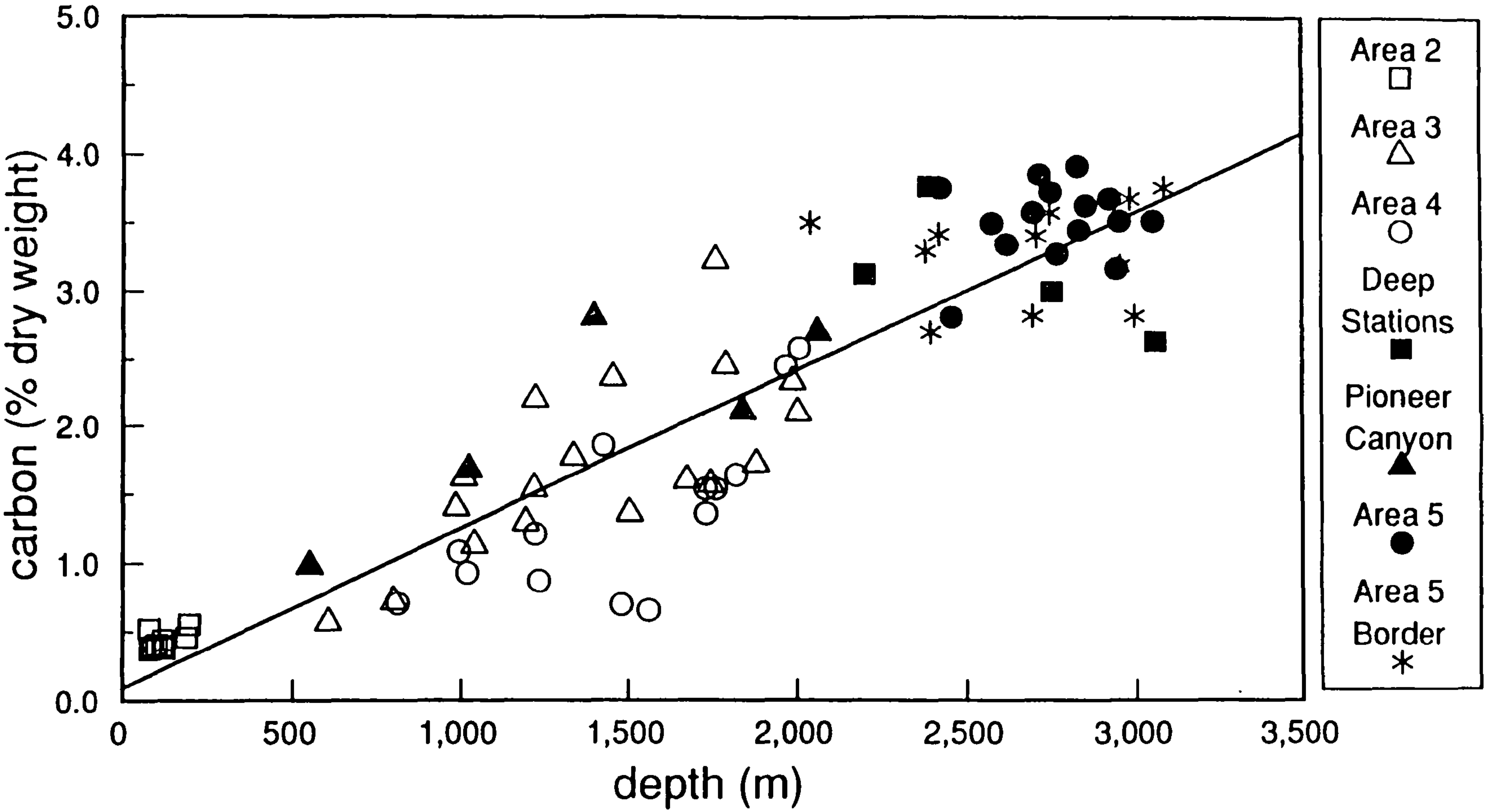

Figure 3.2-14. **Patterns in Sediment Total Organic Carbon Concentrations with Depth Within the LTMS Study Region.**
Symbols indicate the origins of the composite samples.
Source: SAIC 1992a,c.

Table 3.2-6. Trace Metal Concentrations in Sediments for Study Areas 2, 3, 4, and 5, and Pioneer Canyon.

Metal concentrations are in ppm (dry weight) except for aluminum (Al) which is in percent (dry weight). Range is the difference between the maximum and minimum value.

Area	Ag	Al	Cd	Cr	Cu	Hg	Ni	Pb
Study Area 2								
Mean	0.115	6.83	0.854	189	11.7	0.04	54.5	15.7
Minimum	0.101	6.77	0.829	141	11.6	0.03	54.4	15.6
Maximum	0.129	6.89	0.878	236	11.7	0.04	54.5	15.7
Range	0.028	0.12	0.049	95	0.1	0.01	0.1	0.1
No. Samples	2	2	2	2	2	2	2	2
Study Area 3								
Mean	0.518	6.47	0.373	168	24.3	0.08	66.3	13.8
Minimum	0.191	6.17	0.172	156	15.8	0.05	61.0	12.1
Maximum	0.687	6.83	0.770	173	34.1	0.12	73	14.8
Range	0.496	0.66	0.598	17	18.3	0.07	12.0	2.7
No. Samples	5	5	5	5	5	5	5	5
Study Area 4								
Mean	0.403	5.92	0.188	162	27.4	0.06	65.1	15.1
Minimum	0.250	4.85	0.144	117	17.3	< 0.01	54.1	10.3
Maximum	0.526	6.72	0.284	185	42.6	0.12	75.7	24.9
Range	0.276	1.87	0.140	68	25.3	0.12	21.6	14.6
No. Samples	4	4	4	4	4	4	4	4
Study Area 5								
Mean	0.55	6.67	0.31	149	41.9	0.20	92.2	10.4
Minimum	0.45	5.90	0.24	127	19.8	0.13	77.0	9.6
Maximum	0.64	7.61	0.38	168	62.5	0.36	115.0	12.0
Range	0.19	1.71	0.14	41	42.7	0.23	38.0	2.4
No. Samples	4	13	4	13	13	11	13	4

Table 3.2-6. Continued.

Area	Ag	Al	Cd	Cr	Cu	Hg	Ni	Pb
Pioneer Canyon								
Mean	0.713	6.62	0.462	151	28.1	0.06	71.1	12.5
Minimum	0.186	6.24	0.185	143	15.8	< 0.01	55.7	12.0
Maximum	1.070	7.01	1.060	164	38.3	0.10	85.5	13.1
Range	0.884	0.77	0.875	21	22.5	0.10	29.8	1.1
No. Samples	5	5	5	5	5	5	5	5

Source: SAIC (1992a,c).

Table 3.2-7. Trace Metals in Sediments from the Study Areas and Comparison Data.

	Study Areas 2, 3, and 4[1]		NOAA NS&T Program[2] San Francisco Bay Sites: Fine Seds (> 20% with phi > 4.0)		NOAA NS&T Program[2] San Francisco Bay Sites: Coarse Seds (> 20% with phi < 4.0)	NOAA NS&T Program[2] All U.S. Sites	Deep-Sea Sediments[3]		Average Franciscan Complex[4]	
Metals (ppm dry wt):	Mean	Range	Mean	Range		Range	Clay	Carbonate	Chert	Shale
Aluminum (%)	6.42	4.85–7.01	(NA)	(NA)	(NA)	(NA)	8.40	2.00	1.4	12.2
Cadmium	0.41	0.14–1.06	0.42	0.18–0.81	0.28	0.01–11.3	0.42	(NA)	(NA)	(NA)
Chromium	164	117–236	425	185–1,587	259	5.2–3,374	90	11	9.5	90
Copper	24.7	11.6–42.6	69.4	49.9–93.7	13.7	0.4–319	250	30	(NA)	(NA)
Lead	13.9	10.3–24.9	40.8	21.4–84.9	5.2	0.9–280	80	9	25	78
Mercury	0.06	< 0.01–0.12	0.32	0.03–0.54	0.05	0.007–4.31	(NA)	(NA)	(NA)	(NA)
Nickel	66.0	54.1–85.5	151.6	103.4–252.1	72.1	1–252	225	30	16	70
Silver	0.50	0.10–1.07	0.5	0.08–0.87	0.44	0.01–11.6	0.11	(NA)	(NA)	(NA)

[1]Data are from 16 composite samples (SAIC 1992c).
[2]NOAA (1988).
[3]Turekian and Wedepohl (1961).
[4]Data from the Franciscan Complex (Central belt) in Sausalito (CA), 1.5 km north of the Golden Gate Bridge are from Yamamoto (1987).

NA = not available

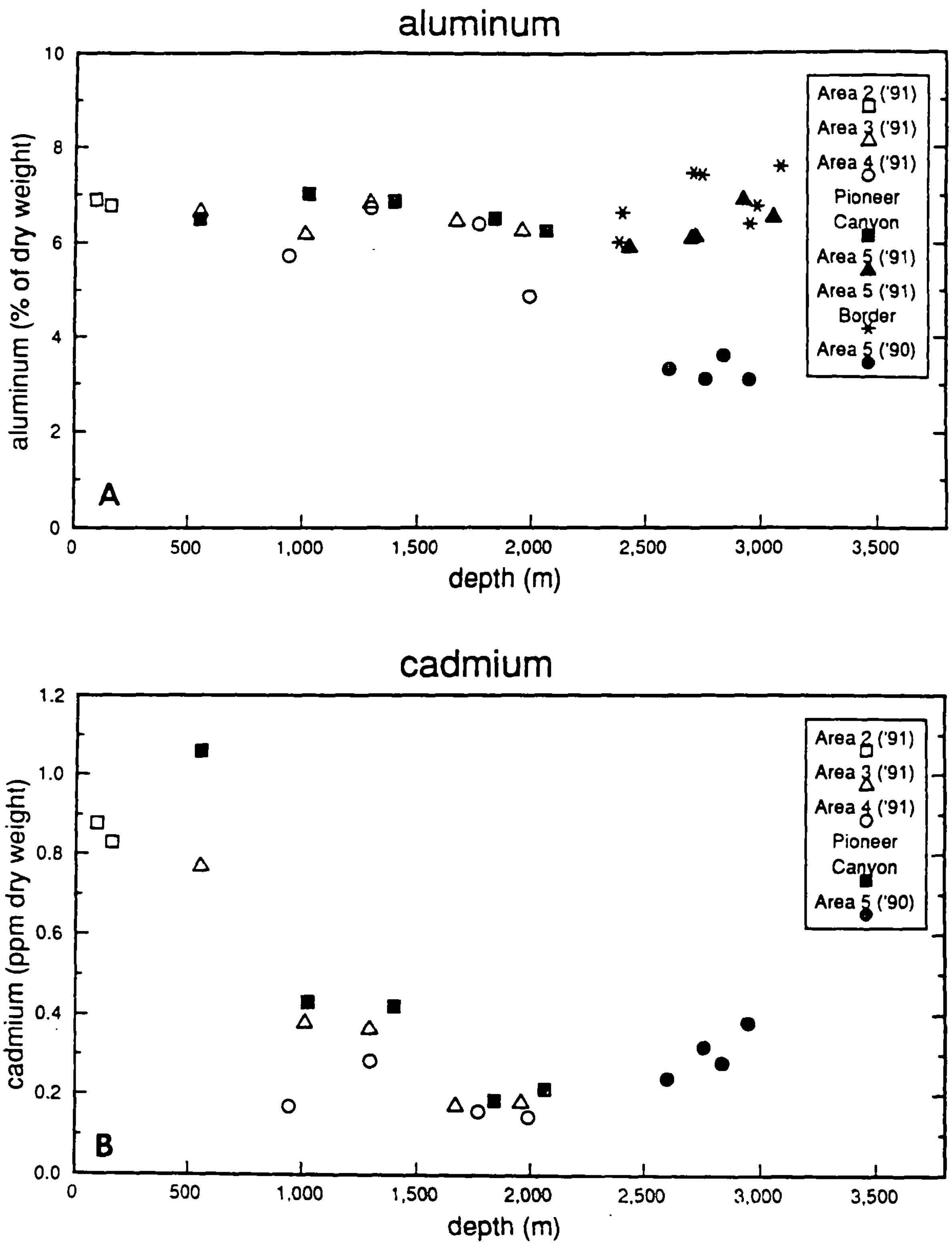

Figure 3.2-15. **Sediment Concentrations of: (A) Aluminum; (B) Cadmium; (C) Chromium, and (D) Copper Within the LTMS Study Region.**
Symbols indicate the origins of the composite samples.
Source: SAIC 1992a,c.

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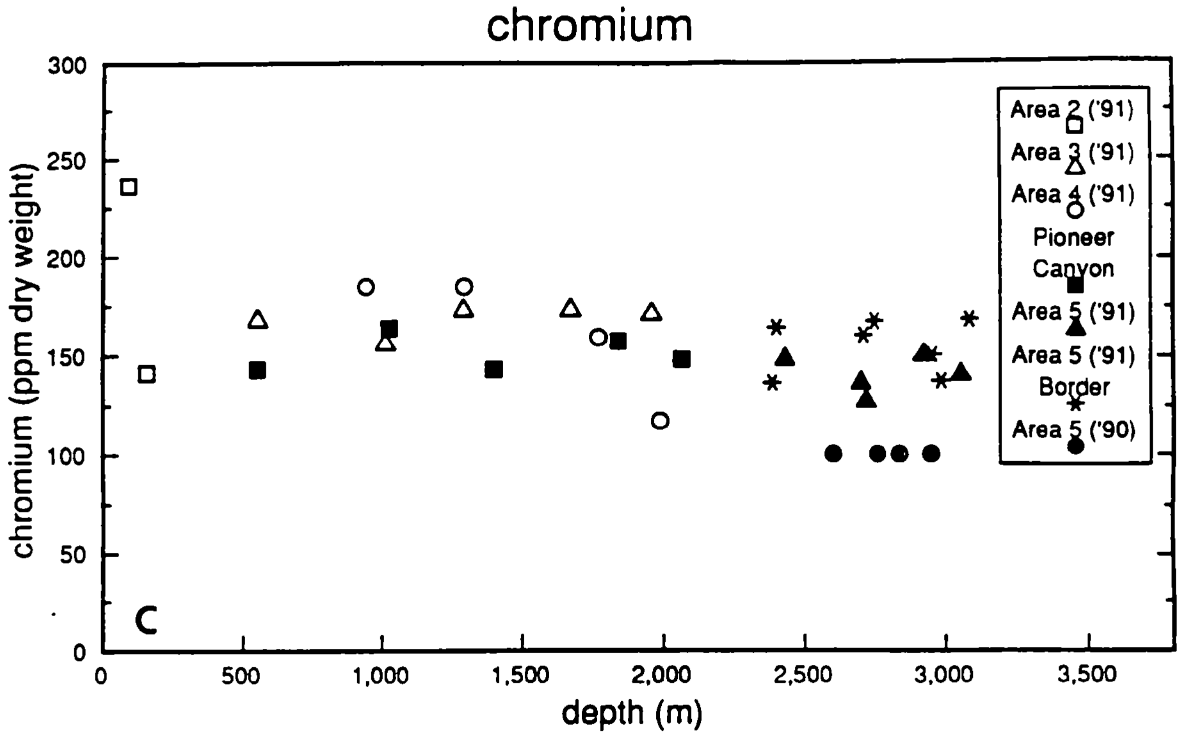

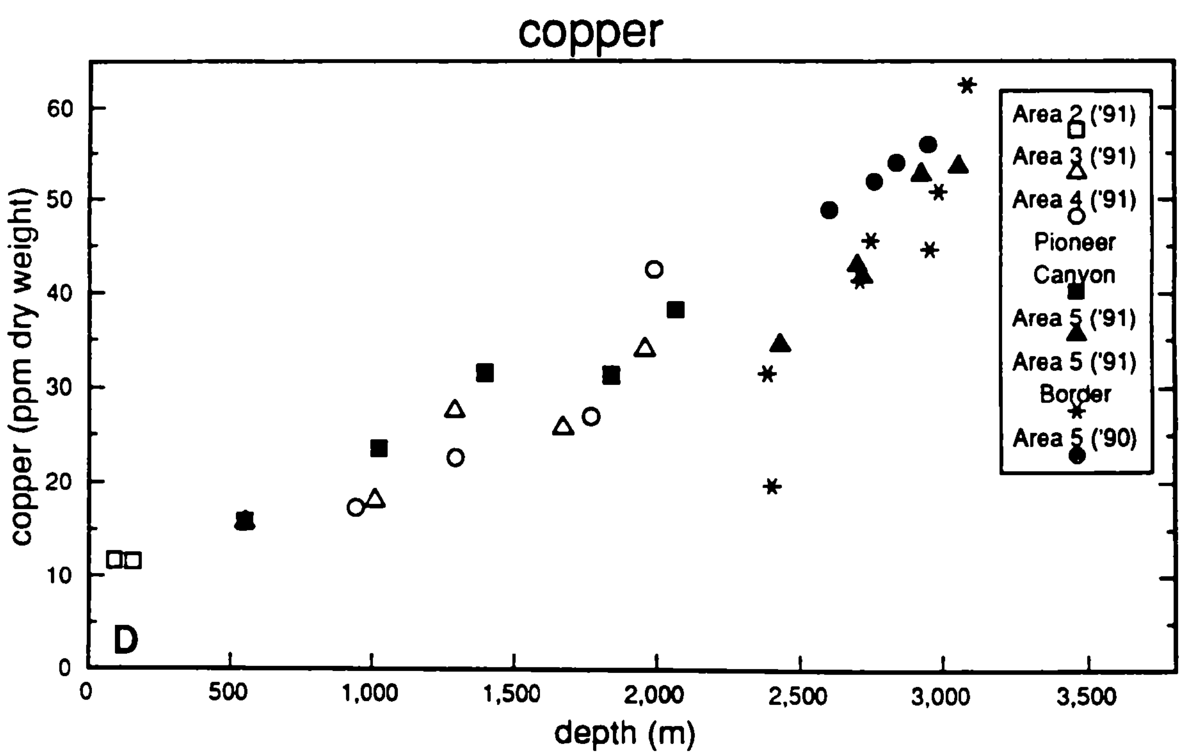

Figure 3.2-15. **Continued.**

The concentrations of aluminum, cadmium, copper, lead, and nickel in sediments from the study areas are comparable to those in deep-sea sediments and to the Franciscan Complex. In contrast, concentrations for chromium and silver are higher in samples from the study areas. Comparative data for silver and mercury concentrations in deep-sea sediments or the Franciscan Complex are limited. However, measured concentrations of these metals generally are comparable to those reported in sediments from other coastal areas (e.g., Bruland *et al.* 1974). Nevertheless, mean concentrations of chromium, copper, lead, mercury and nickel in sediments from the study areas are lower than those in sediments in San Francisco Bay as measured in the NS&T Program.

Trends in concentrations of trace metals with water depth are illustrated in Figure 3.2-15. Values represent the composite sediment samples and the average depth of the locations sampled for each composite sample during the EPA and Navy surveys. In general, concentrations of copper, mercury, nickel, and silver increase with depth over the study region (Figure 3.2-15D). These trends also follow the trends for decreasing TS content and increasing organic carbon and nitrogen concentrations and decreasing sediment grain size. In contrast, cadmium concentrations decrease with increasing depth (Figure 3.2-15B), whereas, distinct trends with depth are not apparent for aluminum, chromium, and lead (Figure 3.2-15A,C).

The association of relatively higher concentrations of metals in sediments with finer grain size has been reported from other geographic regions (Forstner and Wittman 1983). The observed differences between study areas in the sediment trace metal concentrations generally are consistent with spatial patterns of sediment grain size and organic content. There is no evidence of elevated sediment metals concentrations (i.e., unsupported by higher percentages of fine-grained sediments) indicative of significant anthropogenic contaminations over the study region.

Study Area 2

Sediments from Study Area 2 generally contained relatively high concentrations of cadmium and chromium, but lower concentrations of silver and copper, compared to those in the other study areas (Table 3.2-6). The mean cadmium concentration (0.854 ppm) is approximately two to five times higher than mean concentrations for the other study areas, but is comparable to concentrations measured in shelf sediments by Nybakken *et al.* (1984) and to concentrations in sediments at similar depths in a relatively pristine area of the Santa Maria Basin, California (Steinhauer and Imamura 1990). The chromium concentration (mean=189 ppm) was higher than average concentrations for Santa Maria Basin sediments (45–102 ppm; Steinhauer *et al.* 1991) and concentrations in local source rocks (Table 3.2-7). It is possible that enriched chromium concentrations in the study area sediments are from weathering of bedrock sources containing chromite minerals. Although the mean silver (0.115 ppm) and copper (11.7 ppm) concentrations were relatively low, they were similar to average concentrations in Santa Maria Basin sediments (0.15 and 13 ppm, respectively).

Concentrations of chromium, copper, lead, and mercury measured in shelf sediments by Nybakken *et al.* (1984) were up to several times lower than those measured in Study Area 2 sediments during the EPA surveys. The relatively lower concentrations reported by Nybakken *et al.* likely were due to differences in analytical methodologies (sediment digestion procedures) rather than to spatial or temporal changes.

Study Area 3

Concentrations of cadmium in Study Area 3 sediments were lower than those at Study Area 2 and decreased with increasing depth. The concentrations generally were greater than those at Study Area 4, except at depths greater than 1,500 m (region of Alternative Sites 3 and 4), where the concentrations were comparable. All measured cadmium concentrations are less than those found in southern California slope sediments (1.45 ppm) and average deep-sea clays (Table 3.2-7). Chromium concentrations were relatively uniform but somewhat high (mean=168 ppm). The average silver concentration in Study Area 3 was 0.518 ppm, which is greater than that found in typical southern California slope or shelf sediments, crustal rocks, average shales, and deep-sea clays and carbonates. Concentrations increased with depth to a maximum of approximately 0.7 ppm. The average copper concentration in the study area was 24.3 ppm, which is intermediate to those of the southern California slope (31 ppm) and continental shelf (13 ppm). While the higher copper concentrations occur in deeper water, the range of concentrations in Study Area 3 falls within the values cited above for other California slope and shelf regions.

Study Area 4

The cadmium concentrations in Study Area 4 generally were low and uniform with few exceptions. Concentrations for all other metals were similar to those in Study Area 3.

Pioneer Canyon

Pioneer Canyon sediments contained higher silver concentrations (mean=0.713 ppm) than any of the study areas. The source of the silver, above natural background concentrations, is unknown. Other trace metal concentrations generally were similar to those in Study Area 3.

Study Area 5

Concentrations of silver, chromium, lead, and aluminum in Study Area 5 (SAIC 1992a) were similar to those at Study Areas 3 and 4. Cadmium concentrations were similar to those at Study Area 3. Concentrations of copper (mean=41.9 ppm), mercury (mean=0.20 ppm), and nickel (mean=92.2 ppm) were higher than those from the other study areas.

Although some differences between the study areas in the concentrations of individual trace metals were apparent, the observed trends may relate to differences in sediment grain size and organic content. The magnitudes of the concentrations of individual metals generally are comparable to expected natural or background levels. With the possible exception of silver concentrations in Pioneer Canyon sediments and mercury concentrations in the Study Area 5 sediments, there is no strong evidence of unusually high or enriched trace metal concentrations suggestive of contamination from historical waste disposal operations or other anthropogenic sources.

3.2.5.5 Sediment Hydrocarbons

Hydrocarbons in sediments include a variety of organic compound classes such as non-chlorinated aliphatics (i.e., saturates), non-chlorinated aromatics, chlorinated pesticides, and PCBs. Many aliphatic and aromatic hydrocarbons may be derived from a variety of natural (e.g., oil seeps), anthropogenic, and biogenic sources. For example, saturated and aromatic hydrocarbons are principal components in residues of both crude and refined petroleum products. In addition to direct inputs from spills of petroleum products and diagenetic sources (i.e., in situ processes associated with marine sediments such as submarine oil seeps), inputs to marine sediments of aliphatic and aromatic compounds of oil-related origin can result from atmospheric fallout of combustion products. Certain hydrocarbons are produced naturally by marine as well as terrestrial biota, although the variety of biogenic compounds is limited relative to oil-derived hydrocarbons. The general composition of these biogenic hydrocarbons is quite different from oil-derived hydrocarbons; these differences can be utilized to distinguish between sources of hydrocarbons. For example, n-alkanes in oil have approximately equal concentrations of compounds with odd and even numbers of carbon atoms (i.e., an odd to even ratio of approximately 1). In contrast, biologically-produced n-alkanes have a predominance of n-alkanes with odd numbers of carbon atoms (i.e., odd to even ratio substantially greater than 1). Consequently, the overall composition of hydrocarbon classes such as n-alkanes can be used to identify the generic source of compounds in sediment samples.

Concentrations of total n-alkanes and PAHs in sediments from the LTMS study areas are summarized in Table 3.2-8 and shown in Figure 3.2-16. The values in the figure are from the sixteen composite samples from Study Areas 2, 3, and 4, and from Pioneer Canyon. Concentrations of both n-alkanes and PAHs generally increase with increasing depth in the study areas. As noted, total organic carbon also increases with depth throughout the study areas (Figure 3.2-14). Figure 3.2-17 shows concentrations for total n-alkanes and PAHs in the individual composites and the corresponding concentrations of total organic carbon, and indicates a close correspondence between these parameters. Consequently, the levels of total n-alkanes and PAHs in sediment samples from the study areas appear to be related to transport processes that also affect the overall organic content of sediments in the study areas. Similar correlations between concentrations for total hydrocarbons and organic carbon content have been reported in surface sediments from the Gulf of Mexico (Boehm 1987).

Chlorinated pesticides and PCBs are synthetic compounds that are not native to the marine environment. These classes of compounds can derive from surface runoff, aerial fallout, and disposal of contaminated wastes. Concentrations of total chlorinated pesticides and total PCBs are summarized in Table 3.2-8, and concentrations of total DDT and total PCBs are plotted in Figure 3.2-18.

Table 3.2-8. **Hydrocarbon Concentrations in Sediments for Study Areas 2, 3, and 4, and Pioneer Canyon.**

Hydrocarbon concentrations are in ppb (dry weight) except for the Unresolved Complex Mixture which is in ppm (dry weight). Range is the difference between the maximum and minimum values.

Area	Aliphatic Hydrocarbons Alkanes	Polynuclear Aromatic Hydrocarbons	Unresolved Complex Mixture	Total Pesticides	Total PCBs*
Study Area 2					
Mean	414	127	1.2	1.61	15.0
Minimum	414	123	1.1	1.50	14.8
Maximum	414	131	1.3	1.71	15.1
Range	0.1	8.21	0.2	0.21	0.03
No. Samples	2	2	2	2	2
Study Area 3					
Mean	1,200	317	4.9	3.81	28.4
Minimum	752	211	3.6	2.34	15.5
Maximum	1,440	390	6.3	4.51	68.1
Range	691.2	180	2.7	2.17	52.6
No. Samples	5	5	5	5	5
Study Area 4					
Mean	1,300	349	6.3	3.40	18.8
Minimum	704.5	200	2.4	2.14	14.8
Maximum	2,060	585	13.3	4.84	23.1
Range	1,360	385	10.9	2.70	8.3
No. Samples	4	4	4	4	4
Pioneer Canyon					
Mean	1,745	446	10.1	4.61	18.8
Minimum	964	257	5.0	2.20	15.7
Maximum	2,290	610	16.1	5.98	21.4
Range	1,320	353	11.1	3.78	5.7
No. Samples	5	5	5	5	5

*The method detection limit for total PCB concentrations is approximately 20 ppb; values below 20 ppb should be considered estimates.
Source: SAIC (1992c)

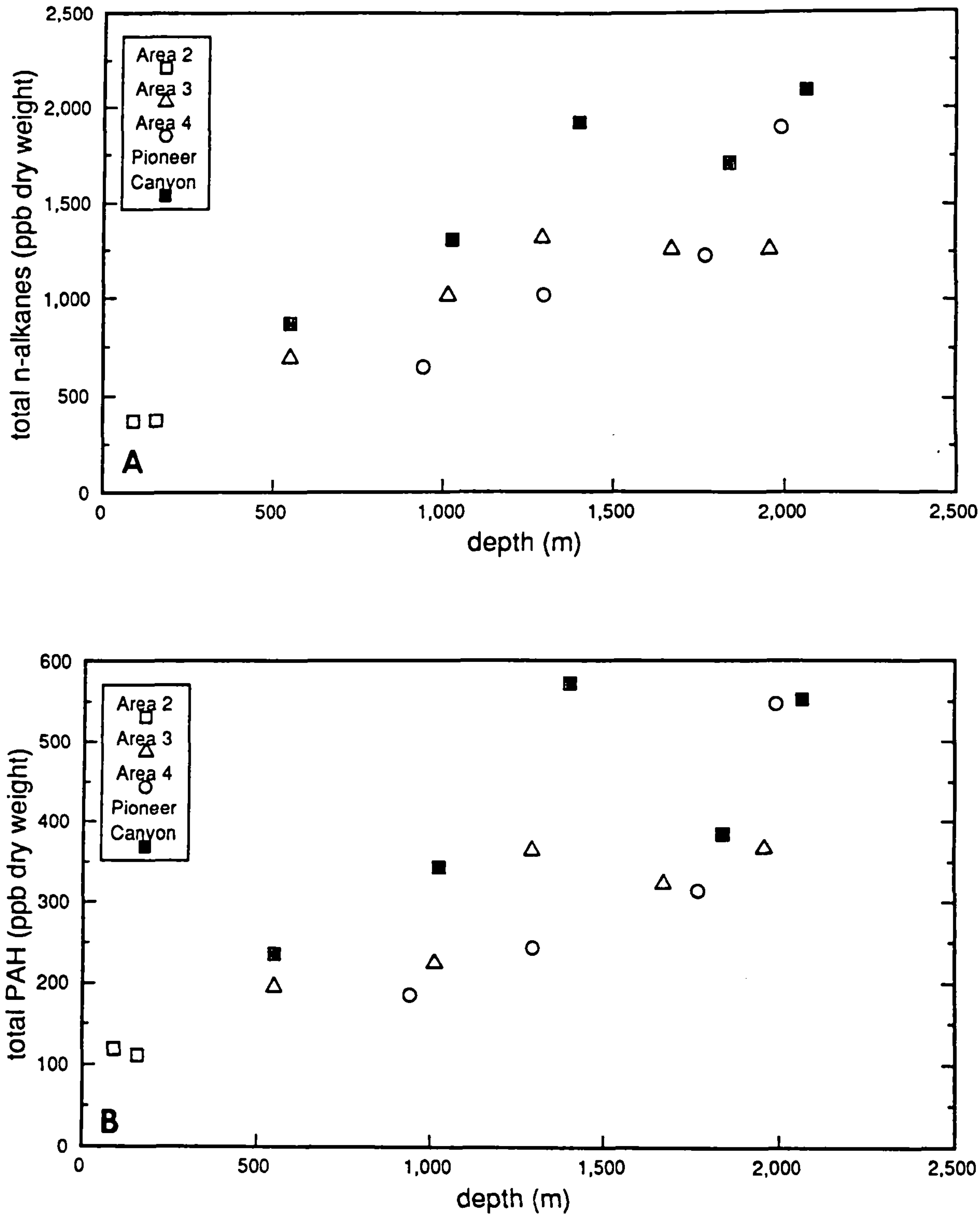

Figure 3.2-16. **Sediment Concentrations of: (A) Total n-alkanes and (B) Total PAHs Within the LTMS Study Region.**
Symbols indicate the origins of the composite samples.
Source: SAIC 1992c.

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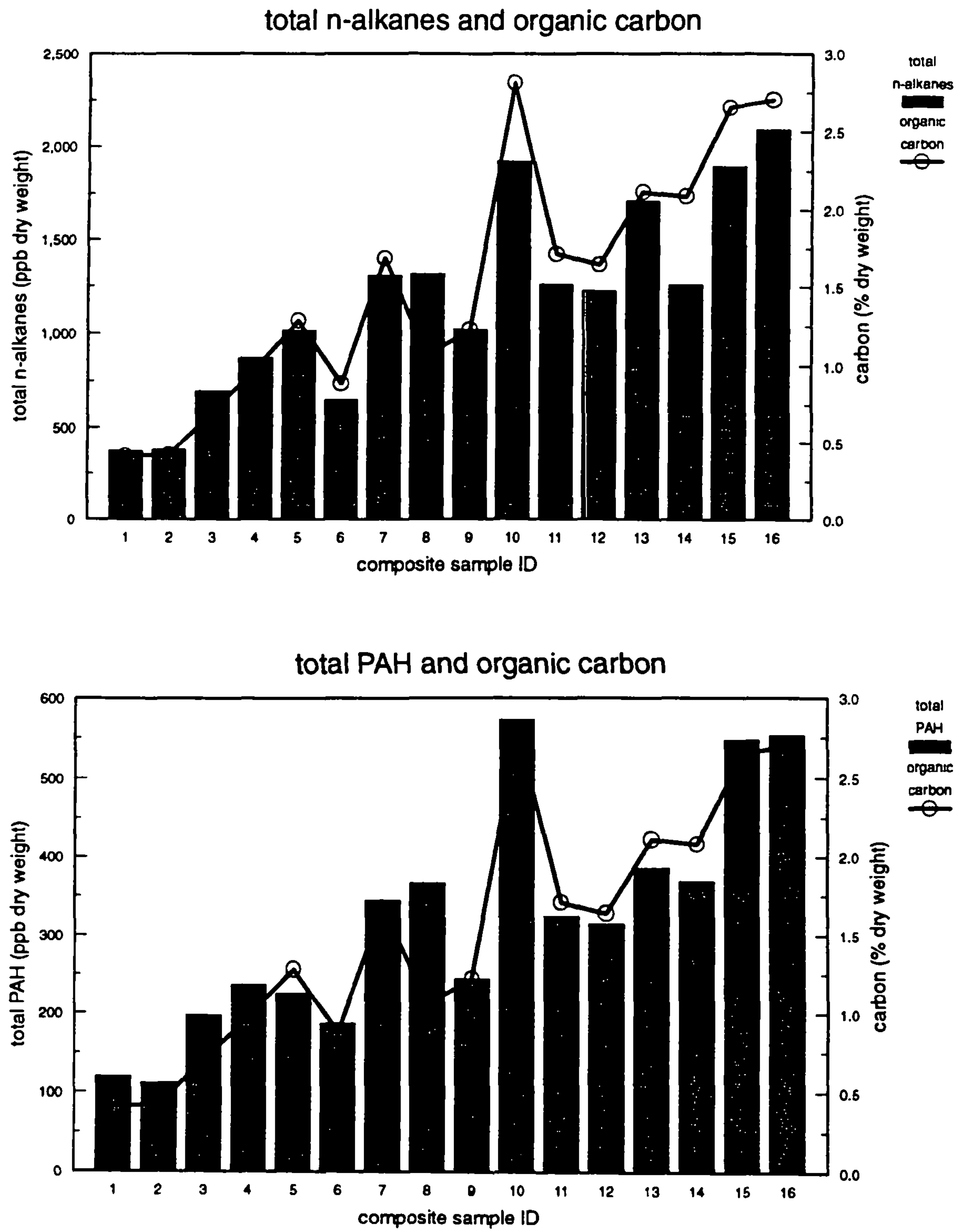

Figure 3.2-17. Sediment Concentrations of: (A) Total n-alkanes and Organic Carbon and (B) Total PAH and Organic Carbon Within the LTMS Study Region.
Source: SAIC 1992c.

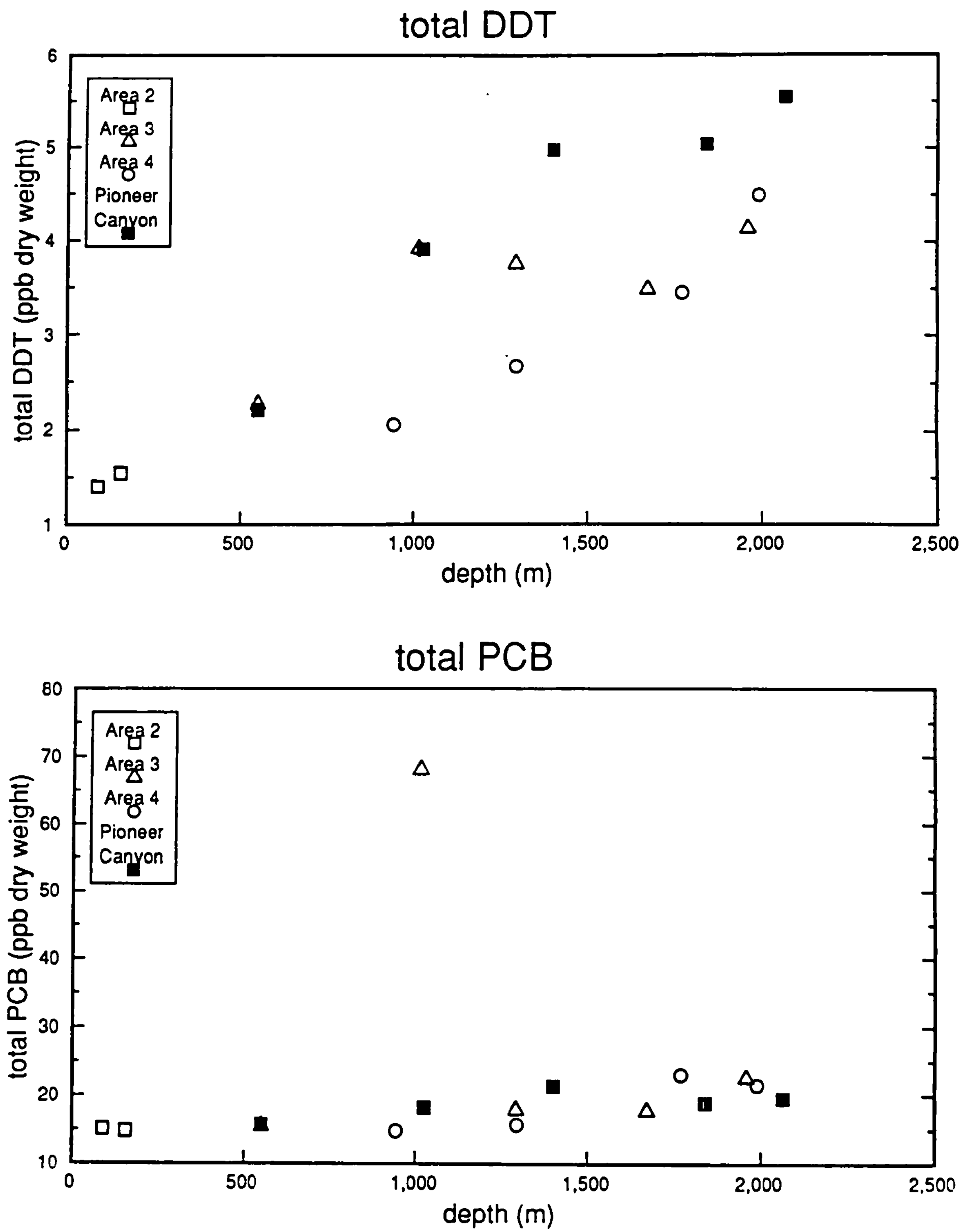

Figure 3.2-18. **Sediment Concentrations of Total DDT and Total PCBs Within the LTMS Study Region.**
Symbols indicate the origins of the composite samples.
Source: SAIC 1992c.

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Study Areas 2, 3, and 4

Summaries of the concentrations of organic compounds in sediments from Study Areas 2, 3, and 4, and from Pioneer Canyon, are presented in Table 3.2-8. Study Area 3 had two to three times the concentration of organic compounds as Study Area 2. However, except for pesticides and total PCBs, the mean concentrations of other hydrocarbons were less than those in Study Area 4 or in Pioneer Canyon. Except for total PCBs, the concentrations of all organic compounds were highest in the Pioneer Canyon, which probably reflects depositional focusing and transport of sediments at this location.

Although samples from the study areas were analyzed for a variety of chlorinated pesticides, only DDT analogs and isomers (particularly 4,4'-DDE, 4,4'-DDD, and 2,4'-DDE) were routinely detected; other chlorinated pesticides were not detected in the sediments. Individual PCBs (congeners) were detected in the sediments, but at concentrations typically at or near the analytical detection limits. Plots of concentrations for total DDT and total PCBs for the composite samples are presented in Figure 3.2-18. Concentrations of total DDT generally increase with depth along with the organic content of the sediments. These trends suggest that DDT concentrations also are related to transport processes, reflecting the overall organic content of sediments in the study areas.

Concentrations of total PCBs typically were at or below the analytical detection limits, with the exception of measurable amounts of PCBs in sediments composited from three stations along the 1,000 m isobath in the northern portion of Study Area 3. Consequently, the sediment PCB concentrations appear to be relatively uniform throughout the study areas, and no correlation between PCB concentrations and organic carbon content is evident. The relatively elevated concentration for PCBs in the single composite sample from Study Area 3 presumably reflects a localized input of PCBs to the area.

Study Area 5

Hydrocarbons and other trace organic contaminants were not detected (i.e., were less than the analytical detection limits) in sediments collected in Study Area 5 during the Navy surveys (SAIC 1991, 1992a). However, these samples were analyzed using different methods, with lower analytical sensitivity (i.e., higher detection limits), than those used for sediments from Study Areas 2, 3, and 4. Also, the concentrations of n-alkanes and many of the PAHs were not analyzed in Study Area 5 sediments. Only the PCB Aroclor 1221 was present in concentrations near the detection limit. The pesticide Lindane (=Gamma-BHC) also was detected in Study Area 5 sediments; whereas, this compound was not found in any of the samples from Areas 2, 3, 4, and the Pioneer Canyon.

Regional Summary

In general, a trend in increasing concentrations of hydrocarbon compounds with depth over the study region is apparent. This relationship likely is not related to historical waste discharges or proximity to source inputs. Rather, the magnitudes, composition, and spatial distributions reflect correlations between sediment hydrocarbons, fine grain size, and higher organic contents as observed in other marine environments.

Hydrocarbon data for sediments from San Francisco Bay and sites from the NS&T Program are summarized in Table 3.2-9. Concentrations of hydrocarbons in sediments from the study areas generally are lower than concentrations in San Francisco Bay sediments, although substantially lower and higher concentrations for PAHs, DDT, and PCBs occur in coastal sediments from other locations throughout the U.S.

Previous measurements of sediment hydrocarbons within the region indicated trace concentrations of DDE (2.1–3.2 ng/g), DDD (up to 0.1 ng/g), and chlordane (2.2–2.8 ng/g) in sediments at the 100-Fathom site; PCBs were not detected (IEC 1982). Nybakken *et al.* (1984) reported similar concentrations of DDE (0.2–1.6 ng/g), along with trace quantities of PCBs (0.2–0.5 ng/g), alpha- and gamma-chlordanes (0.01–0.6 ng/g), and selected PAHs (1–74 ng/g phenanthrene, 1–49 ng/g fluoranthene, and 1–56 ng/g pyrene) in sediments from the continental shelf and shelf edge. The PAHs probably are derived primarily from particle discharges from San Francisco Bay and atmospheric deposition of combustion-derived products.

With the exception of the relatively elevated concentration of total PCBs in the one composite sample from Study Area 3, there was no evidence from the recent EPA surveys of significant anthropogenic sediment contamination within the LTMS study areas. In a previous study, Melzian *et al.* (1987) reported relatively high concentrations of chlorinated hydrocarbons (DDT and PCBs) in the liver tissues of Dover sole (*Microstomas pacificus*) and sablefish (*Anoplopoma fimbria*) collected at depths of 500 m and 1,000 m in the vicinities of the former low-level radioactive and chemical munitions disposal sites. Although the source(s) of the chlorinated organics in the fish liver tissues could not be discerned, Melzian *et al.* suggested that historical wastes may represent a source for one or more of these contaminants.

3.2.5.6 Sediment Radionuclides

As discussed in Section 3.1, low-level radioactive wastes were disposed historically at several locations within the Gulf of the Farallones. Several studies (PDC 1961; Dyer 1976; Noshkin *et al.* 1978; Shell and Sugai 1980; Suchanek and Lagunas-Solar 1991) have been conducted to determine whether the historical discharges have resulted in elevated radionuclide concentrations in waters, sediments, or organism tissues. NOAA (1990) estimated that studies conducted between 1960 and 1977 have collected over 900 water samples, 30 sediment cores, and 400 biota samples, primarily near disposal sites A, B, and C (see Table 3.1-3).

Table 3.2-9. Hydrocarbons in Sediments from the Study Areas and Comparison Data.

	Study Areas 2, 3, and 4[1]		NOAA NS&T Program[2]			
			San Francisco Bay Sites			All U.S. Sites
			Fine Seds (> 20% with phi > 4.0)		Coarse Seds (> 20% with phi < 4.0)	
Organics (ppb dry wt):	Mean	Range	Mean	Range		Range
Total PAH	318	111–572	2,166	491–5,230	799	2–57,800
Total DDT	3.42	1.40–5.54	15.8	3.0–44.9	0.33	0.04–6,891
Total PCB	21.3	14.8–68.1	62.6	33.3–82.8	10.5	0.3–2,069

[1]Data are from 16 composite samples (SAIC 1992c).
[2]NOAA (1988).

Detectable amounts of several radionuclides, primarily cesium-137 (^{137}Cs) and plutonium-239/240 ($^{239+240}Pu$), have been measured in the water, sediment, and tissue samples. However, the significance of the measured concentrations, and the contributions to the total concentrations of the waste material relative to inputs from nuclear fallout, are equivocal. For example, Dyer (1976) concluded that the measured concentrations of $^{239+240}Pu$ in sediments near a waste canister cluster were from 2 to 25 times higher than background levels. Suchanek and Lagunas-Solar (1991) calculated that the concentrations measured by Dyer actually were up to 1,064 times above background. Noshkin *et al.* (1978) questioned the reference or background levels used by Dyer and concluded that the total $^{239+240}Pu$ inventory in the Gulf of the Farallones (2.1–3.5 mCi/km^2) is not significantly different from fallout levels in the open Pacific ocean (2.2–4.3 mCi/km^2). Shell and Sugai (1980) also collected sediments near ruptured drums which contained 9–137 pCi/kg of $^{239+240}Pu$. They concluded that the sediment plutonium concentrations at this site were from 2 to 200 times higher than levels expected from fallout sources alone.

Therefore, while the presence of ruptured drums containing low-level radioactive wastes in the Gulf of the Farallones has been well-documented, the contributions of these wastes to the measured sediment radionuclide concentrations, the spatial extent of any contamination, and the environmental impacts and potential human health risks associated with the wastes are problematic. NOAA and EPA presently are evaluating these questions to assess the need for remediation.

3.3 Biological Environment

3.3.1 Plankton Community

This section presents information on plankton and their distributions and abundances in the general vicinity of LTMS Study Areas 2, 3, 4, and 5.

Plankton are free-floating organisms that typically drift with ocean currents, in contrast to actively swimming species such as fish. In general, plankton can be divided into three broad categories: prokaryotic bacterioplankton; phytoplankton, representing single-celled plants that are capable of photosynthesis and which form an important base for many marine systems; and zooplankton, which include animals that are a primary link in many food webs between phytoplankton and larger marine organisms such as fish, sea birds, and marine mammals. Zooplankton includes animals that remain planktonic throughout their life (holoplankton) as well as larval stages of benthic invertebrates (meroplankton) and fish (ichthyoplankton). Plankton distributions are characterized by high spatial patchiness, strong seasonal and inter-annual variation, and direct responses to oceanic circulation (McGowan and Miller 1980). The basic circulation pattern along the central California coast consists of the southward-flowing California Current to depths of a few hundred meters and the northward-flowing California Undercurrent, which often becomes a surface current during winter (Noble *et al.* 1992; Hayward and Mantyla 1990). This general pattern for coastal circulation can be modified by local topography and wind fields, and can change considerably on time scales of a few days (Breaker and Mooers 1986).

Satellite imagery indicates that the Gulf of the Farallones is an area of high planktonic activity, due to the combination of seasonal upwelling characteristic of the entire California coast (Barber and Smith 1981), local effects of nutrient inputs from San Francisco Bay (KLI 1991), and such features as the Point Reyes coastal upwelling jet (Noble *et al.* 1992). Detailed information on seasonal patterns of production, abundance, and species composition for the LTMS study areas is not available; however, a general description of the plankton community can be summarized from studies along the central California coast. Bence *et al.* (1992) present a study area-specific review of plankton data available from NMFS, CDFG and CalCOFI research, and from CalCOFI plankton atlases. The NMFS data focus on midwater trawl surveys and one ichthyoplankton survey. The CDFG data consist of zooplankton samples collected between 1975 and 1980 during a study of Dungeness crabs (*Cancer magister*). The CalCOFI data emphasizes ichthyoplankton counts and plankton volume.

3.3.1.1 Phytoplankton

The predominant members of the phytoplankton community are diatoms, silicoflagellates, coccolithophores (Chrysophyta), and dinoflagellates (Pyrrophyta). Three parameters commonly used to describe phytoplankton communities are the following: (1) productivity, reflecting the amount of new plant material formed per unit of time; (2) standing crop, representing the amount of plant material present, usually expressed as concentrations of chlorophyll or cell number; and

(3) species composition. Inter-annual variation and seasonal cycles of productivity and standing crop reflect variations in the upwelling regime along the central and northern coast of California, including the general study areas for this program. During the upwelling season, phytoplankton blooms in northern California generally occur between March and August (Welch 1967). Diatom growth is sparse in years of weak upwelling, while intermittent upwelling stimulates diatom growth (Bolin and Abbott 1963).

The combination of seasonal coastal upwelling events and nutrient inputs from San Francisco Bay promotes high primary productivity throughout the study area (KLI 1991). CalCOFI data indicate that both chlorophyll *a* and phaeopigments are highest in continental shelf waters, which suggests that standing stocks of phytoplankton are higher in nearshore areas (e.g., water depths similar to Study Area 2 and the shallow portion of Study Area 3) than in offshore regions (Bence *et al.* 1992). Highest productivity levels between Point Sur and the Gulf of the Farallones occur within approximately 50 km of the coast (Owen 1974). Average productivity values in the latter study ranged from 342 to 586 mg carbon/m^2/day over the course of a year. The maximum productivity (1,300 mg carbon/m^2/day) was reported for a site within 50 km of the Golden Gate during August–September. The minimum productivity (256 mg carbon/m^2/day) was observed during a May–June cruise.

Standing crop lagged behind the cycle of productivity by about two months. Surface chlorophyll concentrations ranged from less than 0.5 mg/m^3 during July–September to 2–8 mg/m^3 during October–December (Owen 1974). Although Garrison (1976) reported similar values from waters near the mouth of Monterey Bay, Ambler *et al.* (1985) measured chlorophyll concentrations ranging from less than 1 mg/m^3 between October and January to nearly 5 mg/m^3 in April and June. Differences in measurements of chlorophyll concentrations among studies may be related to the time lag required for phytoplankton growth (Abbott and Zion 1985). Phytoplankton initially respond to nutrient input with increased primary production, leading to increased population size after a time lag, and resulting in a dynamic biological structure (Denman and Abbott 1988).

Species composition of phytoplankton communities also varies seasonally. The spring/summer phytoplankton bloom, coincident with upwelling events, is dominated by diatoms, specifically species of *Chaetoceros* and *Rhizosolenia.* During non-upwelling periods, dinoflagellates of the genera *Ceratium* and *Peridinium* dominate (Bolin and Abbott 1963; Welch 1967). A similar seasonal pattern of species composition was observed along the central coast (Malone 1971) and approximately 200 km south of the study area near Diablo Canyon (Icanberry and Warrick 1978).

In summary, several studies on phytoplankton along the central California coast indicate seasonal cycles of productivity, standing crop, and species composition. It is anticipated that phytoplankton within the LTMS study areas will exhibit the same general cycles, although factors such as upwelling, the complex topography of the Gulf of the Farallones, and nutrient inputs from San Francisco Bay may have significant localized effects. Productivity and standing crop appear to be highest in continental shelf waters including Study Area 2 and the shallow portion of Study Area 3. Potential impacts to phytoplankton communities from dredged material disposal activities are expected to be temporary (Section 4.4).

3.3.1.2 Zooplankton

An estimated 546 invertebrate zooplankton species occur in the California Current system (Kramer and Smith 1972). Copepods and euphausiids, an important food source for many organisms, including juvenile fish, dominate the holoplankton in terms of numbers and biomass, although thalacians (salps), chaetognaths (arrow worms), and pelagic molluscs also are abundant (Table 3.3.1-1). Common species in the California Current include the euphausiid *Euphausia pacifica*, copepods of genera *Calanus*, *Neocalanus*, *Eucalanus*, and *Acartia*, and salps. Based on CalCOFI data, Bence *et al.* (1992) classified 34 holoplankton species that are common to the California Current into nearshore or offshore distribution categories (Table 3.3.1-1). Various species of copepods, euphausiids, and chaetognaths were found in both nearshore and offshore waters, whereas thaliaceans and pelagic molluscs occurred primarily offshore.

The CalCOFI summary was supplemented by results of zooplankton studies conducted by Hatfield (1983) and Tasto *et al.* (1981). These latter samples were collected as part of a CDFG study on Dungeness crabs. Hatfield identified inshore and offshore zooplankton groups of both holoplankton and meroplankton (Table 3.3.1-1) from oblique tows collected in spring 1976, winter and spring 1977, and March 1979. Few of the holoplankton species identified from the CalCOFI atlases were reported by Hatfield, possibly due to different sampling techniques and/or sampling schedules. Further, Hatfield (1983) noted substantial differences in spatial distributions and abundances of a number of zooplankton species associated with upwelling and seasonal and localized current patterns. For example, plankton species that are characteristic of more northerly latitudes were rare in the Gulf of the Farallones. Additionally, in the winter of 1977 when the Davidson Current dominated the area, species typically seen nearshore were found farther offshore and mixed with offshore forms.

Holoplankton and meroplankton species (Tasto *et al.* 1981) were characterized as nearshore and offshore species (Table 3.3.1-1) by Bence *et al.* (1992). Examples of peak densities for certain forms of zooplankton include the following: the copepod *Acartia clausi* (15,000/100m^3), *Cancer* spp. larvae (2,500/100m^3), and zoeae stages I-III for *Cancer antennarius* (1,200/100m^3). There were few holoplankton species common to the CalCOFI, Hatfield, and Tasto *et al.* reports. For example, Table 3.3.1-1 shows that adult euphausiids were present in low abundances in samples from 1975–1977 (Tasto *et al.* 1981), but three species (*Euphausia pacifica*, *Nematoscelis difficilis*, and *Thysanoessa gregaria*) were more abundant in March 1979 samples taken on two transects off San Francisco Bay (Hatfield 1983).

Using differences in species compositions and distributions that could be identified from CalCOFI atlases, Hatfield (1983) and Tasto *et al.* (1981) noted the following characteristics of zooplankton distributions: (1) the distribution of zooplankton are dynamic in nature due to the complex hydrography in the California Current system; and (2) the variance between data sets that likely results from differences in sampling schedules, designs, and collection equipment. In addition,

Table 3.3.1-1. Dominant Zooplankton in Waters Offshore Central California Based on a Review of CalCOFI Atlases, Hatfield (1983) and Tasto *et al.* (1981; 1975–1977 samples).

Nearshore = continental shelf waters; Offshore = seaward of the continental shelf; summarized from Bence *et al.* (1992).

	Nearshore	Offshore
	CalCOFI (as summarized in Bence *et al.* 1992)	
Holoplankton		
Copepods	*Acartia tonsa*	*Acartia danae*
	Calanus helgolandicus	*Calanus gracilis*
	Clausocalanus pergens	*Clausocalanus arcuicornis*
	Ctenocalanus vanus	*Gaidius pungens*
	Metridia luceus	*Plueromamma abdominalis*
	Tortanus discaudatus	
Euphausiids	*Euphausia pacifica*	*Euphausia gibboides*
	Thysanoessa spinifera	*Euphausia mutica*
	Nyctiphanes simplex[1]	*Euphausia recurva*
		Thysanoessa gregaria
Chaetognaths	*Sagitta enflata*	*Sagitta bierii*
	Sagitta scrippsae[2]	*Sagitta minima*
	Sagitta euneritica[2]	*Eukrohnia hamata*
Thaliaceans	*Dolioletta gegenbauri*	*Thalia democratica*
		Ritteriella pecteti
		Doliolum denticulatum
		Salpa fusiformis[3]
Molluscs		*Carinaria japonica*
		Limacina helicina
		Limacina inflata
		Clio pyramidata
		Corolla spectabilis

Table 3.3.1-1. Continued.

	Nearshore	Offshore
	Hatfield (1983)	
Holoplankton		
Copepods	*Acartia clausi*	*Candacia bipinnata*
	Tortanus discaudatus	*Euchaeta japonica*
	Epilabidocera longipedata	*Euchaeta acuta*
		Neocalanus cristatus
		Neocalanus plunchrus
		Eucalanus bungii
Euphausiids	*Thysanoessa spinifera*	*Nematoscelis difficilis*
		Thysanoessa gregaria
Chaetognath		*Sagitta scrippsae*
Ctenophore	*Pleurobrachia bachei*	
Meroplankton		
	Cancer productus zoeae (stages I-III)	*Cancer productus* zoeae (stages IV-V)
	Cancer antemarius zoeae	*Cancer oregonensis* zoeae (stages IV-V)
	Cancer gracilis zoeae (stages I-III)	
	Pinnotherid zoeae (commensal crab)	
	Pagurid megalopa larvae (hermit crab)	
	Callianassa spp. larvae (ghost shrimp)	
	Grapsid crab zoeae (stages IV-V)	
	Porcellanid larvae (Anomuran decapods)	
	Upogebia pugettensis larvae	
	Xanthid zoeae (stages I-II)	
	Majid zoeae I	

Table 3.3.1-1. Continued.

	Nearshore	Offshore
	Tasto *et al.* (1981)	
Holoplankton		
Copepods	*Acartia clausi*[1]	
	Acartia longiremis[2]	
	Calanus pacificus[3]	
	Calanus tenuicornis[2]	
	Epilabidocera longipedata	
	Eucalanus bungii[1]	
	Metridia lucens[2]	
	Pseudocalanus spp.[2]	
Chaetognath	*Sagitta euneritica*[2]	
Mollusc	*Limacina helicina*[2]	
Ctenophore	*Pleurobrachia bachei*	
Meroplankton		
	Cancer gracilis zoeae (stages I-III)	*Cancer gracilis* zoeas (stages IV-V)
	Cancer spp. larvae	*Cancer oregonensis* (stages I-III)
	Cancer antennarius zoeae (stages I-III)	
	Callianassa spp. larvae	
	Porcellanid larvae	
	Grapsid zoeae (stages I-III)	
	Majid zoeae[3]	

[1]Found only in some years; typically a more southern species.
[2]Nearly uniform distribution between nearshore and offshore areas.
[3]Large concentrations occasionally found nearshore/offshore.

taxonomic uncertainties remain for some species. For example, difficulties in the taxonomy of *Acartia* may in part explain why *A. tonsa* and *A. danae* are identified as the most abundant copepods in the CalCOFI atlases, while Tasto *et al.* (1981) identify *A. clausi* and *A. longiremis* as most abundant and do not list *A. tonsa* and *A. danae* at all.

Ichthyoplankton

Ichthyoplankton (larval fish) are an important component of the zooplankton and have been the focus of numerous CalCOFI surveys due to the importance of this group to commercial fishing, with approximately 1,000 ichthyoplankton species occurring in the California current system (Kramer and Smith 1972). Bence *et al.* (1992) summarized data from CalCOFI surveys by season and depth. The highest ichthyoplankton abundances occurred over shallow water in winter, with lowest abundances at deep stations in fall (Figure 3.3.1-1). Seasonal differences in total fish larvae showed some variation among sampling stations, with highest overall values in winter and spring and lowest values in summer and fall (Figure 3.3.1-1). The CalCOFI data are supplemented by data on larval Pacific hake and shortbelly rockfish from a single ichthyoplankton survey conducted by Bence *et al.* (1992). Preliminary analyses of these data suggest that at the time of the survey, Pacific hake larvae were relatively more abundant south of the Farallon Islands at depths greater than 600 m (Figure 21 in Bence *et al.* 1992). In contrast, the relative abundance of short belly rockfish was greatest at depths just beyond the shelf break and at depths greater than 1,800 m (Figure 23 in Bence *et al.* 1992).

Due to the inherent variability in plankton populations outlined above, the species composition and distribution of zooplankton can be related to the LTMS study areas in only a general way. Species common in nearshore waters likely would be present in Study Area 2. These include a variety of holoplankton, and perhaps more importantly, most of the identified species of meroplankton and ichthyoplankton, several of which become important to commercial fisheries as adults. Zooplankton in offshore waters in the vicinity of Alternative Sites 3, 4, and 5 are primarily holoplankton and late larval stages of Dungeness crab. However, abundances of Dungeness crab larvae and other meroplankton in offshore study areas are lower than in nearshore waters. Dominant species contributing to holoplankton populations also are different in nearshore and offshore waters. Zooplankton serve as primary prey items for other carnivorous zooplankton, pelagic invertebrates such as squid, adult fish, seabirds, and marine mammals. Significant disruptions of normal planktonic productivity patterns can negatively impact marine mammal and seabird populations. For example, a reduction in planktonic productivity levels caused by the 1982–83 El Niño event coincided with high adult mortality and reproductive failure among numerous seabirds and marine mammals in the eastern subtropical Pacific Ocean (Barber and Chavez 1983). This interdependence between lower trophic level organisms and those higher in the food web demonstrates the ecological importance of plankton within marine communities, including those in the Gulf of the Farallones. However, effects of dredged material disposal on plankton populations are expected to be transitory in nature compared to dramatic natural disturbances such as El Niño.

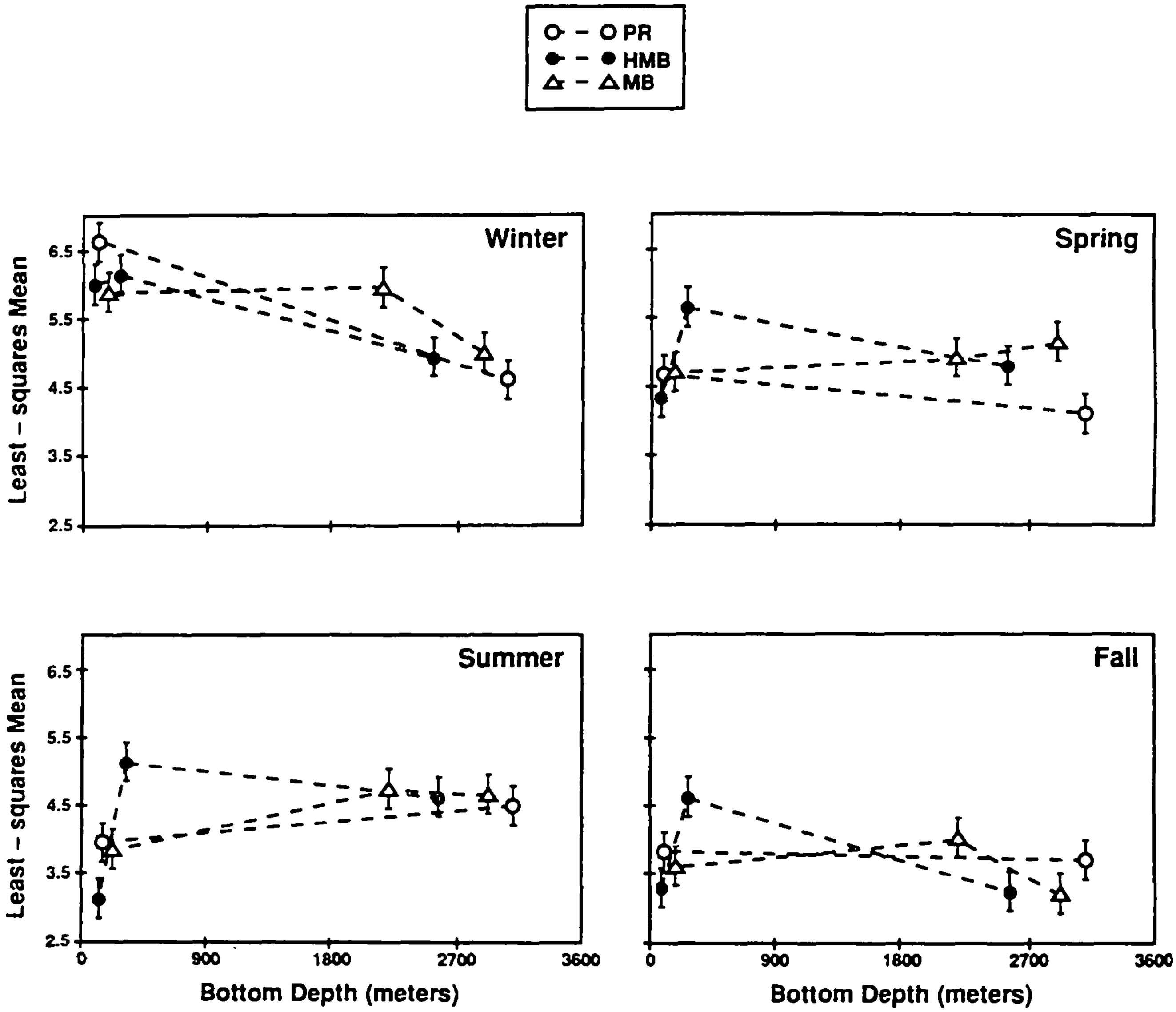

Figure 3.3.1-1. Total Number of Fish Larvae (Abundance) Versus Bottom Depth (top panel) and by Season (bottom panel).

Shown are least-squares means (LSMs) for $\log_e$ transformed abundance collected during CalCOFI surveys for individuals sampling stations (top panels) or by season (bottom panels). PR = Point Reyes line, HMB = Half Moon Bay line, MB = Monterey Bay line. Seasons are Dec.–Feb. = winter, March–May = spring, June–Aug. = summer, Sept.–Nov. = fall. Standard errors of LSMs are indicated by vertical bars. Source: Bence *et al.* 1992.

Pequegnat *et al.* (1978) assessed potential impacts of dredge material disposal in the open ocean and concluded that, although increased turbidity would occur from dredge material disposal, reductions of light and resulting impacts to plankton populations are likely to be short-term due to the temporal and spatial variability of plankton communities. Thus, disposal events in the Gulf of the Farallones are expected to be short-term and not result in significant impacts to plankton populations.

3.3.2 Invertebrates

Information on infauna, demersal epifauna, pelagic invertebrates, and commercially important species within the study region is presented in Sections 3.3.2.1 through 3.3.2.4, respectively.

3.3.2.1 Benthic Infauna

Benthic infaunal communities, defined generally as small invertebrates such as polychaete worms and amphipods living within sediments, are described by a number of parameters, such as faunal composition (what species are present), dominant taxa (which species are most abundant), density (number of individuals/m²), diversity (number of different species relative to the total number of individuals), species richness (number of species), and community assemblage patterns (which species are usually found together in a sample or how similar the samples are to each other). The following sections describe community parameters for Study Areas 2, 3, 4, and 5, including Alternative Sites 3, 4, and 5. These descriptions are based primarily on recent EPA and Navy surveys of the LTMS study region (SAIC 1992a,c).

Study Area 2

The infauna of Study Area 2 was typical of continental shelf habitats along the California coast. The number of species collected from individual grab samples by SAIC (1992c) ranged from 95 to 131 per 0.1 m^2, with a total of 261 species identified from 10 grab samples (Table 3.3.2-1). Polychaete worms represented 48% of the total species and 76% of all individuals. Two genera of surface deposit-feeding spionid polychaetes, *Prionospio* and *Spiophanes*, contributed 50% of the individuals. Amphipod crustaceans and gastropod snails were the next most dominant taxa. Gastropods were much more diverse in Study Area 2 than in any of the other LTMS study areas surveyed. Major infaunal taxa found only in Study Area 2, and absent from the slope areas, included decapods, mysids, ostracods, and phoronids. Taxonomic groups typical of the deep sea, including pogonophorans, aplacophoran molluscs, and isopod and tanaidacean crustaceans, were either absent or collected infrequently in Study Area 2.

Infauna densities (individuals/m^2) were highest in Study Area 2 with spionid and capitellid polychaetes predominant at stations with the highest densities (Table 3.3.2-2). These high densities probably are caused by relatively high productivity in the surface waters in this continental shelf location (see Section 3.2.3). From approximately 75 to 125 m depth, infaunal densities exceeded approximately 20,000 individuals/m^2, decreasing to less than 15,000 near the shelf break (approximately 200 m depth).

Table 3.3.2-1. **Total Number of Species Belonging to Each Major Taxonomic Group Collected from Study Areas 2, 3, 4, and 5 (SAIC 1992c,d).**

Taxon (Number of Samples)	Study Area 2 (10)	Study Area 3 (18)	Study Area 4 (14)	Study Area 5 (21)
Porifera	—	—	—	1
Coelenterata				
Anthozoa	3	2	2	4
Platyhelminthes	1	1	1	3
Nemertinea	1	8	6	14
Annelida				
Hirudinea	1	1	—	—
Oligochaeta	1	1	1	1
Polychaeta	125	232	234	184
Pogonophora	—	1	1	2
Sipuncula	2	5	3	3
Echiura	1	—	—	0
Mollusca				
Aplacophora	1	13	13	11
Bivalvia	18	25	23	19
Gastropoda	27	9	15	3
Scaphopoda	2	2	—	1
Arthropoda				
Amphipoda	33	33	31	39
Cumacea	13	30	32	21
Decapoda	3	—	—	—
Isopoda	5	45	41	39
Leptostraca	1	1	—	—
Mysidacea	1	—	—	—
Ostracoda	4	—	—	—
Tanaidacea	1	47	43	23
Phoronida	1	—	—	—
Echinodermata				
Asteroidea	—	1	—	1
Echinoidea	1	2	—	1
Holothuroidea	4	2	3	6
Ophiuroidea	10	12	12	8
Hemichordata				
Enteropneusta	—	2	1	1
Urochordata	1	—	—	—
TOTAL	261	475	462	385

Table 3.3.2-2. Benthic Infaunal Community Parameters for Study Areas 2, 3, 4, and 5 (SAIC 1992a,c).

Data for Alternative Sites 3, 4, and 5 are included in parentheses.

Area (Alternative Site)	Number of Species	Density (Ind./m²)	Hurlbert's rarefraction (Species per 100 Ind.)	Shannon-Wiener Index (H')	Evenness (J')
Study Area 2					
Range	95-131	12,920-42,490	26.3-40.6	4.12-5.37	0.626-0.784
$\bar{X} \pm 1$ SD	114 ±12.7	26,870 ±13,017	32.9 ±4.9	4.67 ±0.43	0.685 ±0.058
No. Samples	10	10	10	10	10
Study Area 3 (Alternative Site 3)[1]					
Range	59-165 (100-165)	3300-19560 (7840-19,560)	22.9-54.9 (34.7-50.5)	3.55-6.24 (4.02-6.05)	0.534-0.855 (0.534-0.822)
$\bar{X} \pm 1$ SD	115 ± 34.6	10,303 ±4590 (14,810 ±5574)	40.2 ±7.6 (39.5 ±7.6)	4.98 ±0.75 (4.64 ±0.98)	0.649 (0.13)
No. Samples	19 (4)	19 (4)	19 (4)	19 (4)	19 (4)
Study Area 4 (Alternative Site 4)[2]					
Range	63-164 (121-143)	4530-13,190 (9310-13,190)	33.2-57.2 (33.2-49.5)	4.28-6.34 (4.28-5.84)	0.619-0.886 (0.619-0.830)
$\bar{X} \pm 1$ SD	118.5 ±27.9 (132 ±11.0)	8446 ±2314 (10,947 ±2010)	44.8 ±6.8 (42.6 ±8.43)	5.46 ±0.53 (5.17 ±0.8)	0.798 ±0.66 (0.734 ±0.107)
No. Samples	14 (3)	14 (3)	14 (3)	14 (3)	14 (3)

Table 3.3.2-2. Continued.

Area (Alternative Site)	Number of Species	Density (Ind./m²)	Hurlbert's rarefraction (Species per 100 Ind.)	Shannon-Wiener Index (H')	Evenness (J')
Study Area 5 (1990) (Alternative Site 5)[3]					
Range	77-131 (90-91)	4970-9870 (4970-5290)	33.3-50.9 (41.9-43.8)	4.35-5.96 (5.31-5.35)	0.694-0.862 (0.818-0.822)
$\bar{x} \pm 1$ SD	105.9 ±16.9 (90.5)	7715 ±1706 (5130)	44.0 ±5.4 (42.9)	4.94 ±1.58 (5.33)	0.810 ±0.51 (.820)
No. Samples	10 (2)	10 (2)	10 (2)	10 (2)	10 (2)
Study Area 5 (Alternative Site 5)[4]					
Range	44-97 (44-73)	750-7540 (750-5790)	27.2-44.5 (29.8-34.5)	3.45-5.23 (3.62-5.23)	0.582 (0.582)
$\bar{x} \pm 1$ SD	74.4 ±15.4 (56 ±15.1)	4450 ±1953 (3123 ±2533)	37.5 ±5.8 (32.2)	4.71 ±0.68 (4.47 ±0.81)	0.582-0.959 (0.638-0.959)
No. Samples	10 (3)	10 (3)	9 (2)	10 (3)	10 (3)

[1] Alternative Site 3 stations were 3-13, 3-17, 3-18, and 3-19 (SAIC 1992c).
[2] Alternative Site 4 stations were 4-4, 4-6, and 4-11 (SAIC 1992c).
[3] Alternative Site 5 stations from the 1990 samples were F-17, K-15, and L-17 (SAIC 1991).
[4] Alternative Site 5 stations from the 1991 samples were B-4, B-5, and B-7 (SAIC 1992a).
* Sample size was too small to calculate this parameter.

Species diversity, measured by Hurlbert's rarefaction (number of expected species per 100 individuals) or by the Shannon-Wiener index (*H'*), also was high, although these measures showed an increase in species diversity with increasing depth within the study area. In contrast, species richness did not show a depth-related pattern (SAIC 1992c). Similarity analysis showed that the two deepest stations were different from the remaining stations, indicating a distinct faunal break between 125 and 180 m depth (SAIC 1992c).

Study Area 3

The number of species collected from individual box core samples within Study Area 3 ranged from 59 to 165 per 0.1 m^2, with a total of 475 species identified from 18 box core samples (Table 3.3.2-1). Subsurface deposit-feeding polychaete worms of the families Paraonidae, Cossuridae, and Cirratulidae each contributed between 9 and 11% of the entire infauna, and represented 49% of the total species collected. Detrital-feeding or scavenging tanaidacean and isopod crustaceans were the next most dominant taxa, each representing 9% of the total number of species collected by SAIC (1992c). The filter-feeding amphipod *Photis* "blind" was extremely abundant at five stations, and by itself accounted for almost 18% of the entire fauna. Because Study Area 3 stations occur over a large depth range (depths from 610 to 2,005 m), half of the dominant species collected were abundant at only a single station. The subsurface deposit-feeding polychaetes *Tharyx* sp. 1, *Cossura pygodactylata, Cossura rostrata,* and *Aricidea ramosa* were the most common species of the taxa that predominated. The most common crustacean was the tanaidacean *Pseudotanais* sp. 7, and the most common mollusc was the aplacophoran Scutopidae sp. 2.

Densities (number of individuals/m^2) in Study Area 3 ranged from 3,300 at 800 m to 19,560 at 1,780 m depth, respectively (SAIC 1992c). The highest densities were found at deep stations (depths greater than 1,780 m) due to dense populations of the amphipod *Photis* "blind." Elevated densities at other stations within Study Area 3 were due to dense assemblages of polychaetes in the families Paraonidae, Cirratulidae, and Cossuridae. The lowest densities were observed at stations between 800 and 985 m depth, located within the OMZ. These stations were dominated by oligochaetes, which are frequently associated with low dissolved oxygen, and cossurid or paraonid polychaetes.

Generally, there was a trend toward increasing species diversity and species richness with increasing depth across the continental slope stations. The diversity of infauna in Study Area 3 was high, especially at some of the deepest stations (SAIC 1992c). Low diversity at three deep stations was due to the abundance of *Photis* "blind."

Species richness was lowest at stations ranging in depth from 800 to 985 m and corresponding to the lower edge of the OMZ (Figure 3.3.2-1). The number of species per station increased slightly with depth between 1,000 and 1,500 m, and then showed a pronounced increase at depths greater than 1,600 m. Similarity analysis for Study Area 3 showed two main clusters that are defined by depth, with a distinct break at 1,600 m (SAIC 1992c).

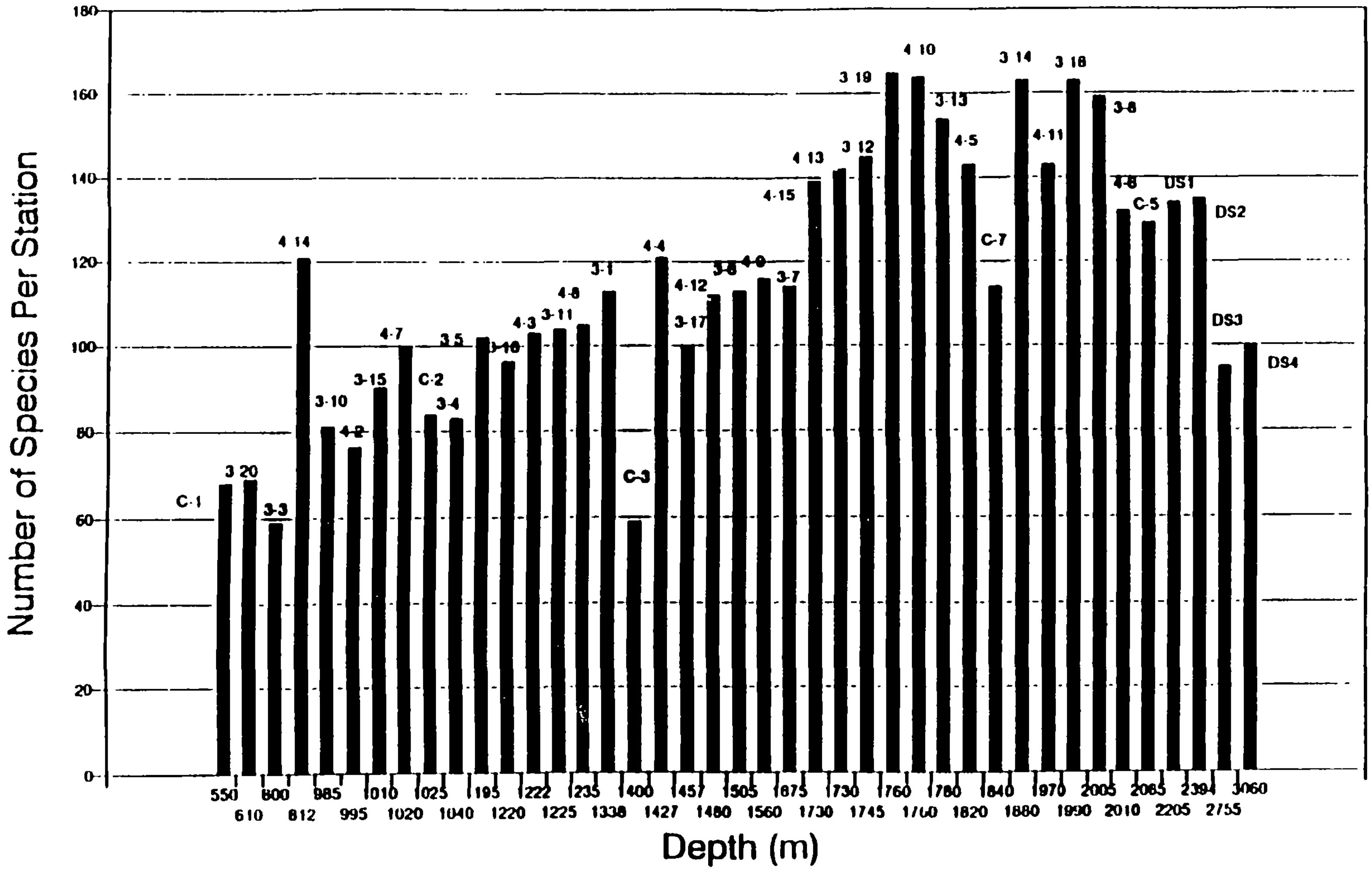

Figure 3.3.2-1. **Bar Graph of the Total Number of Species at Each Station in LTMS Study Areas 3, 4, and Pioneer Canyon, Arranged by Depth.**
Source: SAIC (1992c)

The infauna at four stations (3-13, 3-17, 3-18, and 3-19; SAIC 1992c) located within the depositional area (including Alternative Site 3), was characterized by three predominant species groups, two groups of which were similar to other nearby stations outside the depositional area. The two similar groups were based on the polychaete *Tharyx* sp. 1, and the amphipod *Photis* "blind." All the stations within Alternative Site 3 were variable in species composition, similar to the other stations throughout Study Area 3. This is notable considering the more limited depth range of Alternative Site 3 (1,450–1,900 m) as compared to Study Area 3. The third species group, represented by Station 3-19 within Alternative Site 3, had the most species (165) of any station sampled within the entire study region and was characterized by the lack of true dominant species (Figure 3.3.2-1).

Study Area 4

The number of species collected from individual box core samples within Study Area 4 ranged from 63 to 164 per 0.1 m^2 (Table 3.3.2-2), with a total of 462 species identified from 14 samples (Figure 3.2.2-1) (SAIC 1992c). Polychaete worms comprised 51% of the total species collected, while tanaidacean and isopod crustaceans each accounted for 10% (Table 3.3.2-1). Similar to Study Area 3, the filter-feeding amphipod *Photis* "blind" was the most abundant crustacean, accounting for 26% of the individuals collected at Station 4-11 (1,970 m depth). Different dominant species characterized the individual stations within Study Area 4. Subsurface deposit-feeding polychaete species including *Tharyx* sp. 1, *Aricidea simplex*, and *Cossura pygodactylata* were predominant. Three stations (4-5, 4-12, and 4-13) within Study Area 4 lacked a true dominant, with the top ranking polychaete comprising less than 10% of the animals collected.

Densities (number of individuals/m^2) in Study Area 4 ranged from 4,530 (812 m depth) to 13,190 (1,427 m depth) (SAIC 1992c). The overall range in total density was not as great as that noted for Study Area 3 (Table 3.3.2-2) even though high *Photis* densities were observed at Stations 4-10 and 4-11 (1,760 and 1,970 m depth, respectively). Most of the variability observed in densities at individual stations was due to paraonid, cirratulid, and cossurid polychaetes. Similar to Study Area 3, the lowest densities in Study Area 4 were found in the OMZ at Station 4-14 (812 m depth). Station 4-4 (1,427 m depth) exhibited the highest density in Study Area 4, primarily due to high abundances of the polychaetes *Paraonella monilaris* and *Tharyx* sp. 1.

Generally, infaunal diversity in Study Area 4 was comparable to that found in Study Area 3, although both the minimum and maximum values for the Shannon-Wiener index of diversity (*H'*) were somewhat higher than for Study Area 3 (Table 3.3.2-2). Some stations having lower diversities were dominated by exceptionally high numbers of *Tharyx* sp. 1 (Station 4-4, 1,600 m) and *Photis* "blind" (Stations 4-10 and 4-11, 1,900 m).

As in Study Area 3, stations in Study Area 4 located closest to the OMZ (approximately 800 m depth) had a distinctly lower species richness than stations between 1,000 m and 1,600 m. Additionally, a pronounced increase in species richness was noted at stations between 1,700 and 2,000 m depth (Figure 3.3.2-1).

Similarity analysis showed two main species groups defined by proximity to Pioneer Canyon rather than by depth (SAIC 1992c). One group of stations, dominated by the polychaetes *Cossura pygodactylata* and *Aricidea simplex*, occurred in the northern half (closer to Pioneer Canyon) of Study Area 4, while the second group included stations in the southwestern part of this study area (including Alternative Site 4).

Three infauna sampling stations, 4-4, 4-6, and 4-11, ranging in depth from 1,427 to 2,010 m, were included within Alternative Site 4. These stations were relatively dissimilar to one another with respect to infaunal communities in Study Area 4. Station 4-4 was characterized by extremely high numbers of a single species (*Tharyx* sp. 1), and also was the least diverse of any station in the study area. Station 4-6 was the deepest station (2,010 m) and had a low similarity with other stations in its group, due to predominant deep-sea species such as *Levinsenia* sp. 5 and *Aricidea* cf. *catherinae*. Thus, while densities at Station 4-6 were low, diversity was among the highest seen in Study Area 4. In contrast, Station 4-11 (associated with the southwest group away from the Pioneer Canyon) was dominated by *Photis* "blind" and had the greatest number of species (tied with Station 4-5) found in an individual sample in Study Area 4.

Study Area 5

Study Area 5 is located on the lower continental slope, with most samples collected deeper than 2,400 m. In 1990 and 1991, 18 box core samples were collected within this study area and another seven were taken in an adjacent area approximately 5 nm to the south (SAIC 1992a,c). Most of the summary information presented in this section refers only to those samples collected within Study Area 5.

Of the 385 species of infauna collected in Study Area 5 (Table 3.3.2-1), polychaetes comprised 48%, crustaceans 32%, and molluscs 8%. The remaining 45 species represented a variety of other taxa. Many of these taxa are typical of the deep-sea infaunal communities, including carnivorous or scavenging aplacophoran molluscs, tube-dwelling pogonophorans, and detrital-feeding desmosomatid isopods and tanaidaceans, and were also important faunal elements in Study Areas 3 and 4. The highest infaunal densities (number of individuals/m^2) in Study Area 5 were recorded in 1990, ranging from 4,970 to 9,870. Densities from the 1991 survey were lower and more variable, ranging from 750 to 7,540. Species diversities, like the densities, were higher in 1990 than in 1991.

Similarity analysis indicated that the infaunal community was distributed by depth, with deeper stations (between 2,700 and 3,000 m depth) grouped together and more similar than stations along the 2,400 m isobath (SAIC 1992c). When stations along isobaths were grouped, different dominant taxa became characteristic. For example, stations along the 2,400 m depth contour were dominated by a paraonid polychaete (*Aricidea simplex*), whereas the stations occurring along the 2,700 m depth were dominated by the polychaetes *Prionospio delta, Chaetozone* sp. 1, and *Aricidea simplex*. Predominant taxa collected at stations on the 3000 m contour included the polychaetes *Prionospio delta*, *Levinsenia* nr. *flava*, and the aplacophoran *Spathoderma* sp. 1.

Alternative Site 5 overlaps with the Naval Ocean Disposal Site (NODS) described in SAIC (1992a). NODS encompasses an area of approximately 2 nmi by 2 nmi at the southwest corner of the Chemical Munitions Dumping Area (CMDA), at depths ranging from 2,800 to 3,050 m, that was surveyed in part by the Navy (SAIC 1992a). Five box cores were taken within Alternative Site 5: Stations E-19 and F-17 in 1990 and B-1, B-4, and B-5 in 1991 (SAIC 1992a,c).

The values of benthic community parameters in Alternative Site 5 were generally higher in 1990 than in 1991, similar to the overall results for Study Area 5. One station (B-5) within this alternative site had the lowest infaunal densities recorded (750 per m^2) within any study area. In contrast, if Station B-5 is excluded, the remaining 1991 stations averaged 4,310 per m^2 and the two 1990 stations averaged 5,130 per m^2. The most abundant infaunal species in Alternative Site 5 was the spionid polychaete *Prionospio delta*, a surface deposit feeder characteristic of lower slope and rise depths.

Two benthic surveys were conducted in Area 5 (SAIC 1991, 1992a,c). Seven stations sampled in 1991 had lower infaunal densities than any station sampled in 1990. These stations include the deepest stations in the trough of the CMDA which are mostly within Alternative Site 5, the deepest stations on the southern flank of the CMDA, and the two deepest stations sampled in an adjacent area 10 miles to the south. None of these stations is close to any station sampled in 1990, except for B-5, which is very close to Station F-17 (1990) that had infaunal densities of more than 5,000 individuals per m^2. The reason that the densities at these two stations differ by a factor of 7 may be a disturbance of the environment. Bottom photographs taken by a towed camera sled that crossed the coordinates of these stations revealed a lumpy bottom that suggested a local disturbance, possibly related to turbidity flow. It is not known when this disturbance took place, but the low infaunal densities at Station B-5 in 1991, compared with the high values at Station F-17 in 1990, suggest that it occurred after August 1990. The identification of a natural disturbance in Alternative Site 5 is of considerable interest in evaluating the effects of dredged material disposal on benthic infaunal populations. The data derived from the single box core taken from Station B-5 suggest that, although the expected species such as *Prionospio delta* and the typically dominant aplacophorans and deposit-feeding polychaetes are present, they occur in greatly reduced numbers. It is not known whether the resident population at this station is a remnant of the pre-disturbance fauna or a result of specimens that recruited to the site after the disturbance. (See Section 4.4.2.2 for a general discussion of impacts of burial on the benthos.)

Comparisons Between Study Areas

The most characteristic feature distinguishing Study Area 3 from the other LTMS study areas sampled on the continental slope is the relatively high variability of parameters such as diversity, species richness, and density. The wide ranges in these parameters primarily are related to extremely high abundances of two species, the filter-feeding amphipod *Photis* "blind" and the deposit-feeding polychaete *Tharyx* sp. 1, that make up large percentages of the total infauna at 1,900 and 1,400 m depths, respectively. The most common (frequently occurring) species in Study Area 3 (not necessarily the most abundant) were *Tharyx* sp. 1, *Cossura pygodactylata*, *C. rostrata*, *Aricidea ramosa*, *Pseudotanais* sp. 7, and Scutopidae sp. 2. Similarity analyses revealed that the infaunal community was clearly zoned by depth, with a major faunal break occurring at 1,600 m.

Infaunal community parameters were less variable in Study Area 4 than in Study Area 3 and are within the range of those reported for Study Area 3. This characteristic is related to lower densities of *Photis* "blind" and *Tharyx* sp. 1 found at the same depths as in Study Area 3. In addition, although the most common polychaetes in both areas belong to the same families, the overall faunal composition of Study Area 4 is slightly different from that of Study Area 3. These differences most likely are attributable to differences in sediment characteristics. Similarity among stations within Study Area 4 also is influenced by sediment characteristics. Cluster analysis indicated two main groups of stations that are divided by a narrow band of very sandy sediment crossing Study Area 4 from northwest to southeast.

In a broad sense, Study Area 5 is somewhat less rich in terms of the numbers of species, compared to Study Areas 3 and 4, and has lower infaunal densities. This latter result is expected because of trends of decreasing density with depth in continental slope environments on both coasts of North America (SAIC 1992a; Blake *et al.* 1987). Structurally, the benthic infauna of Study Area 5 are similar to Study Areas 3 and 4 in that the most common species belong to the polychaete families Paraonidae, Cirratulidae, and Cossuridae. One important difference is the dominance in Study Area 5 of a surface deposit-feeding spionid polychaete, *Prionospio delta*, in the 2,700 to 3,000 m depth range. Cluster analysis reveals a faunal break between 2,400 and 2,700 m; this break can be attributed to this spionid (SAIC 1992a). Spionids are not dominant in Study Areas 3 and 4. *Prionospio delta* is the dominant infaunal species in Alternative Site 5. Available data suggest that spionids would be more susceptible to burial than subsurface deposit-feeders (Jumars 1977), but are, in turn, more likely to rapidly recolonize a disturbed environment.

From a trophic standpoint, differences in the types of organisms at each alternative site are expected to result in differences in their responses to dredged material. For example, Alternative Site 3 is dominated by filter-feeding amphipods, while amphipods are less important in Alternative Site 4, which is dominated by subsurface deposit-feeders. The filter-feeding amphipods would be the most susceptible to dredged material disposal because of their feeding activities and relative inability to burrow out of deposits. It is possible, however, that they might be able to move away from an affected site. Surface deposit-feeders have been shown to be more susceptible to burial than subsurface deposit-feeders (Jumars 1977). All three areas and their alternative sites include numerous species of tanaidaceans and isopods. These small crustaceans are mostly detrivores, feeding on particulate material on the surface of the sediment. It is likely that they would be highly susceptible to dredged material deposits.

Thus, from a trophic standpoint, the response of the benthic infauna in each of the areas and alternative sites is mixed. The greatest impact would clearly be in Alternative Site 3, where the populations of highly sensitive filter-feeding amphipods are the most dense. It is likely that the dominant spionids in Alternative Site 5 also would be sensitive, but because overall species richness and density is lower, the composite impact would be less than in Alternative Site 4.

Comparisons With Other Studies

The Continental Shelf—Study Area 2. The occurrence of 261 infaunal species from only ten 0.1 m^2 samples in Study Area 2 is remarkably high when compared with the MMS Monitoring program in Santa Maria Basin where 886 species were collected from 551 0.1-m^2 box core samples over a three-year period (Hyland *et al.* 1991). The diversity estimates from Study Area 2 are similar to those recorded from similar depths in the Santa Maria Basin (Hyland *et al.*, 1991), but higher than those recorded by Parr *et al.* (1987) from stations within and adjacent to Study Area 2 (Table 3.3.2-2). This suggests that the Study Area 2 infauna is very rich and does not differ in that regard from other well-studied shelf and upper slope areas off California.

The lower range of the densities measured in Study Area 2 by SAIC (1992c) is comparable to some stations sampled as part of the MMS Northern and Central California Reconnaissance and Santa Maria Basin programs (SAIC 1989b; Hyland *et al.* 1991). However, the densities (number of individuals/m^2), ranging between 30,000 and 40,000, are among the highest values ever recorded in eastern Pacific waters and comparable to environments such as Georges Bank off Massachusetts (Neff *et al.* 1989).

Parr *et al.* (1987) found much lower total densities (number of individuals/m^2) ranging from 3,400 to 6,200 in Study Area 2. The variation in diversities and densities among the various studies may be due to differences in sampling techniques. For example, samples collected by SAIC (1992c) in Study Area 2 and by Hyland *et al.* (1991) were live-sieved through a 0.3-mm sieve in the field and subsequently resieved through nested 0.3 and 0.5-mm mesh sieves in the laboratory. In contrast, Parr *et al.* (1987) used live-sieving techniques with 0.5-mm screens. Thus, two different methods were used to separate the fauna from the sediments. Although no comparative data are available from samples taken at the same site, it is evident that the 0.3-mm sieve retains many more specimens than a 0.5 mm mesh screen when live-sieved in the field.

The overwhelming dominance of spionid polychaetes noted by SAIC (1992c) was not apparent in the data from a previous study by Parr *et al.* (1987), who reported very different communities at three sites within or adjacent to Study Area 2. The most abundant species from SAIC (1992c) were the paraonid polychaete *Aricidea catherinae* and the bivalve *Axinopsida serricata*, whereas the spionid *Spiophanes missionensis* was predominant at one of the Parr *et al.* stations. The top ranking species of each station in both SAIC (1992c) and Parr *et al.* (1987) accounted for between 7% and 10% of the total fauna. Although similar species composition was found among stations in Study Area 2, almost all the predominant species collected by SAIC (1992c) were rare at stations sampled by Parr *et al.* (1987), and *vice versa.* These differences probably are due to the sieve size differences discussed previously rather than to real year-to-year differences.

The Continental Slope—Study Areas 3, 4, and 5. Infaunal species composition from the eastern Pacific continental slope is very similar to the Western North Atlantic, as identified in a study that used comparable methods, (Blake *et al.* 1987; Maciolek *et al.* 1987a,b). However, some notable differences include the absence of the polychaete family Chrysopetalidae and the lower number of pognophoran species in the Pacific.

The continental slope represents a rich source of biodiversity (Grassle and Maciolek 1992). Species richness estimates from the Navy and EPA samples from the continental slope off San Francisco are very high when compared with the continental shelf environment. However, they are lower overall than those in the western North Atlantic (see Blake *et al.*, 1985). The major difference between the western North Atlantic and eastern Pacific faunas is that infaunal densities are much higher off California. The maintenance of high species richness in deep-sea habitats where certain individual species achieve high densities was first reported by SAIC (1991) and SAIC (1992a) as part of the Navy surveys in Study Area 5.

Although the lack of replicates from the EPA and Navy studies precludes the development of site-specific estimates of species accumulation, it is evident that species are continuously added with additional sample collections (Figure 3.3.2-2). However, these estimates must be viewed with some caution since the EPA samples encompassed a much greater depth range and variety of sediment types than the Navy samples. Nevertheless, Figure 3.3.2-2 indicates that leveling-off does not occur after 68 samples from slope depths ranging from 550 to 3,050 m. These results clearly support the concept of high species richness in deep-sea habitats.

Figure 3.3.2-3 represents a composite profile of similar depth intervals from the Navy and EPA studies off the Farallones (SAIC 1992a,c), a transect off Cape Lookout, North Carolina (Blake *et al.* 1985), and a transect off Massachusetts (Maciolek *et al.* 1987b). The most obvious difference between transects done on the slope in the LTMS study region and those from the Atlantic is the higher density in samples collected from middle and lower slope depths off California. High benthic productivity in middle and lower slope depths off California very likely is due to a high flux of phytal detritus to the seabed (SAIC 1992c). For example, evidence derived from measurements of carbon-nitrogen ratios, stable isotopes ($\delta^{15}N$, $\delta^{13}C$), and chlorophyll *a* and phaeopigments in the sediments from Study Area 5 suggests that phytodetritus flux is higher than has previously been measured in the deep sea (SAIC 1992c). While phytoplankton is known to impinge on the seabed in the Atlantic (Hecker 1990), the fluxes appear to be more seasonal and irregular than in the eastern Pacific, where surface productivity associated with upwelling extends over longer time intervals (see Sections 3.2 and 3.3). The very marked decrease in densities between 800 and 1,000 m depth off California may be associated with the presence of the OMZ which may vary in depth between 600 and 1,000 m. There is no comparable OMZ in the Atlantic, where infaunal densities decline more or less evenly with depth.

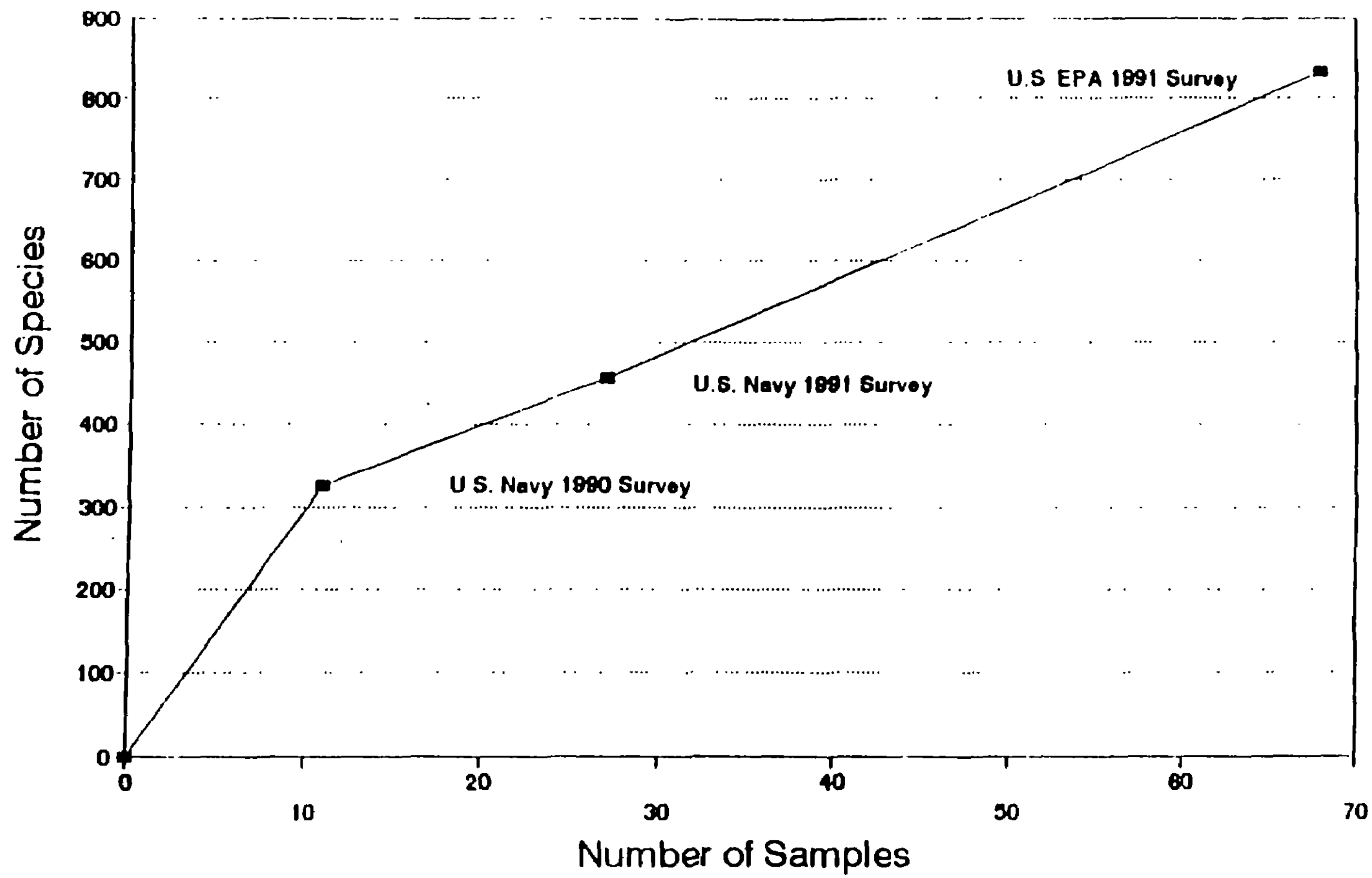

Figure 3.3.2-2. **Species Accumulation Curve for 68 Samples Collected in Study Areas 3, 4, and 5 in 1990 and 1991.**

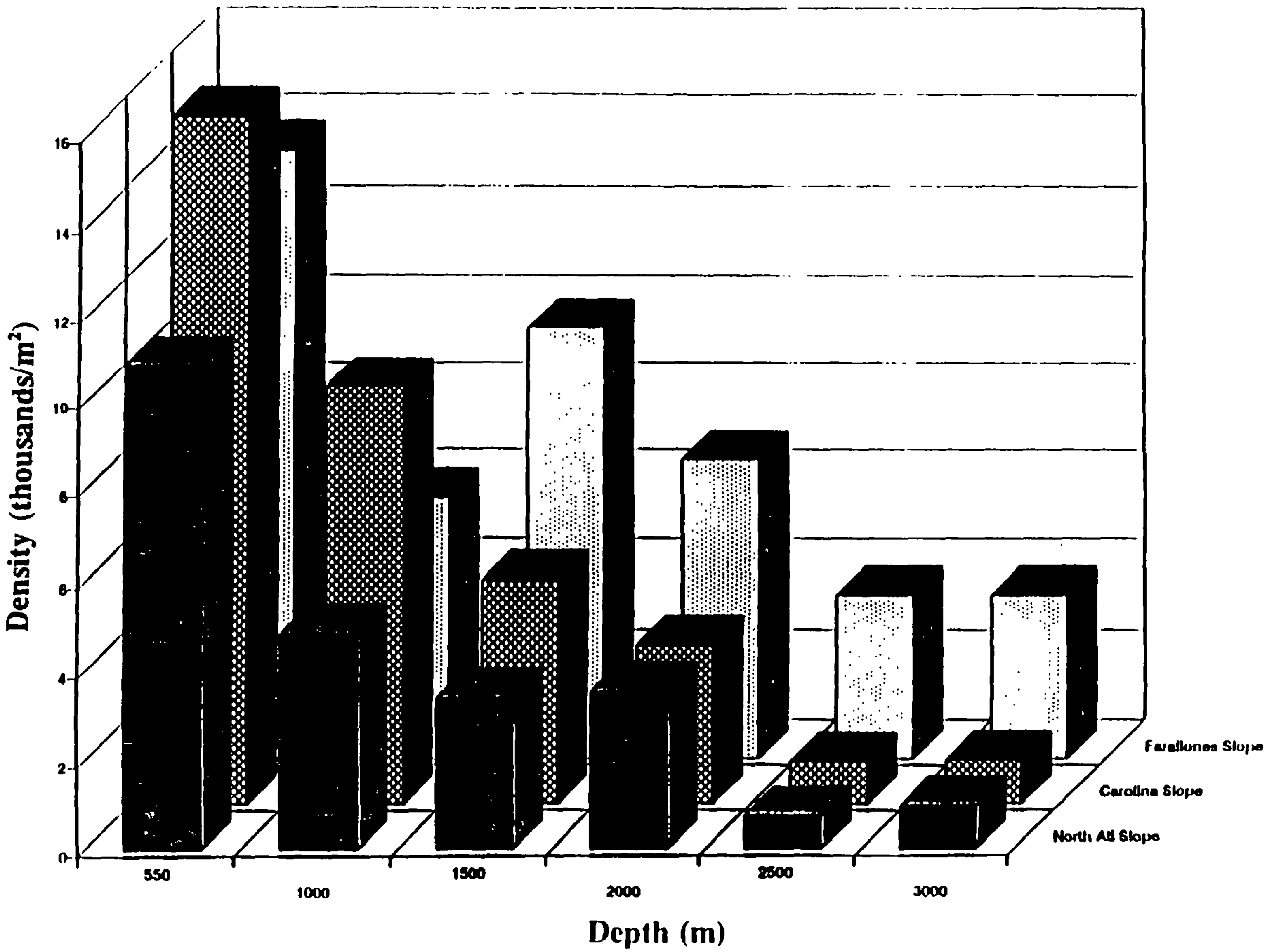

Figure 3.3.2-3. **Infaunal Densities at Two Transects on the U.S. Atlantic Continental Slope and Rise (Blake *et al.* 1985; Maciolek *et al.* 1987b) and One Transect off the Farallon Islands (SAIC 1992c).**

Factors Influencing Community Patterns

In typical marine infaunal communities, the dominant taxa are polychaetes. Polychaetes of the families Paraonidae, Spionidae, Cossuridae, and Cirratulidae were predominant at most stations in Study Areas 2, 3, 4, and 5 . However, in Study Area 3, unusually high densities of the amphipod *Photis* "blind" were observed between 1,745 and 2,000 m depth. Filter-feeding amphipods are common in nearshore environments. The amphipods remove particles from the water for food and tube construction. For dense populations of such amphipods to persist, sediment transport mechanisms must be present to move organic materials over the site.

In summary, the infaunal slope communities off San Francisco are clearly zoned by depth (SAIC 1992c). Sediments change from sands to fine silty muds at about 1,800 m, corresponding to one of the faunal breaks observed. The upper slope is influenced by the OMZ, especially between 600 and 1,000 m depth where oligochaetes are present in the fauna and indicative of sites with some partial oxygen stress.

3.3.2.2 Demersal Epifauna

This section describes the demersal epifaunal invertebrate communities found in the study region, including Study Areas 2, 3, 4, and 5. Extensive trawl and remotely operated vehicle (ROV) studies were conducted by the EPA in Study Areas 2 through 4 and adjacent sites within Pioneer Canyon and at "mid-depth" sites during September and October 1991 (SAIC 1992b). U.S. Navy surveys of Study Area 5 were conducted during July 1991 using beam trawls, otter trawls and camera sled tows (Nybakken *et al.* 1992; SAIC 1992a). Previous trawl studies within Study Area 2 were conducted by KLI (1991).

Similar to general distributional patterns observed for infaunal invertebrate communities (Section 3.3.2.1), megafaunal communities in the study region also are differentiated based on depth or depth-related factors. Types of depth-related factors recognized as influencing megafaunal community structure include differences in the sedimentary environment, the OMZ, and regional current patterns (Wakefield 1990) within the study region. Characterizations of each LTMS study area regarding "low, moderate, or high" parameters are relative comparisons with other SAIC (1992b) transects. These communities are summarized below and discussed in greater detail later in this section.

- A shelf community (from depths of at least 72 m to approximately 200 m), including Study Area 2 and some mid-depth locations, was characterized by low numbers of megafaunal species, density, and biomass. This community is characterized by brittlestars, seastars, sea pens, and octopus. Dungeness crab and squid collected infrequently and in low abundances in this study area are the only species which have commercial value.

- Upper and middle slope communities (from depths of approximately 200 m to 500 m and 500 m to approximately 1,200 m), including shallow parts of

Study Areas 3 and 4, Mid-Depth, and Pioneer Canyon, were characterized by moderate to high numbers of species. Density and biomass were moderate to high due to species such as Tanner crabs, seastars, brittlestars, snails, and sea cucumbers. Tanner crabs were collected in high numbers but do not appear to be of significant commercial value in the study area.

- A deep middle slope community (from depths of approximately 1,200 m to at least 1,800 m), including the deeper parts of Study Areas 3 and 4, is characterized by a relatively high number of species including taxonomic groups such as sea cucumbers, brittlestars, seastars, and sea pens. Densities and biomass in these areas also were relatively high and represented primarily by sea cucumbers, brittlestars, and seastars.

- A lower continental slope community (from depths of approximately 2,000 m to almost 4,000 m), including Study Area 5, is characterized by low numbers of megafaunal taxa, densities, and biomass. However, this area is characterized by similar species composition to Study Areas 3 and 4, with predominant species including sea cucumbers, brittlestars, seastars, and sea pens (Nybakken *et al.* 1992).

Study Area 2

Demersal megafaunal communities within the study region exhibited several distinct patterns in the number and type of species (Figure 3.3.2-4), density (Table 3.3.2-3A), and biomass (Table 3.3.2-3B). The total number of megafaunal species collected during trawl surveys by SAIC (1992b) in Study Area 2 ranged from 8 to 12 (Figure 3.3.2-4). Dominant taxonomic groups in this area typically included echinoderms (particularly seastars and brittlestars), cnidarians (sea pens), and molluscs (octopus). Overall, densities in this study area were low and ranged from 0.29 to 64.6 individuals per hectare (Figure 3.3.2-5). Echinoderm densities (Table 3.3.2-3A) for taxa such as brittlestars and sand stars (*Luidia foliolata*) ranked highest, with sea pen and crustacean densities also ranking in the top five, but often in much lower densities. Biomass in this study area generally was low for individual taxonomic groups, ranging from 0.04 to 2.83 kg per hectare (Figure 3.3.2-6). Biomass was highest for anemones (*Metridium spp.*; between 0.42 and 3.83 kg per hectare), while Dungeness crab, octopus, and seastar biomass ranked in the top five (Table 3.3.2-3B). Some Dungeness crab and market squid (*Loligo opalescens*) were collected by SAIC (1992b) in this study area, and represent the only prominent commercial megafaunal fisheries species. Bence *et al.* (1992) collected market squid in midwater trawls, conducted within 30 m of the surface and over depths shallower than 180 m, which is similar in depth to Study Area 2. Hard-bottom habitats were observed infrequently in this study area; sparse occurrences of rocks were noted using an ROV on Transect 2C-1 (SAIC 1992b).

Table 3.3.2-3A. Rank Order of Density for Demersal Megafaunal Invertebrates Collected During Trawl Surveys by SAIC (1992b) in Study Areas 2 through 4 and Adjacent Sites in Pioneer Canyon (PC) and in "Mid-Depth" (MD).

SPECIES (depth in meters)	2A (72)	2B-3 (85)	2C-1 (85)	MD2-1 (128)	MD1-1 (252)	PC1-1 (495)	MD3-1 (504)	PC2-1 (675)	3B-1 (1008)	3C-1 (1143)	PC3-1 (1170)	4B-2 (1278)	4C-1 (1458)	4A-1 (1656)	3A-1 (1764)
Unknown Ophiuroid spp. 1 brittlestar	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Luidia foliata sand star	2	-	2	-	4	-	-	-	-	-	-	-	-	-	-
Stylatula spp. 1 sea pen	3	-	-	3	-	5	-	-	-	-	-	-	-	-	-
Metridium anemone	4	2.5	5	4.5	-	-	-	-	-	-	-	-	-	-	-
Octupus rubescens octopus	5	2.5	3	-	-	-	-	-	-	-	-	-	-	-	-
Asteronyx loveni brittlestar	-	2.5	-	-	-	2	2	3	-	4	-	-	-	2	2
Cancer magister Dungeness crab	-	2.5	-	-	-	-	-	-	-	-	-	-	-	-	-
Hippasteria spinosa seastar	-	5	-	-	-	-	-	-	-	-	-	-	-	-	-
Unknown Ophuiroid, Gray brittlestar	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-
Pleurobranchia opisthobranch gastropod	-	-	4	-	-	-	-	-	-	-	-	-	-	-	-
Rathbunaster californicus seastar	-	-	-	1	5	-	-	-	-	-	-	-	-	-	-
Gorgonocephalus brittlestar	-	-	-	2	-	-	-	-	-	-	-	-	-	-	-

Table 3.3.2-3A. Continued.

SPECIES (depth in meters)	2A (72)	2B-3 (85)	2C-1 (85)	MD2-1 (128)	MD1-1 (252)	PC1-1 (495)	MD3-1 (504)	PC2-1 (675)	3B-1 (1008)	3C-1 (1143)	PC3-1 (1170)	4B-2 (1278)	4C-1 (1458)	4A-1 (1656)	3A-1 (1764)
Parastichopus simpsoni? sea cucumber	-	-	-	4.5	1	-	-	-	-	-	-	-	-	-	-
Pandalus platyceros spot prawn	-	-	-	-	2	-	-	-	-	-	-	-	-	-	-
Allocentrotus fragilis sea urchin	-	-	-	-	3	-	-	-	-	-	-	-	-	-	-
Myxoderma platyacanthum seastar	-	-	-	-	-	1	1	1	-	-	-	-	-	-	-
Pannychia sea cucumber	-	-	-	-	-	3	5	-	2	-	-	1	1	5	1
Unknown Pagurid Crab Hermit crab	-	-	-	-	-	4	4	-	-	-	-	-	-	-	-
Neptunea lyrata snail	-	-	-	-	-	-	3	2	4	2	2	3	-	-	-
Chionoecetes tanneri Tanner crab	-	-	-	-	-	-	-	4	3	1	4	2	-	-	-
Ophiomusium jollensis brittlestar	-	-	-	-	-	-	-	5	-	-	3	-	-	-	-
Bathybembix bairdii snail	-	-	-	-	-	-	-	-	1	-	1	-	-	-	-
Hormathiidae anemone	-	-	-	-	-	-	-	-	5	-	-	-	-	-	-
Heterozonias alternatus seastar	-	-	-	-	-	-	-	-	-	4	-	-	-	-	-

Table 3.3.2-3A. Continued.

SPECIES (depth in meters)	2A (72)	2B-3 (85)	2C-1 (85)	MD2-1 (128)	MD1-1 (252)	PC1-1 (495)	MD3-1 (504)	PC2-1 (675)	3B-1 (1008)	3C-1 (1143)	PC3-1 (1170)	4B-2 (1278)	4C-1 (1458)	4A-1 (1656)	3A-1 (1764)
Paractinistola-like anemone	-	-	-	-	-	-	-	-	-	4	-	-	-	-	-
Unknown gastropod #1 snail?	-	-	-	-	-	-	-	-	-	-	5	-	-	-	-
Paralithoides crab	-	-	-	-	-	-	-	-	-	-	-	4	-	-	-
Braided sea pen sea pen	-	-	-	-	-	-	-	-	-	-	-	5	-	-	-
Unknown Ophiuroid spp. 2 brittlestar	-	-	-	-	-	-	-	-	-	-	-	-	2	-	-
Lophaster furcilliger seastar	-	-	-	-	-	-	-	-	-	-	-	-	3	-	-
Pteraster tessalatus seastar	-	-	-	-	-	-	-	-	-	-	-	-	4	4	3.5
Actinostola-like anemone	-	-	-	-	-	-	-	-	-	-	-	-	5	-	-
Scotoplanes globosa *sea cucumber*	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-
Orange, flat corallimorph anemone	-	-	-	-	-	-	-	-	-	-	-	-	-	3	-
Aphrodita sea mouse	-	-	-	-	-	-	-	-	-	-	-	-	-	-	3.5
Stylatula spp 2. sea pen	-	-	-	-	-	-	-	-	-	-	-	-	-	-	5

Table 3.3.2-3B. Rank Order of Biomass for Demersal Megafauna Collected During Trawl Surveys of Study Areas 2 Through 4 and Adjacent Sites in Pioneer Canyon (PC) and in "Mid-Depth" (MD) (SAIC 1992b).

SPECIES (depth in meters)	2A (72)	2B-3 (85)	2C-1 (85)	MD2-1 (128)	MD1-1 (252)	PC1-1 (495)	MD3-1 (504)	PC2-1 (675)	3B-1 (1008)	3C-1 (1143)	PC3-1 (1170)	4B-2 (1278)	4C-1 (1458)	4A-1 (1656)	3A-1 (1764)
Metridium anemone	1	2	1	1	-	-	-	-	-	-	-	-	-	-	-
Cancer magister Dungeness crab	2	1	3	2	-	-	-	-	-	-	-	-	-	-	-
Octopus rubescens octopus	3	4.5	5	-	-	-	-	-	-	-	-	-	-	-	-
Astropecten verrilli Spiny sand star	4.5	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Luidia foliata sand star	4.5	-	2	5	4	-	-	-	-	-	-	-	-	-	-
Hippasteria spinosa seastar	-	3	-	-	-	-	-	-	5	-	-	-	-	-	-
Tritonia snail	-	4.5	-	-	-	-	-	-	-	-	-	-	-	-	-
Pleurobranchia opisthobranch gastropod	-	-	4	-	-	-	-	-	-	-	-	-	-	-	-
Parastichopus simpsoni? sea cucumber	-	-	-	3	1	-	-	-	-	-	-	-	-	-	-
Gorgonocephalus brittlestar	-	-	-	4	-	-	-	-	-	-	-	-	-	-	-
Allocentrotus fragilis sea urchin	-	-	-	-	2	-	-	-	-	-	-	-	-	-	-
Pandalus platyceros spot prawn	-	-	-	-	3	-	-	-	-	-	-	-	-	-	-

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Table 3.3.2-3B. Continued.

SPECIES (depth in meters)	2A (72)	2B-3 (85)	2C-1 (85)	MD2-1 (128)	MD1-1 (252)	PC1-1 (495)	MD3-1 (504)	PC2-1 (675)	3B-1 (1008)	3C-1 (1143)	PC3-1 (1170)	4B-2 (1278)	4C-1 (1458)	4A-1 (1656)	3A-1 (1764)
Rathbunaster californicus seastar	-	-	-	-	5	-	-	-	-	-	-	-	-	-	-
Myxoderma platyacanthum seastar	-		-	-	-	1	1	2	-	-	-	-	-	-	-
Pannychia sea cucumber	-	-	-	-	-	2	-	-	2	-	-	3	1	-	1
Paractinistola-like anemone	-	-	-	-	-	3	3	-	4	2	3	-	-	-	-
Asteronyx loveni brittlestar	-	-	-	-	-	4	5	-	-	-	-	-	-	-	2
Chionoecetes tanneri Tanner crab	-	-	-	-	-	5	2	1	1	1	1	1	-	-	-
Neptunea lyrata snail	-	-	-	-	-	-	4	5	-	-	4	5	-	-	-
Octopus dofleini octopus	-	-	-	-	-	-	-	3	-	-	-	-	-	-	-
Moroteuthis robusta octopus	-	-	-	-	-	-	-	4	-	-	-	-	-	-	-
Bathybembix bairdii snail	-	-	-	-	-	-	-	-	3	-	2	-	-	-	-
Thrissacanthias penicillatus seastar	-	-	-	-	-	-	-	-	-	3	-	-	5	-	-
Paralithoides crab	-	-	-	-	-	-	-	-	-	4	-	2	-	-	-

Table 3.3.2-3B. Continued.

SPECIES (depth in meters)	2A (72)	2B-3 (85)	2C-1 (85)	MD2-1 (128)	MD1-1 (252)	PC1-1 (495)	MD3-1 (504)	PC2-1 (675)	3B-1 (1008)	3C-1 (1143)	PC3-1 (1170)	4B-2 (1278)	4C-1 (1458)	4A-1 (1656)	3A-1 (1764)
Heterozonias alternatus seastar	-	-	-	-	-	-	-	-	-	5	-	-	-	-	5
Opisthoteuthis california octopus	-	-	-	-	-	-	-	-	-	-	5	-	-	-	-
Braided sea pen sea pen	-	-	-	-	-	-	-	-	-	-	-	4	-	-	-
Actinoscyphia-like anemone	-	-	-	-	-	-	-	-	-	-	-	-	2	-	4
Brown "sweet potato" sea cucumber	-	-	-	-	-	-	-	-	-	-	-	-	3	-	3
Pteraster tessalatus seastar	-	-	-	-	-	-	-	-	-	-	-	-	4	3	-
Orange, flat corallimorph anemone	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-
Scotoplanes globosa sea cucumber	-	-	-	-	-	-	-	-	-	-	-	-	-	2	-
Heterozonias-like seastar	-	-	-	-	-	-	-	-	-	-	-	-	-	4	-
Solaster borealis seastar	-	-	-	-	-	-	-	-	-	-	-	-	-	5	-

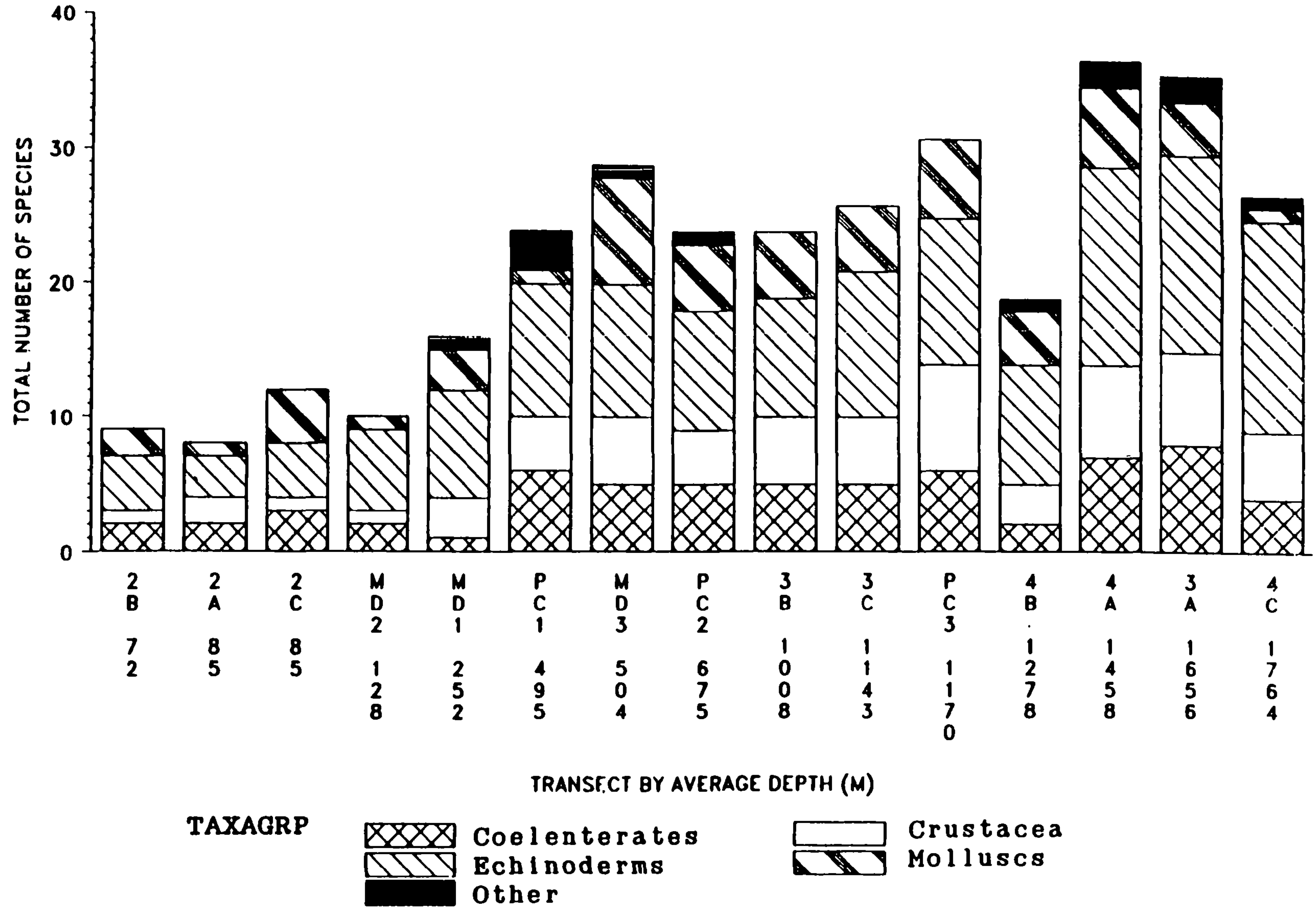

Figure 3.3.2-4. **Number of Benthic Megafaunal Invertebrate Species by General Taxonomic Group Collected During Trawl Surveys by SAIC (1992b) at Each Transect; Transects Sorted in Order of Increasing Depth.** Average Depth (m) is indicated beneath each transect.

Study Area 3

Study Area 3 is characterized by relatively moderate to high numbers of megafaunal species (Figure 3.3.2-4). Densities over the entire study area were low to moderate, ranging from approximately 200 to 1,000 individuals per hectare (Figure 3.3.2-5). Densities and biomass from the shallow parts of Study Area 3 (depths between 1,000 m and 1,200 m) were generally higher than from the deeper part (approximately 1,700 m), including Alternative Site 3, primarily due to the predominance of molluscs (*Bathybembix bairdii* and *Neptunia amianta*), sea cucumbers (*Pannychia* spp.), brittlestar (*Asteronyx loveni*), seastars, and crustaceans such as Tanner crabs (*Chionoecetes tanneri;* Tables 3.3.2-3A and 3.3.2-3B; SAIC 1992b) In the deeper parts of the study area (Transect 3A-1), *Pannychia, Asteronyx loveni,* and seastar (*Pteraster tessalatus*) were the predominant taxa collected by SAIC (1992b). Hard-bottom substrate (small rock outcroppings) was observed with an ROV by SAIC (1992b) on Transects 3A-1 and 3B-1 with sessile invertebrates such as anemones predominating.

Study Area 4

Study Area 4 is characterized by relatively high numbers of megafaunal invertebrate species, ranging from 19 to 37 (Figure 3.3.2-4). Densities in the shallow parts of this study area (depths between 1,278 m and 1,458 m) were low to moderate, with densities ranging from 100 to 400 individuals per hectare (Figure 3.3.2-5). Biomass in the shallow parts ranged from approximately 10 to 25 kg per hectare (Figure 3.3.2-6). Predominant taxonomic groups in the shallow parts of the study area include echinoderms, cnidarians, and crustaceans (Table 3.3.2-3A). In the deepest part of the study area (Transect 4C), including the vicinity of Alternative Site 4, densities and biomass were relatively low (Figures 3.3.2-5 and 3.3.2-6), with echinoderms (e.g., the seastars *Heterozonias* and *Pteraster* and the sea cucumber *Scotoplanes*) and cnidarians (e.g., anemones) comprising the predominant taxonomic groups. No hard-bottom substrate was observed using an ROV (SAIC 1992b) within this study area.

Study Area 5

Study Area 5, surveyed in part by the Navy in 1991 (Nybakken *et al.* 1992; SAIC 1992a), represents a deeper survey region (depths primarily between 2,300 m and 3,200 m) than Study Areas 2, 3, and 4 (depths between approximately 72 m and 1,800 m) surveyed by SAIC (1992b). Within Study Area 5, (including Alternative Site 5) Nybakken *et al.* (1992) collected 95 taxa of megafaunal invertebrates, of which 71 species were identified, including at least five believed to be species previously unknown to science. Overall densities in this study area were low (ranging from a mean of near zero to 870 individuals per hectare) for most taxa such as sea cucumbers, (*Molpadia intermedia* and *Paelopadites confundeus*), brittlestars (*Amphiura carchara*), seastars, and cnidarians. The highest density (870 individuals per hectare) occurred in a single family (Ypsilothuriidae). Biomass was not determined for taxa collected by Nybakken *et al.* (1992) in this study area; however, it most likely was low based on the low densities and small sizes of the organisms.

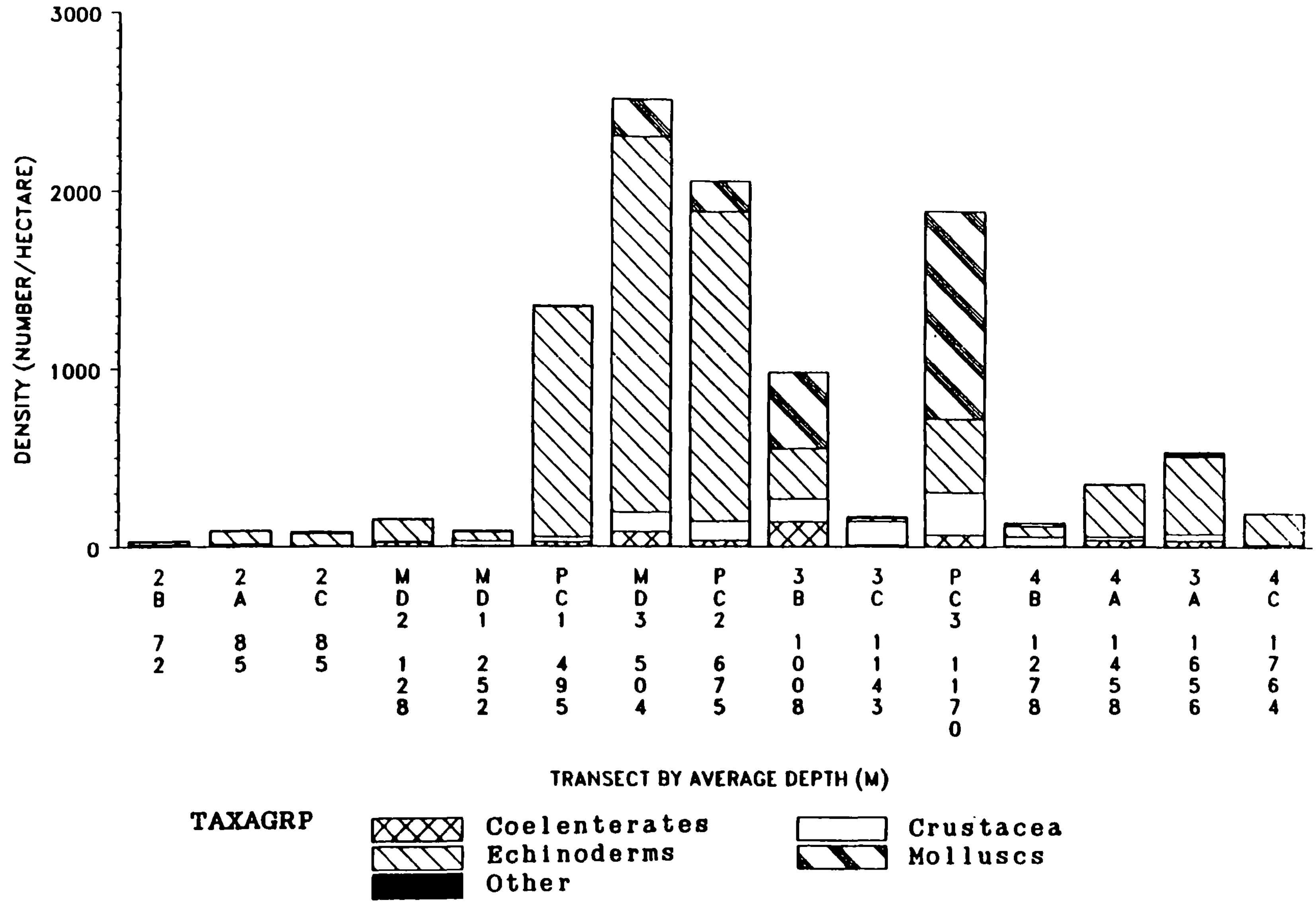

Figure 3.3.2-5. **Sum of Densities of Megafaunal Invertebrate Species by General Taxonomic Group Collected During Trawl Surveys by SAIC (1992b) at Each Transect; Transects Sorted in Order of Increasing Depth.** Average Depth (m) is indicated beneath each transect.

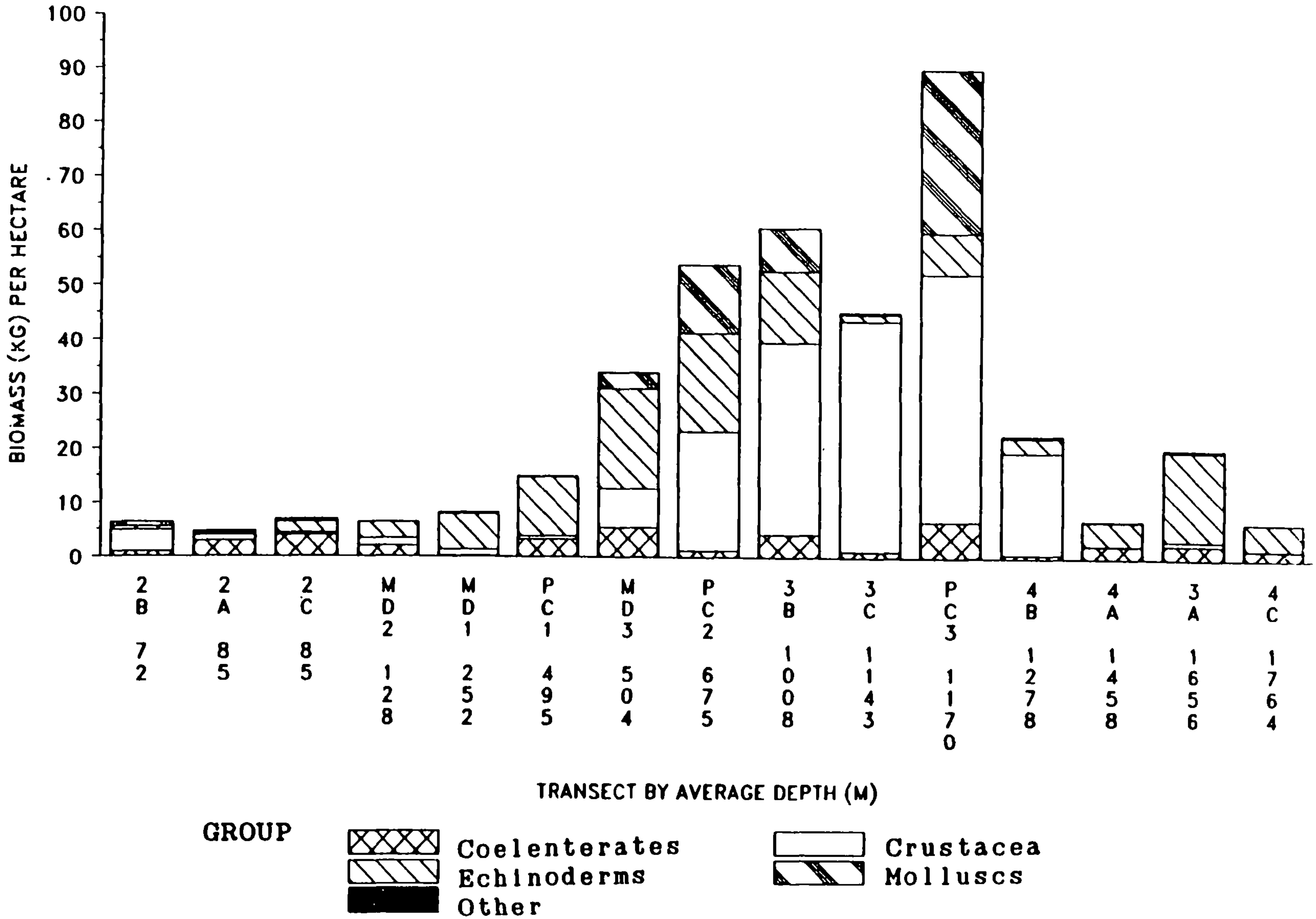

Figure 3.3.2-6. **Sum of Biomasses of Benthic Megafaunal Invertebrate Species by General Taxonomic Group Collected During Trawl Surveys by SAIC (1992b) at Each Transect; Transects Sorted in Order of Increasing Depth.**

Average Depth (m) is indicated beneath each transect.

Primary qualitative differences between results from the EPA study in Study Areas 2, 3, and 4 (SAIC 1992b) and the Navy study (Nybakken *et al.* 1992; SAIC 1992a) reflect depth-related trends between shelf (Study Area 2) and upper to middle slope communities (Pioneer Canyon sites and the shallower portions of Study Areas 3 and 4) compared to deep middle slope communities (the deeper portions of Study Areas 3 and 4), and the lower continental slope (Study Area 5). This conclusion is based on the predominance of very similar megafaunal taxa (Nybakken *et al.* 1992; SAIC 1992b) and fish communities (Cailliet *et al.* 1992; SAIC 1992b) at depths from approximately 1,200 m to 3,200 m (i.e., deep middle and lower slope). For example, echinoderms (sea cucumbers, brittlestars, and seastars) and cnidarians (primarily sea pens) were predominant in the deep parts of Study Area 3 and 4 (SAIC 1992b), as well as in Study Area 5 (Nybakken *et al.* 1992). Clearly, these similarities are based partly on upper level taxonomic comparisons and do not account for other potentially important species density and biomass differences. Nonetheless, the relative similarity of the deeper communities suggests a broad-scale pattern that appears to be consistent across the deeper portions of Study Areas 3 and 4 and within Study Area 5.

Comparisons with Other Studies

Prior to recent studies (SAIC 1992 a,b; Nybakken *et al.* 1992), knowledge of benthic megafaunal communities and information concerning the processes that regulate these communities on the continental slope (from depths of approximately 200 m to 4,000 m depth) has been limited. Nearly all studies of deeper slope communities in the northeastern Pacific, as well as those in other continental margins, report depth as a major factor related to changes in the number of species, abundance, biomass, and size structure of populations (Astrahantseff and Alton 1965; Alton 1966, 1972; Carey 1972, 1990; Pereyra 1972; Pereyra and Alton 1972; Carney and Carey 1976). However, it is clear from these studies that depth-associated physical, chemical, and biological changes along these depth gradients, and not depth alone, are collectively responsible for the observed patterns.

SAIC conducted a survey of the northern and central California demersal communities at depths ranging from 30 to 300 m (SAIC 1989b). This study concluded that substrate type (hard versus soft bottom) and relief were the most important physical factors influencing the biological communities. Depth was next most important while latitude seemed to be least important. The influence of substrate type was illustrated by its effect on the number of species. On transects with 75 to 100% hard substrate, 36–44 taxa were identified. Transects with at least 10% hard substrate still had 23–30 taxa, whereas transects with less than 10% hard substrate contained only 11–14 taxa. Sampling stations were north and south of the LTMS study region and did not overlap the LTMS areas sampled.

Wakefield's (1990) trawl data off Point Sur, California, indicated invertebrates accounted for about 35% to 75% of the total catch, based on individual abundances, for each 200 m depth stratum from 400 m to 1,400 m. This contrasts dramatically with results from SAIC (1992b) where megafauna only contributed from 3% to 13% of the total individuals caught for the same depth strata. Also in contrast, the average total biomass of megafauna collected by SAIC (1992b) at slope depths between 400 m and 1,400 m was approximately 465 kg/ha compared with half that for the Point Sur area (calculated from Wakefield 1990).

Biomass of megafauna collected on the continental slope and near the Columbia River off the Oregon coast differ from results obtained by SAIC (1992b) off the California coast. For example, megafaunal biomass collected by SAIC (1992b) was approximately four times that reported by Pearcy *et al.* (1982) for the continental slope off central Oregon. In contrast, invertebrate biomass in the SAIC (1992b) study was less than 20% of the total near the Columbia River, off the northern Oregon coast (Pereyra and Alton 1972). These differences may be significantly influenced by differences in the trawl gear used.

Differences in the number of species, density, and biomass of megafaunal invertebrates off central California (SAIC 1992b) as compared to Oregon (Pereyra and Alton 1972) probably were related to several factors including gear selectivity, inherent latitudinal differences in the faunas, and more limited knowledge of taxonomy for many species groups (e.g., cnidarians) off the central California coast. For example, Pereyra and Alton (1972) noted at least 343 species of megafauna (including infauna), with an estimated 150 additional species unidentified, from their study off the Columbia River. This represents considerably higher megafaunal diversity than the approximately 110 species found by SAIC (1992b).

Factors Influencing Community Patterns

The community differences by depth observed by SAIC (1992a,b) and Nybakken *et al.* (1992) were generally similar to those suggested by Gage and Tyler (1991) and Wakefield (1990), with the exception that the "upper slope" was divided for the SAIC (1992b) study into two parts: upper slope (depths of approximately 200 to 500 m) and middle slope (depths of approximately 500 to 1,200 m).

Sediment Types

In general, sediment types change from relatively coarse-grained in shelf and upper continental slope habitats (approximately < 500 m) to fine-grained muds on the middle to lower slope (> 1,000 m) and can have a significant effect on the distribution and abundance of megafauna (Wakefield 1990; Vercoutere *et al.* 1987). Area-specific studies by SAIC (1992c) concluded that infaunal distribution corresponded to changes in sediment characteristics. Similarly, SAIC (1992b) found taxonomic differences in megafauna (at the Genus level) that may be attributed to broad changes in sediment types within the study region (see Section 3.3.2.1). For example, seastars (*Asteronyx loveni* and *Myxoderma platyacanthum*) were generally predominant at depths corresponding to sedimentary changes from sand to sandy mud (see Section 3.2.5.1), while no distributional trends in epifaunal species composition corresponding to sediment characteristics were evident at depths greater than 1,000 m.

Changes in sediment types in the Gulf of the Farallones are related to several factors including the presence of the California Undercurrent, which can reach to depths of about 600 m (Section

3.1). The California Undercurrent can erode fine-grained sediments (Karlin 1980; Smith 1983) and create favorable habitats for many megafaunal invertebrate species. Thus, due to its role in defining erosional and depositional zones on the slope (Wakefield 1990), the boundary of the California Undercurrent may strongly influence the abundance and distribution of species along this depth gradient. It is notable that the 600 m boundary of the California Undercurrent is close to the approximate boundary between the upper and middle slope communities (combined fish and megafauna) defined by SAIC (1992b).

Results from the ROV video and photographic surveys suggest a generally uniform mud bottom over most transect areas (see Section 3.3.3). Thus, major changes in the sedimentary environment, as might be associated with community differences, were not evident. However, the resolution of sediment grain-size differences from the ROV data may not be sufficient to recognize subtle changes.

The proximity of the study region to waters outflowing from San Francisco Bay also may have an influence on the diversity of the fish and megafaunal communities. Seasonal changes related to river runoff, sediments derived from the estuary, and other factors such as organic fluxes may influence benthic habitat heterogeneity and complexity, leading to changes in species diversity. For example, the differences in species composition noted by Pereyra and Alton (1972) may be attributed to runoff by the Columbia River.

Oxygen Minimum Zone

The presence of gradients such as those produced by the oxygen minimum zone (OMZ) may be responsible for the depth-related patterns of some species on the California continental slope between approximately 600 and 800 m depths (Wakefield 1990). Perhaps the most striking distribution related to the oxygen minimum was that of the seastar *Myxoderma platyacanthum*, which was the most abundant megafaunal invertebrate in the OMZ, where it was found almost exclusively. Although there are no relevant physiological studies that have been performed on this species, it is notable that extensive respiratory structures (papulae), which potentially could be important in low oxygen environments, are present in high densities over the surface of this seastar. Because of the apparent effect of the OMZ on at least some common species, this boundary may strongly influence the patterns of community distribution noted from the cluster analyses (see SAIC 1992b Figure 3-12). SAIC (1992c) also found upper slope infaunal communities to be influenced by the OMZ, especially in the 600 to 800 m depth zones where oligochaetes are present in the fauna and indicative of sites with some partial oxygen stress.

The number of megafaunal invertebrate species tended to increase through the OMZ, perhaps due to reduced movement and activity (and lesser sensitivity to low oxygen conditions) of most species (SAIC 1992b). This pattern of increasing number of megafaunal species from the shelf break towards the middle of the continental slope is similar to general patterns reported from the western Atlantic (Rex 1981, 1983) and for many continental slope communities (Sanders and Hessler 1969; Haedrick *et al.* 1980).

Biological Factors

The majority of studies on biological processes have been conducted in intertidal or shallow subtidal habitats and their applicability to processes influencing deeper water species is unknown. Biological factors, including competition for space or food (Sebens 1986), predation (Paine and Vadas 1969; Lubchenco 1978), and larval selectivity and availability (Crisp 1974; Scheltema 1974) may also influence the distribution and abundance of benthic communities within the study region. Additional studies to evaluate biological processes in deep-water habitats would expand the understanding of the ecology and interactions of these organisms.

3.3.2.3 Pelagic Invertebrates

This section describes the pelagic invertebrates collected by SAIC (1992b), Nybakken *et al.* (1992), and Bence *et al.* (1992) within the study region. Because they were not specifically targeted by the EPA or Navy studies, pelagic invertebrates collected during these surveys represent incidental catches. Midwater trawls by NMFS represent the most comprehensive database for pelagic species within the general study region.

Pelagic invertebrates include those species capable of movement throughout the water column and/or just above the bottom. Examples include euphausiids, squid, pteropods, heteropods, and octopuses. Documentation of pelagic invertebrate populations and abundances in the region is limited. Most of the available information focuses on euphausiids and cephalopods that are either of commercial importance or are prey items for fish, marine birds, and marine mammals.

Midwater surveys in the region (Bence *et al.* 1992) and the analyses of commercial fishery catches (MMS/CDFG Commercial Fisheries Database 1992) indicated that cephalopods were a predominant pelagic invertebrate group in the study region. Market squid collected in midwater trawls at depths of approximately 30 m tended to be most abundant in areas less than 180 m in bottom depth, similar to Study Area 2, while squid abundances in Study Areas 3, 4, and 5 (including Alternative Sites 3, 4, and 5), were uniformly low (Bence *et al.* 1992). In contrast, other squids (not including market squid) had low abundances within Study Area 2 and higher abundances at depths greater than 1,200 m, corresponding to Study Areas 3, 4, and 5 (Bence *et al.* 1992). Euphausiids were patchily abundant throughout the study region and available data do not provide a clear indication that they were more abundant in any particular study area (Bence *et al.* 1992). Because virtually no deep-water pelagic habitats on the Farallon slope have been sampled, information concerning these pelagic species at similar depths off the central California coast is important. For example, a combination of deep-water sampling and monitoring of local commercial fisheries in Monterey Bay resulted in the collection of ten species of previously unreported cephalopods including *Gonatus* spp., *Berryteuthis anonychus*, *Chiroteuthis calyx*, *Octopoteuthis deletron*, *Valbyteuthis danae*, *Japetella heathi*, and *Graneledone* spp. (Anderson 1978). Catches from large midwater trawls and commercial anchovy purse-seine hauls analyzed for pelagic assemblages were dominated by the common market squid *Loligo opalescens* (Cailliet *et al.* 1979). SAIC (1992b) collected seven species of cephalopods, including market squid, *Moroteuthis robusta*, *Vampiroteuthis infernalis*, *Benthoctopus* spp., *Octopus* *dofleini*, *O. rubescens*, and *Opisthoteuthis californiana*. Cephalopods are also a primary prey item for many marine mammals foraging over the continental shelf (Fiscus 1982; Roper *et al.* 1984) such as whales which feed on squid off the central California coast (Fiscus *et al.* 1989).

3.3.2.4 Commercially Important Species

The offshore coastal regions of central California support fisheries for a number of epifauna species including spot prawn (*Pandalus platyceros*); four crab species of the genus *Cancer*, including Dungeness crab (*C. magister*); and market squid (*Loligo opalescens*; Roper *et al.* 1984).

Commercially and/or recreationally important species collected within the study region by SAIC (1992b) included Dungeness crab, market squid, and various species of shrimp; however, all these species were collected infrequently (primarily as incidentals) and in low abundances. Assessments of local squid populations have been made to determine fishery size and structure (Roper *et al.* 1984; Recksick and Frey 1978) and correlations between oceanographic conditions and squid catches (McInnis and Broenkow 1978). The predominance of squid off the central coast of California, and their importance as prey species to marine mammals suggest that these species are a major component of the pelagic invertebrate community.

Study Area 2, with a maximum depth of approximately 180 m, is likely to support the most substantial commercial fisheries for both pelagic and demersal invertebrates within the study region, with species such as spot prawn, *Cancer* crabs, and market squid predominating. Dungeness crab, a significant bottom fishery resource in shallow inshore depths along the west coast of North America from central California to Southern Alaska (Botsford *et al.* 1989), was collected infrequently within Study Area 2 by SAIC (1992b) and Parr *et al.* (1987). Market squid populations were most abundant in midwater trawls in the top 30 m of the water column, over bottom depths less than approximately 180 m, corresponding to similar depths within Study Area 2 (Bence *et al.* 1992). However, crabs and urchins were the primary megafaunal species being targeted in Study Area 2, according to the MMS/CDFG Commercial Fisheries Database (1992). Although MMS/CDFG Commercial Fisheries Database (1992) data also indicated abalone were taken in Study Areas 2 and 3, these data may be inaccurate and a result of reporting or database tabulation errors. Abalone are usually limited to shallow intertidal or subtidal (less than 40 m) hard-bottom substrate.

In contrast to fishery resources in Study Area 2 and shallower inshore areas, little information exists regarding commercial invertebrate fisheries in Study Areas 3, 4, or 5. This may be due to lower fishing effort for invertebrates within Study Areas 3, 4, or 5 by commercial fishermen.

3.3.3 Fish Community

This section describes the fish communities in the study region. Separate sections are included on demersal fishes (those which live on or near the bottom; Section 3.3.3.1) and pelagic fishes (those that spend all or part of their life in the water column; Section 3.3.3.2). Information also is presented on commercially and/or recreationally important species that inhabit the study region (Section 3.3.3.3).

3.3.3.1 Demersal Species

This section describes the demersal fishes found in the study region, including Study Areas 2, 3, 4, and 5. Specifically, information is presented on predominant species, density, and biomass within each study area. Also, details are presented on the rank order of density (Table 3.3.3-1A) and biomass (Table 3.3.3-1B) for the top five fishes collected during trawl surveys by SAIC (1992b) in each study area. A summary overview of demersal fish community characteristics by study area is presented in Table 3.3.3-2. Because a number of fish species (e.g., rockfishes) possess both pelagic juvenile and demersal adult stages, juvenile stages of these fishes collected by SAIC (1992b) and Bence *et al.* (1992) are discussed in Section 3.3.3.2.

Extensive trawl and ROV biological surveys were conducted for the EPA in Study Areas 2 through 4, at adjacent transects within Pioneer Canyon, and at "mid-depth" transects during September and October 1991 (SAIC 1992b), and by the Navy in Study Area 5 during July 1991 (Cailliet *et al.* 1992). Previous trawl studies within Study Area 2 also were conducted by KLI (1991). Additional information from midwater and bottom trawls is summarized in Bence *et al.* (1992).

Similar to general distributional patterns observed in the study region for invertebrate communities (see infauna, Section 3.3.2.1; and epifauna, Section 3.3.2.2), demersal fish communities were differentiated based on depth or depth-related factors in the study region (Figures 3.3.3-1 and 3.3.3-2). Although these depth distributions are similar to those described for invertebrate communities, a deep middle slope community was not evident for demersal fishes. These communities are summarized as follows:

- A shelf community (from depths of at least 72 to approximately 200 m), including Study Area 2 and some mid-depth transects (Figure 3.3.3-2), was characterized by relatively high numbers of fish species and abundances (including commercially/recreationally important species) but relatively low biomass (Table 3.3.3-2). This community is dominated by sanddabs, English sole, rex sole, rockfishes (not including thornyheads), pink surfperch, plainfin midshipman, and white croakers (Table 3.3.3-1A). Of these, all except pink surfperch and plainfin midshipman have important commercial value. Figure 3.3.3-1 depicts a typical shelf community assemblage.

Table 3.3.3-1A. Rank Order of Density (number of individuals/hectare) by Increasing Trawl Depth for Demersal Fishes Collected by SAIC (1992b) During Surveys in Study Areas 2 Through 4 and Adjacent Sites in Pioneer Canyon (PC) and at "Mid-Depth" (MD).

SPECIES (depth in meters)	2A (72)	2B-3 (85)	2C-1 (85)	MD2-1 (128)	MD1-1 (252)	PC1-1 (495)	MD3-1 (504)	PC2-1 (675)	3B-1 (1008)	3C-1 (1143)	PC3-1 (1170)	4B-2 (1278)	4C-1 (1458)	4A-1 (1656)	3A-1 (1764)
Citharichthys sordidus Pacific Sanddab	1	1	1	—	—	—	—	—	—	—	—	—	—	—	—
Errex zachirus Rex Sole	2	4	3	2	—	2	—	—	—	—	—	—	—	—	—
Porichthys notatus Plainfin Midshipmen	3	—	—	5	—	—	—	—	—	—	—	—	—	—	—
Zalembius rosaceus Pink Surfperch	4	2	4	—	—	—	—	—	—	—	—	—	—	—	—
Pleuronectes vetulus English Sole	5	—	2	—	—	—	—	—	—	—	—	—	—	—	—
Genyonemus lineatus White Croaker	—	3	—	—	—	—	—	—	—	—	—	—	—	—	—
Peprilus simillimus Pacific Butterfish	—	5	—	—	—	—	—	—	—	—	—	—	—	—	—
Microstomus pacificus Dover Sole	—	—	5	—	1	1	1	2	2	2	4	2	—	—	—
Sebastes jordani Shortbelly Rockfish	—	—	—	1	—	—	—	—	—	—	—	—	—	—	—
Lyopsetta exilis Slender Sole	—	—	—	3	3	—	—	—	—	—	—	—	—	—	—
Sebastes saxicola Stripetail Rockfish	—	—	—	4	2	—	—	—	—	—	—	—	—	—	—
Anoplopoma fimbria Sablefish	—	—	—	—	4	—	—	3	4	—	5	—	—	—	—

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Table 3.3.3-1A. Continued.

SPECIES (depth in meters)	2A (72)	2B-3 (85)	2C-1 (85)	MD2-1 (128)	MD1-1 (252)	PC1-1 (495)	MD3-1 (504)	PC2-1 (675)	3B-1 (1008)	3C-1 (1143)	PC3-1 (1170)	4B-2 (1278)	4C-1 (1458)	4A-1 (1656)	3A-1 (1764)
Sebastes diploproa Splitnose rockfish	—	—	—	—	5	—	—	—	—	—	—	—	—	—	—
Sebastolobus altivelis Longspine Thornyhead	—	—	—	—	—	3	2	1	1	1	1	4	4	4	—
Sebastolobus alascanus Shortspine Thornyhead	—	—	—	—	—	4	5	4	—	—	—	—	—	—	—
Lycodes cortezianus Bigfin Eelpout	—	—	—	—	—	5	3	—	—	—	—	—	—	—	—
Nezumia stelgidolepis California Grenadier	—	—	—	—	—	—	4	—	—	—	—	—	—	—	—
Merluccius productus Pacific Hake	—	—	—	—	—	—	—	5	—	—	—	—	2.5	—	—
Alepocephalus tenebrosus California Slickhead	—	—	—	—	—	—	—	—	5	5	2	5	—	5	—
Coryphaenoides acrolepis Pacific Grenadier	—	—	—	—	—	—	—	—	3	3	3	1	1	1	1
Albatrossia pectoralis Giant Grenadier	—	—	—	—	—	—	—	—	—	4	—	3	2.5	3	5
Antimora microlepis Finescale Codling	—	—	—	—	—	—	—	—	—	—	—	—	5	2	2
Lycenchelys jordani Shortjaw Eelpout	—	—	—	—	—	—	—	—	—	—	—	—	—	—	3
Coryphaenoides filifer Threadfin Grenadier	—	—	—	—	—	—	—	—	—	—	—	—	—	—	4

Table 3.3.3-1B. **Rank Order of Biomass by Increasing Trawl Depth for Demersal Fishes Collected by SAIC (1992b) During Surveys in Study Areas 2 Through 4 and Adjacent Sites in Pioneer Canyon (PC) and at "Mid-Depth" (MD).**

SPECIES (depth in meters)	2A (72)	2B-3 (85)	2C-1 (85)	MD2-1 (128)	MD1-1 (252)	PC1-1 (495)	MD3-1 (504)	PC2-1 (675)	3B-1 (1008)	3C-1 (1143)	PC3-1 (1170)	4B-2 (1278)	4C-1 (1458)	4A-1 (1656)	3A-1 (1764)
Citharichthys sordidus Pacific Sanddab	1	1	2	—	—	—	—	—	—	—	—	—	—	—	—
Errex zachirus Rex Sole	2	4	3	4	5	3	—	—	—	—	—	—	—	—	—
Pleuronectes vetulus English Sole	3	5	1	—	—	—	—	—	—	—	—	—	—	—	—
Raja binoculata Big Skate	4	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Porichthys notatus Plainfin Midshipmen	5	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Genyonemus lineatus White croaker	—	2	4	—	—	—	—	—	—	—	—	—	—	—	—
Zalembius rosaceus Pink Surfperch	—	3	—	—	—	—	—	—	—	—	—	—	—	—	—
Microstomus pacificus Dover Sole	—	—	5	2	1	1	1	2	1	1	4	1	—	—	—
Sebastes jordani Shortbelly Rockfish	—	—	—	1	—	—	—	—	—	—	—	—	—	—	—
Sebastes goodei Chilipepper	—	—	—	3	—	—	—	—	—	—	—	—	—	—	—
Sebastes saxicola Stripetail Rockfish	—	—	—	5	3	—	—	—	—	—	—	—	—	—	—
Anoplopoma fimbria Sablefish	—	—	—	—	2	2	2	1	2	2	1	4	—	—	—
Lyopsetta exilis Slender Sole	—	—	—	—	4	—	—	—	—	—	—	—	—	—	—

Table 3.3.3-1B. Continued.

SPECIES (depth in meters)	2A (72)	2B-3 (85)	2C-1 (85)	MD2-1 (128)	MD1-1 (252)	PC1-1 (495)	MD3-1 (504)	PC2-1 (675)	3B-1 (1008)	3C-1 (1143)	PC3-1 (1170)	4B-2 (1278)	4C-1 (1458)	4A-1 (1656)	3A-1 (1784)
Merluccius productus Pacific Hake	—	—	—	—	—	4	—	4	—	—	—	—	—	—	—
Sebastolobus alascanus Shortspine Thornyhead	—	—	—	—	—	5	—	5	5	4	—	—	—	—	—
Sebastolobus altivelis Longspine Thornyhead	—	—	—	—	—	—	3	3	3	5	5	—	—	5	—
Raja rhina Longnose Skate	—	—	—	—	—	—	4	—	—	—	—	—	—	—	—
Lycodes cortezianus Bigfin Eelpout	—	—	—	—	—	—	5	—	—	—	—	—	—	—	—
Coryphaenoides acrolepis Pacific Grenadier	—	—	—	—	—	—	—	—	4	—	3	2	2	1	1
Albatrossia pectoralis Giant Grenadier	—	—	—	—	—	—	—	—	—	3	—	3	1	2	2
Alepocephalus tenebrosus California Slickhead	—	—	—	—	—	—	—	—	—	—	2	—	—	—	—
Antimora microlepis Finescale Codling	—	—	—	—	—	—	—	—	—	—	—	5	4	3	3
Bathyraja trachura Black Skate	—	—	—	—	—	—	—	—	—	—	—	—	3	—	—
Bathyraja abyssicola Deepsea Skate	—	—	—	—	—	—	—	—	—	—	—	—	5	4	—
Bathyraja rosispinus Flathead Skate	—	—	—	—	—	—	—	—	—	—	—	—	—	—	4
Coryphaenoides filifer Threadfin Grenadier	—	—	—	—	—	—	—	—	—	—	—	—	—	—	5

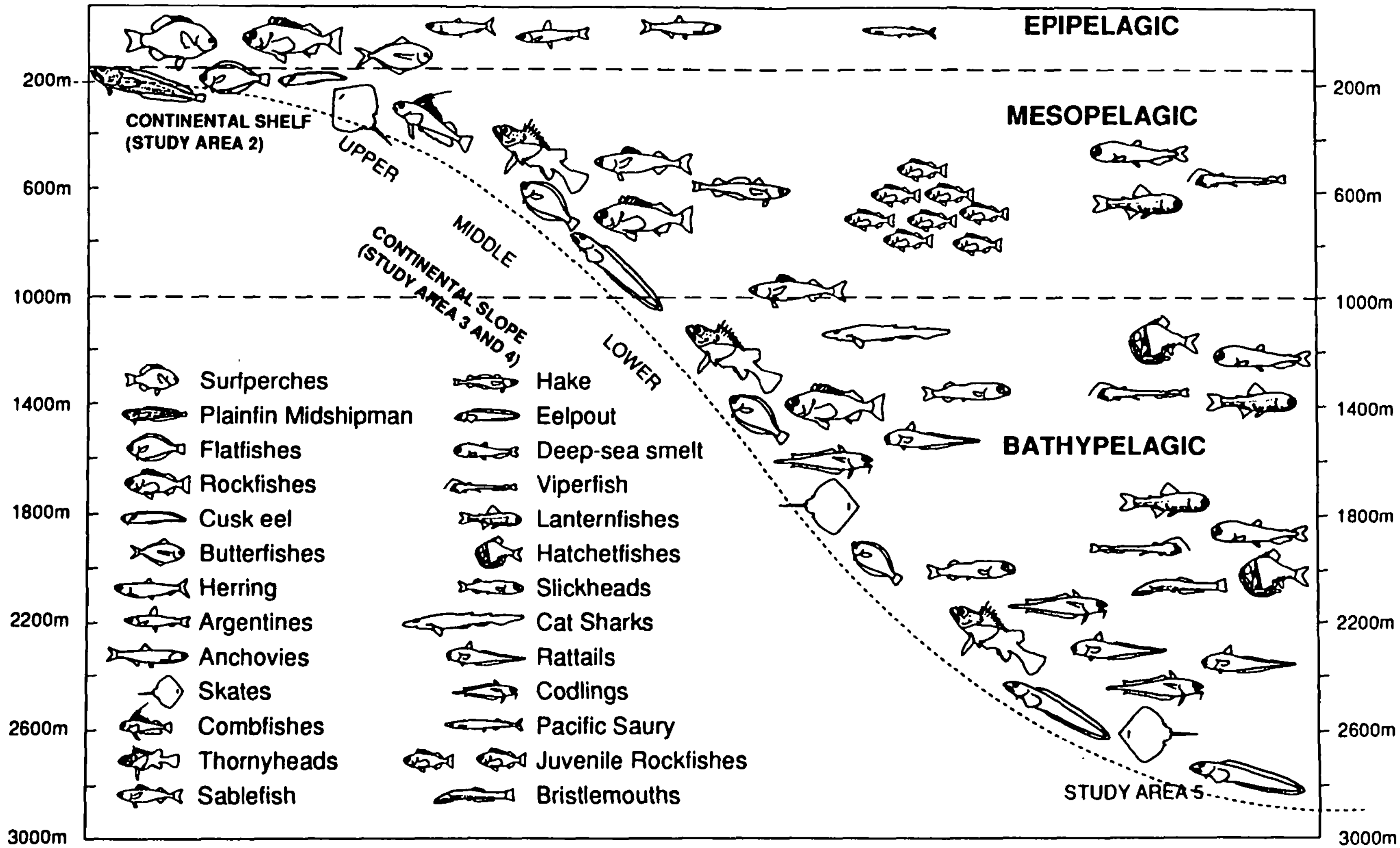

Figure 3.3.3-1. **Community Assemblages on Continental Shelf and Slope off San Francisco, California, for Common Fishes Collected in Trawls by SAIC (1992b), Cailliet et al. (1992), and Bence *et al.* (1992) in LTMS Study Areas 2, 3, 4, and 5.**

Taxonomic groups (e.g., families) may represent more than one species. Fishes do not accurately reflect size differences. Drawings taken from Miller and Lea (1972).

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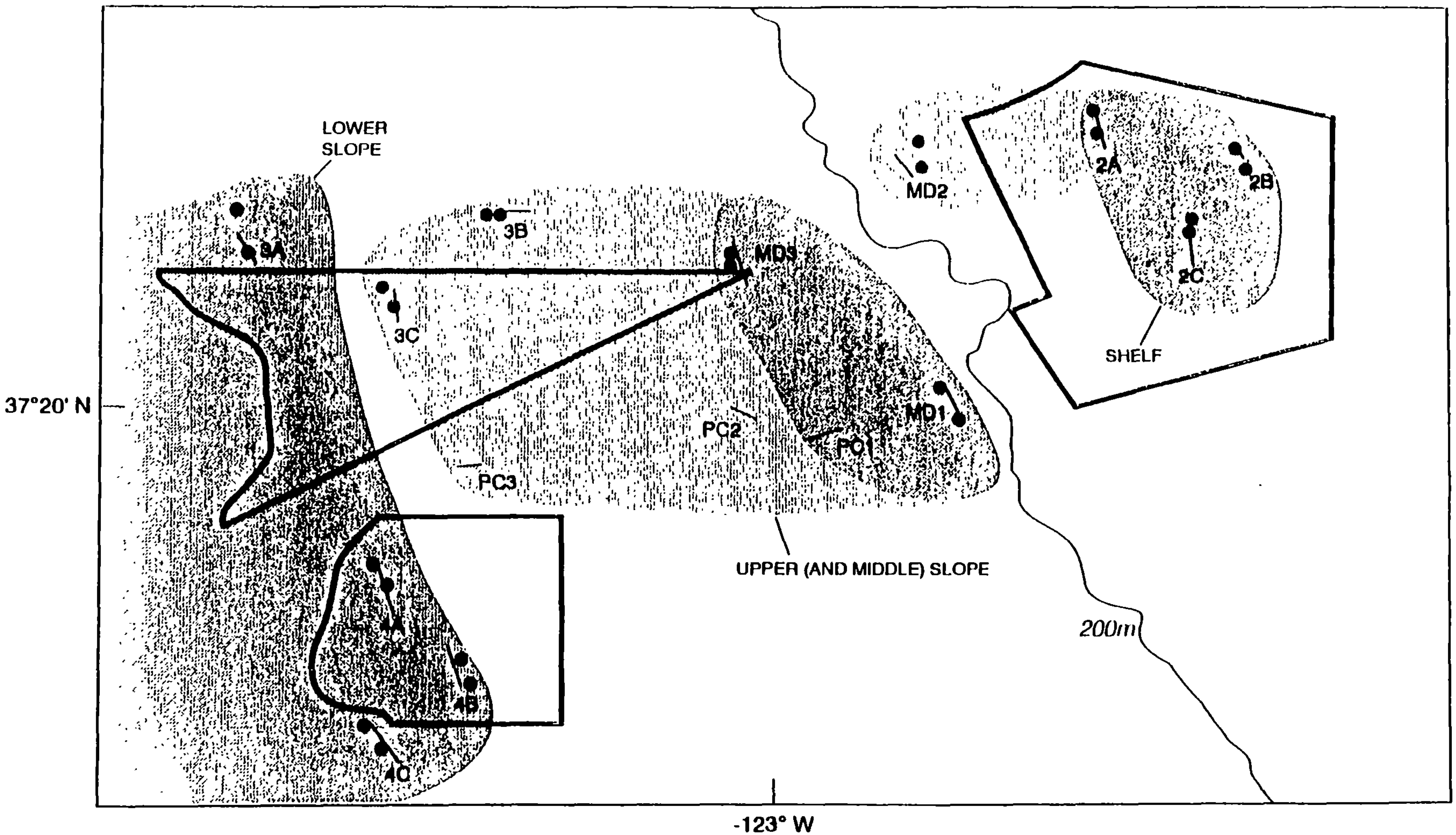

Figure 3.3.3-2. Summary of Distribution Patterns of Benthic Communities (Fishes and Megafaunal Invertebrates) from Trawl and ROV Studies Conducted in September and October 1991.

Transect start and end coordinates are indicated for trawls (solid lines) and ROV (dots mark coordinates). Study Areas 2, 3, and 4 locations are shown by "2," "3," and "4"; MD=Mid-depth; PC=Pioneer Canyon. Shelf communities are less than or equal to 200 m; upper slope is 200–500 m; middle slope is 500–1,200 m; and lower slope is greater than 1,200 m. Shades of blue correspond to areas with similar species composition (dark blue) and areas with less similar species composition (light blue) based on cluster analysis by SAIC (1992b).

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Figure 3.3.3-2. Continued.

- Upper and middle slope communities (from approximately 200 to 500 m and 500 to 1,200 m depth, respectively), including shallow parts of Study Areas 3 and 4, mid-depth, and Pioneer Canyon (Figure 3.3.3-2), were characterized by moderate numbers of fish species and densities and the highest relative biomass (including commercially/recreationally important species; Table 3.3.3-2). Fishes collected using trawls and/or observed from ROV records on the upper slope include rockfishes, flatfishes, sablefish, eelpouts, and thornyheads (Figure 3.3.3-1). Rockfishes, thornyheads, flatfishes, sablefish, hake, slickheads, and rattails were collected from the middle slope. Figure 3.3.3-1 depicts typical upper and middle slope fish assemblages.

- Lower slope communities (from depths of approximately 1,200 m to at least 3,200 m), including the deeper parts of Study Areas 3 and 4 and Study Area 5 (including Alternative Sites 3, 4, and 5), were characterized by relatively low numbers of fish species, abundance, and biomass (Table 3.3.3-2). This community is characterized by rattails, thornyheads, finescale codling, and eelpouts (Figure 3.3.3-1).

Types of depth-related factors recognized as influencing community structure include differences in the sedimentary environment, the OMZ, and regional current patterns (e.g., summarized in Wakefield 1990). These factors are discussed in greater detail below.

Demersal fish communities within the study region exhibited several distinct patterns related to the number and type of species, density, and biomass (Tables 3.3.3-2, 3.3.3-1A, and 3.3.3-1B; Figures 3.3.3-3 through 3.3.3-5). The numbers of species collected from transects in Study Area 2 by SAIC (1992b) ranged from 18 to 29 (Figure 3.3.3-3), with flatfishes (such as Pacific sanddab, *Citharichthys sordidus;* English sole, *Pleuronectes vetulus*; and rex sole, *Errex zachirus*), rockfishes (*Sebastes* spp.), and species such as pink surfperch (*Zalembius rosaceus*) being abundant (Table 3.3.3-1A). Similar results were obtained by Bence *et al.* (1992) and KLI (1991) in Study Area 2, with Pacific sanddabs, plainfin midshipmen, and pink surfperch predominating. Overall fish densities (number of individuals per hectare) were high in Study Area 2 (Figure 3.3.3-4), with flatfish densities (Table 3.3.3-1A) and biomass (Table 3.3.3-1B) for species such as Pacific sanddabs and English sole the highest of any of the study areas. However, biomass (kg/ha) in this area was relatively low (less than approximately 250 kg/ha) due to the presence of numerous small flatfishes such as Pacific sanddabs and rex sole (Figure 3.3.3-5). Rockfishes (*Sebastes* spp.) as a group were most abundant from depths of approximately 180 to 270 m (Bence *et al.* 1992), corresponding to similar depths adjacent to Study Area 2. Pelagic juvenile Dover sole and adult Pacific hake were collected in midwater trawls within 30 m of the surface and had higher abundances in Study Area 2 (Bence *et al.* 1992).

Study Area 3 was characterized by moderate numbers of species (Table 3.3.3-2 and Figure 3.3.3-3). Fish densities (Figure 3.3.3-4) from the shallow parts of Study Area 3 (at depths of approximately 1,000 to 1,200 m; Transects 3B-1 and 3C-1) were higher than the deeper part (at depths of approximately 1,700 m; Transect 3A-1) including Alternative Site 3 (SAIC 1992b).

Table 3.3.3-2. Summary by Study Area of Demersal Fish Community Characteristics.

Survey Location	Depth Range (m)	Total Species	Density (individuals per hectare)	Biomass (kg per hectare)	Predominant Species	Commercially Important Species
Study Area 2 [1]	72-85	29	1500-2500	100-250	Sanddabs Rex Sole English Sole Pink Surfperch	yes yes yes no
MD	128-504	19	500-14,000	220-1200	Shortbelly Rockfish Flatfishes Sablefish Skates	yes yes yes no
PC	495-1170	19	1500-2500	550-1150	Flatfishes Rockfishes Sablefish	yes yes yes
Study Area 3 [1]	1008-1656	16	500-1500	80-400	Rattails Thornyheads Dover Sole Finescale Codlings	potential yes yes no
Study Area 4 [1]	1278-1764	14	< 100-500	20-400	Rattails Thornyheads Eelpouts	potential yes no
Study Area *5 [2]	2300-3065	15	~ 14	Data not collected	Rattails Finescale Codlings Eelpouts Snailfishes	potential no no no

[1] SAIC 1992b
[2] Cailliet *et al.* 1992
* Data are not directly comparable to SAIC (1992b) since different trawl methods were used (beam and small otter trawl versus large otter trawl for SAIC 1992b).

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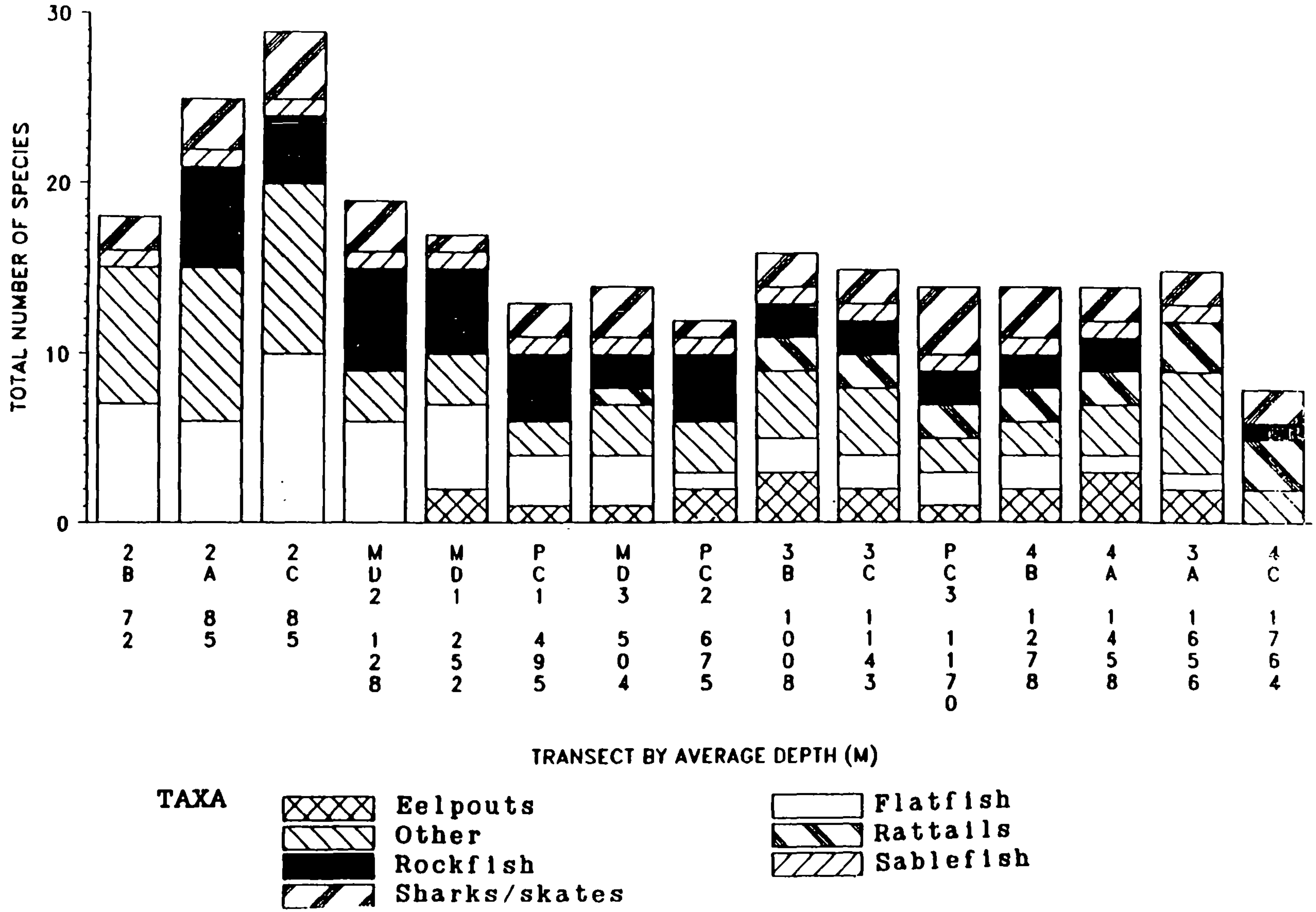

Figure 3.3.3-3. Number of Benthic Fish Species by General Taxonomic Group Collected During Trawl Surveys by SAIC (1992b) by Each Transect.

Transects sorted in order of increasing depth. Average depth (m) is indicated beneath each transect.

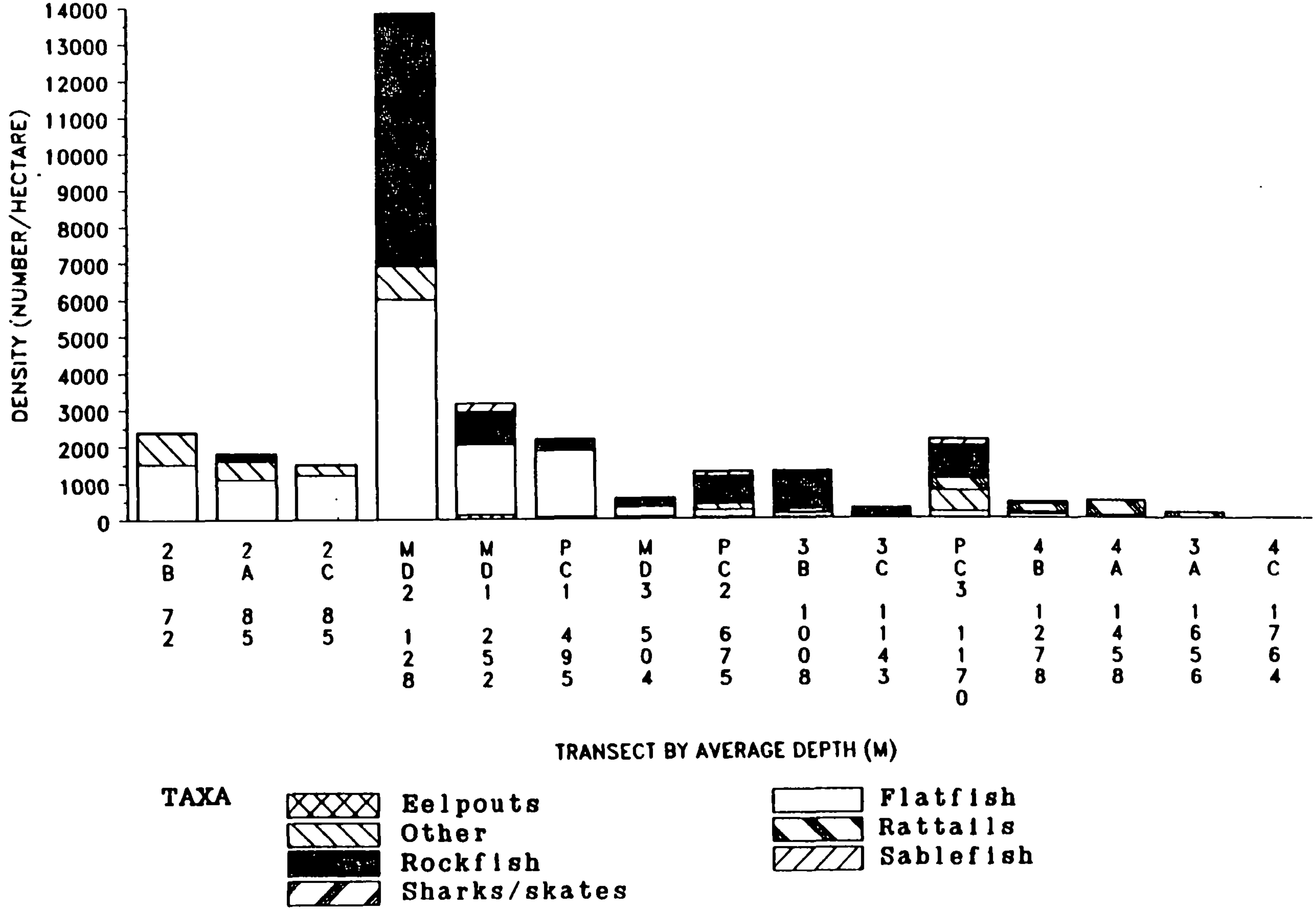

Figure 3.3.3-4. Sum of Densities of Benthic Fish Species by General Taxonomic Group Collected During Trawl Surveys by SAIC (1992b) by Each Transect.
Transects sorted in order of increasing depth. Average depth (m) is indicated beneath each transect.

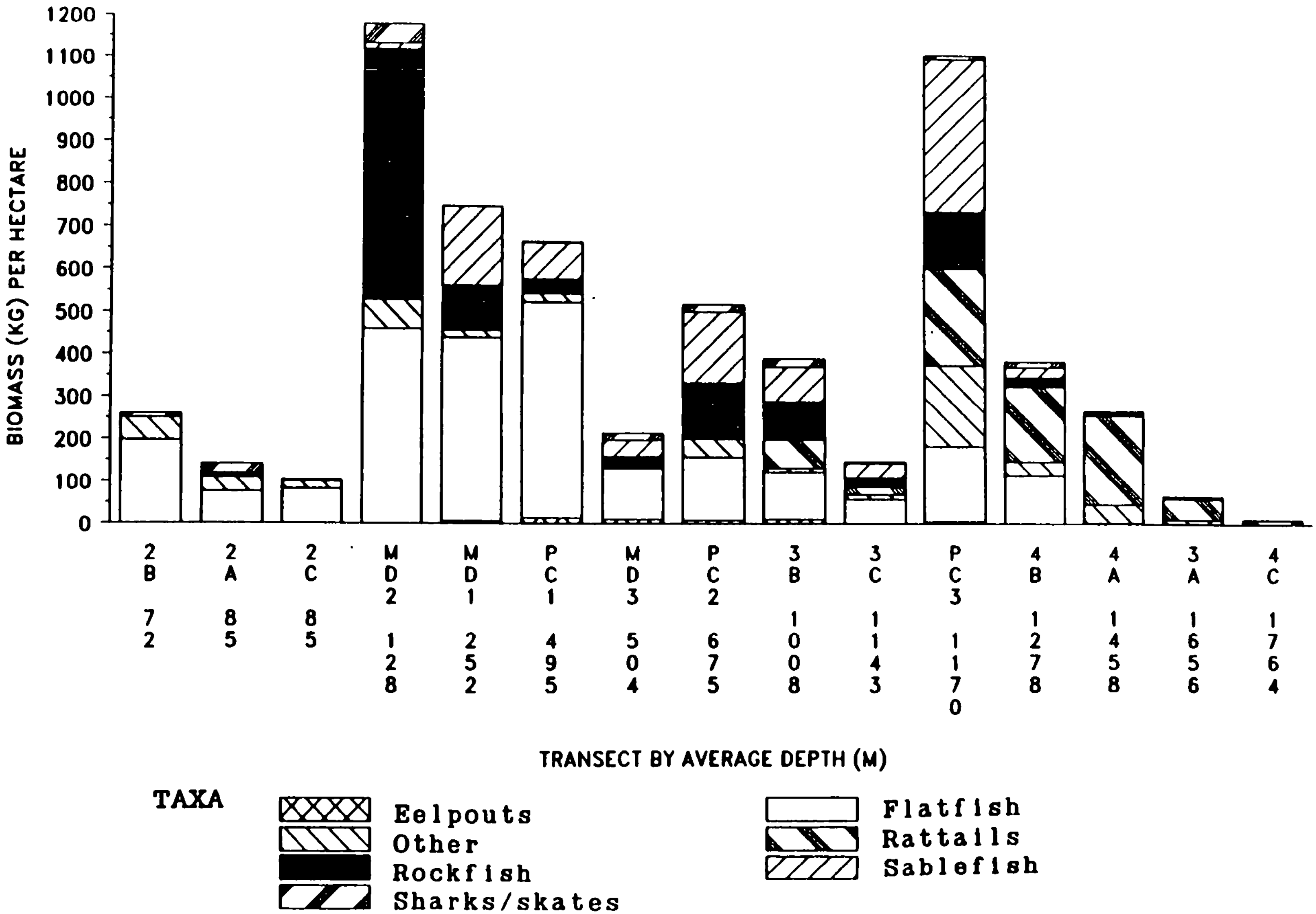

Figure 3.3.3-5. **Sum of Biomasses of Benthic Fish Species by General Taxonomic Group Collected During Trawl Surveys by SAIC (1992b) by Each Transect.** Transects sorted in order of increasing depth. Average depth (m) is indicated beneath each transect.

Rockfishes such as thornyheads (*Sebastolobus* spp.) and flatfishes such as Dover sole, comprised the highest densities in the shallower parts of this study area, while rattails and finescale codling represent characteristic species at deeper depths (SAIC 1992b; Bence *et al.* 1992). Densities of both thornyheads and Dover sole were relatively high (Table 3.3.3-1A). Biomass decreased in the shallowest to deepest parts of the study area, from 400 to 80 kg/ha, with Dover sole and sablefish contributing the highest proportion of biomass (Table 3.3.3-1B; Figure 3.3.3-5). Slender sole (*Lyopsetta exilis*) and spotted ratfish (*Hydrolagus colliei*) were abundant at depths of approximately 270 to 360 m, suggesting they also might be common in the shallowest parts of this study area (Bence *et al.* 1992).

SAIC (1992b) collected the lowest number of species in the deepest part of Study Area 4 including Alternative Site 4, although this may have been due to problems with sampling gear on one of the three trawls. Over the entire study area, rattails (*Coryphaenoides* spp.) comprised the majority of the trawl fish catch. Densities of fishes varied, but were usually less than 500/ha (Figure 3.3.3-4). At depths greater than approximately 1,500 m (e.g., Transect 4C), the numbers of fish species, densities, and biomass were extremely low. The highest biomass contribution at these deeper depths was from rattails and slickheads (Table 3.3.3-1B; Figure 3.3.3-5). Bence *et al.* (1992) indicated thornyheads (*Sebastolobus* spp.) were most abundant at depths between 700 to 900 m. This suggests thornyheads might be common in the shallow parts of Study Area 4 (Bence *et al.* 1992), while rattails were most abundant in the deep portions of Study Areas 3 and 4 and in Study Area 5 (including Alternative Sites 3, 4, and 5).

Study Area 5, surveyed by the Navy in 1991 (Cailliet *et al.* 1992), was dominated by rattails, eelpouts (Zoarcidae), and morids (*Antimora microlepis*). Fish densities in this study area were low (e.g., 207/ha). These general results are very similar to those observed for the deep slope communities in Study Areas 3 and 4 at depths greater than approximately 1,200 m, even though the trawl used by SAIC (1992b) was a large commercial-sized otter trawl, while Cailliet *et al.* (1992) used a small beam trawl and a small otter trawl. Within Study Area 5, Cailliet *et al.* (1992) collected 15 species of fishes, of which rattails, eelpouts, and finescale codling were predominant.

Based on the differences in sampling methods, as noted above, quantitative comparisons between Study Areas 2 through 4 and Study Area 5 do not appear to be appropriate. Primary qualitative differences between results from SAIC (1992b) surveys in Study Areas 2, 3, 4, mid-depth, and Pioneer Canyon, and Cailliet *et al.* (1992) surveys in Study Area 5 reflect depth-related trends between shelf (Study Area 2) and upper to middle slope communities (Pioneer Canyon sites and the shallower portions of Study Area 3) compared to lower slope communities (Study Area 4, the deeper portion of Study Area 3, and Study Area 5). This conclusion is based on the predominance of very similar fish taxa from depths of approximately 1,200 to 3,200 m (i.e., lower slope) as compared to the shallower communities. For example, lower slope fish communities from both studies are characterized by rattails, eelpouts, and finescale codlings. These similarities and differences are based partly on upper level taxonomic comparisons and do not account for other potential species density and biomass differences. Nonetheless, the relative "sameness" of the deeper communities suggests a broad-scale pattern that is consistent across the deeper portions of Study Areas 3 and 4 and within Study Area 5. This similarity is also evident from Bence *et al.* (1992) surveys. Although both midwater and demersal trawls were used, results similar to SAIC (1992b) and Cailliet *et al.* (1992) in species composition were obtained by the NMFS surveys.

Comparisons With Other Studies

Several studies from California to the Pacific Northwest show variations with depth among major fish groups. For shallow depths on the continental shelf and upper continental slope, flatfishes, including Bothidae (e.g., sanddabs) and Pleuronectidae (e.g., rex sole and Dover sole), account for the greatest biomass in most studies. Fishes such as flatfishes, including Dover sole, rex sole, and in some cases Pacific sanddabs (SAIC 1992b; Bence *et al.* 1992), were also dominant on the shelf and upper slope off Point Sur (Wakefield 1990), offshore from the Columbia River (Pearcy *et al.* 1982), and over most trawl locations along the coast of central California which were sampled by NMFS (Butler *et al.* 1989). Smaller individuals of these flatfish species usually were most abundant at the shallowest depths and larger individuals were most abundant on the continental slope (Figures C-6, C-5, and C-2 in SAIC 1992b).

Comparisons of shelf fish communities based on abundance data from SAIC (1992b) and KLI (1991) indicated that flatfishes, pink surfperch, plainfin midshipman, and rockfishes made up the top species or taxonomic groups collected by both studies within the study region. Comparisons of upper slope fish communities at depths between approximately 300 to 600 m with studies by Wakefield (1990) and Cross (1987) at depths between 600 to 1,600 m indicated that flatfishes, rockfishes, and eelpouts ranked in the top five, suggesting that species compositions were similar between both of these studies over the same depth intervals. Finally, on the lower slope (at depths greater than 1,200 m) thornyheads, rattails, eelpouts, and finescale codling ranked high in all studies (SAIC 1992b; Wakefield 1990).

Factors Influencing Community Patterns

Fish community structure within the study region can be influenced by depth or depth-related factors such as the sedimentary environment, regional current patterns, and the OMZ.

Several factors, including the presence of the California Undercurrent, which reaches to a depth of about 600 m, may contribute to changes in sediment types in the Gulf of the Farallones. Thus, due to its role in defining erosional and depositional zones on the slope (Wakefield 1990), the boundary of the California Undercurrent may also influence the abundance and distribution of demersal fishes along this depth gradient. It is notable that the 600 m boundary of the California Undercurrent is close to the approximate boundary between the upper and middle slope communities defined by SAIC (1992b).

The proximity of the study region to the outflow from San Francisco Bay also may have an influence on the diversity of the fish communities within the study region. Seasonal changes related to river runoff, sediments derived from the estuary, and other factors such as organic fluxes, may influence benthic habitat heterogeneity and complexity, leading to changes in species diversity. The only other west coast study of slope fishes offshore of a large estuary or river is Alton's (1972) study off the Columbia River.

In addition to sedimentary effects on fish communities, the presence of gradients such as those produced by the OMZ may be responsible for the depth-related patterns of some species found on the California continental slope at depths between approximately 600 m and 800 m (Wakefield 1990). Oxygen minima usually underlie surface waters having high primary production or other high inputs of organic material (e.g., upwelling zones along the coast of California). Active species, such as many types of fishes, may be unable to withstand low oxygen concentrations. Although few studies have been conducted, there is some evidence which indicates that species inhabiting the OMZ are well adapted to low oxygen environments. Some mid-water species in this zone have the ability to regulate oxygen consumption (Childress 1975). Dominant species of demersal fishes, such as thornyheads, have several biochemical adaptations which allow them to thrive on the continental slope (reviewed in Wakefield 1990). All of these physical factors may contribute to the overall structure of fish communities within the study region.

3.3.3.2 Pelagic Species

This section describes pelagic species of fishes collected primarily using midwater and plankton trawls by NMFS in the study region. Because surveys by SAIC (1992b) and Cailliet *et al.* (1992) targeted demersal fish species, most of the pelagic fishes collected during these surveys represented incidental species. However, the families of pelagic fish species collected by SAIC (1992b) and Bence *et al.* (1992) are similar to other studies in comparable marine zones (Moyle and Cech 1988). The Bence *et al.* (1992) report represents the most comprehensive data available on pelagic fish species in the study region. Results from Bence *et al.* (1992) are based on CalCOFI ichthyoplankton surveys (mainly the upper 210 m of the water column), NMFS ichthyoplankton surveys (maximum 200 m wire out), and NMFS midwater trawls for juvenile rockfishes (depths to 30 m).

The surface waters of the ocean to depths of approximately 200 m (epipelagic zone) represent an enormous, although relatively featureless, habitat for fishes (Moyle and Cech 1988). Epipelagic zone waters are typically well lighted, well mixed, and capable of supporting actively photosynthesizing algae. At depths between 200 and approximately 1,000 m (mesopelagic zone), light decreases rapidly as does temperature and dissolved oxygen concentrations, while pressure increases. At depths greater than 1,000 m (bathypelagic zone), conditions are characterized by complete darkness, low temperature, low oxygen levels, and great pressure. Each of these zones is distinguished by characteristic fish assemblages.

Epipelagic fishes can be distinguished based on two ecological types. Oceanic forms are those that spend all or part of their life in the open ocean away from the continental shelf, while neritic forms spend all or part of their life in water above the continental shelf (Moyle and Cech 1988). Typical epipelagic species include fast-moving swimmers such as tunas, mackerels, and salmon, as well as schooling baitfish such as herring, anchovy, and juvenile rockfishes. To date, information exists for epipelagic fishes over the continental shelf; however, little information exists for epipelagic fishes collected in Study Areas 3, 4, or 5. Epipelagic species collected by SAIC (1992b) included Pacific herring, Northern anchovy, medusafish, Pacific sardine, Pacific mackerel, Pacific saury, Pacific argentines, and juvenile rockfishes. Bence *et al.* (1992) collected approximately 140 species in midwater trawls including juvenile rockfishes, Pacific herring and Northern anchovy. Although these studies did not target epipelagic fishes, all of these species were of the types collected in Study Area 2 and most are commercially important. Juvenile rockfishes represent an important part of both commercial and recreational fisheries along the entire Pacific coast (Bence *et al.* 1992). Juvenile rockfishes, such as the shortbelly rockfish (*Sebastes jordani*) have been shown to be an important prey item for many seabirds (Ainley and Boekelheide 1990), and for fishes such as chinook salmon, lingcod, and other rockfish species (Chess *et al.* 1988). Some of the pelagic species collected by SAIC (1992), Cailliet *et al.* 1992, and Bence *et al.* (1992) are shown by depth zone in Figure 3.3.3-1.

Mesopelagic fishes comprise the majority of incidental fishes collected by SAIC (1992b) and Cailliet *et al.* (1992) in the study region. Most of these species undergo vertical migrations, often moving into the epipelagic zone at night to prey on plankton and other fishes (Moyle and Cech 1988). Typical mesopelagic species collected in Study Areas 3 and 4 at depths between 100 to 1,000 m by SAIC (1992b) and Bence *et al.* (1992) included deep-sea smelts (Bathylagidae), lanternfishes (Myctophidae), and viperfishes (Chauliodontidae; Figure 3.3.3-1). In Study Area 5, Cailliet *et al.* (1992) also collected six species of mesopelagic fishes, most of which were from the same families Bathylagidae, Myctophidae, Chauliodontidae, and Sternoptychidae.

Bathypelagic species, in contrast to mesopelagic fishes, are largely adapted for a sedentary existence in a habitat with low levels of food and no light (Moyle and Cech 1988). SAIC (1992b) collected bathypelagic fishes such as blackdragons (Idiacanthidae), dragonfish (Melanostomiidae), and tubeshoulders (Searsiidae) primarily in the deeper parts of Study Areas 3 and 4 at depths greater than 1,000 m, while bathypelagic fishes collected by Cailliet *et al.* (1992) in Study Area 5 included lanternfishes (Myctophidae), deep-sea smelts (Bathylagidae), hatchetfishes (Sternoptychidae), and viperfishes (Chauliodontidae). Most of the species found to occupy the bathypelagic zone also occur in the mesopelagic zone during vertical migrations. A typical bathypelagic fish assemblage is shown in Figure 3.3.3-1. Bathypelagic fishes collected by Bence *et al.* (1992) included deep-sea smelts (Bathylagidae) and lanternfishes (Myctophidae).

3.3.3.3 Commercially and Recreationally Important Species

This section describes the commercially and recreationally important species of fishes in the study region including those collected by trawls from EPA (SAIC 1992b) and Navy studies (Cailliet *et al.* 1992), as well as information summarized in Bence *et al.* (1992), Jow (1992), unpublished California Department of Fish and Game (CDFG) Catch Block Data as provided by the Minerals Management Service (MMS), and Battelle (1989). Although some information is presented from recreational fisheries within the study region, the majority of fish species discussed in this section represent commercial landings.

Several of the abundant species collected within the study areas are of commercial importance. In particular, SAIC (1992b) collected various species of flatfishes (Dover sole, rex sole, sanddabs, English sole, and California halibut), rockfishes (splitnose, shortbelly, chilipepper, boccacio, and thornyheads) and sablefish, that are currently targeted by commercial fisheries. The most common fishes taken by recreational fishermen within the study region include salmon, albacore tuna, mackerel, and rockfishes (CDFG Recreational Fisheries Database 1992). A summary of common commercially and recreationally important species within the LTMS study areas is presented in Table 3.3.3-3. Additional information concerning commercial and recreational fisheries is presented in Section 3.4.1.

Flatfishes

Over the entire study region, the rank order of biomass for flatfishes landed by trawlers between 1985 and 1987 was Dover sole, English sole, Pacific sanddabs, petrale sole, and rex sole (Jow 1992). In Study Area 2, commercially important species of flatfishes collected by SAIC (1992b), Bence *et al.* (1992), and KLI (1991) included Dover sole, rex sole, Pacific sanddabs, English sole, petrale sole, and California halibut (Table 3.3.3-3). However, it is notable that California halibut were collected only rarely and primarily in Study Area 2. Bence *et al.* (1992) indicate that slender sole were most abundant between 270–360 m depth, suggesting they might be abundant in the shallowest portions of Study Area 3. In the shallow parts of Study Areas 3 and 4, two species of flatfishes (Dover sole and deep-sea sole) were collected by SAIC (1992b). Of these two species, only Dover sole represents a commercially important flatfish species. No flatfishes were collected by SAIC (1992b) in the deeper part of Study Areas 3 and 4. Dover sole that are collected commercially at depths greater than 800 m have high water content which makes them less valuable to commercial fishermen under current market conditions (Bence *et al.* 1992).

Rockfishes

Rockfishes such as splitnose rockfish, shortbelly rockfish, boccacio, chilipepper, stripetail rockfish, and thornyheads are commercially and/or recreationally important. Rockfishes (not including thornyheads), found primarily in Study Area 2 by SAIC (1992b) and Bence *et al.* (1992), were one of the most abundant and species-rich groups collected on the continental shelf. Juvenile rockfishes had relatively high seasonal abundances inshore (Study Area 2) and in the deep parts of Study Area 5, while lower seasonal abundances were found in the deep parts of Study Areas 3 and 4 (Bence *et al.* 1992). MMS/CDFG Commercial Fisheries Database (1992) and CDFG Trawler Database (Jow 1992) indicated rockfishes, not including thornyheads, were the predominant species collected commercially in Study Area 2, while rockfishes, including thornyheads, were targeted in the shallow parts of Study Areas 3 and 4. Of the 16 species of rockfishes collected by SAIC (1992b), only two species, the thornyheads *Sebastolobus altivelis* and *S. alascanus*, were abundant on the middle and lower continental slope (Study Areas 3 and 4). However, thornyheads accounted for approximately 25% to 50% or more of the total abundance or biomass of the upper to middle slope fishes collected by SAIC (1992b) and other studies (Wakefield 1990; Butler *et al.* 1989; Pearcy *et al.* 1982; Alton 1972). Thornyheads

Table 3.3.3-3. **Summary of Common Commercially and Recreationally Important Fishes Within the LTMS Study Areas.** Information is based on SAIC (1992b), Cailliet et al. (1992), Bence *et al.* (1992), MMS/CDFG Commercial Fisheries Database (1992), CDFG Recreational Fisheries Database (1992), and KLI (1991). Adults are indicated by (A), Juveniles by (J), and Not Specified as A or J by (NS).

Common Name	2 (72-85 m)	3 "Shallow" (1,008-1,143 m)	3 "Deep" (1,656 m)	4 (1,278-1,764 m)	5 (2,300-3,065 m)
Northern Anchovy	A/J	J	J	J	
Pacific Herring	A				A
Pacific Sardine	A				
Pacific Hake	A/J	A/J	A/J	A/J	A/J
Shortbelly Rockfish	A/J	J	J	J	J
Chilipepper Rockfish	A/J	J	J	J	
Boccacio	A/J	J	J	J	J
Widow Rockfish	A				
Yellowtail Rockfish	A	J	J	J	J
Thornyheads		A/J	A/J	A/J	
Sablefish	A/J	A		A	
Lingcod	A/J				
Pacific Sanddab	A/J				
Rex Sole	A/J	J	J	J	J

Table 3.3.3-3. Continued.

Common Name	2 (72-85 m)	3 "Shallow" (1,008-1,143 m)	3 "Deep" (1,656 m)	4 (1,278-1,764 m)	5 (2,300-3,065 m)
California Halibut	A				
English Sole	A				
Dover Sole	A/J	A		A	J
Petrale Sole	A				
Rattails (potential fishery)		A	A	A	A
Salmon	NS				
Albacore Tuna	NS				
Sharks/Skates/Rays	A				
Hagfish		A	A	A	
White Croaker	A				

collected by Bence *et al.* (1992) were most abundant at depths between 700 and 900 m, corresponding primarily to the shallow parts of Study Area 3 (Table 3.3.3-3).

Sablefish

Sablefish commonly ranked third in biomass of the trawl-collected fishes, both along the California coast (SAIC 1992b; Wakefield 1990; Butler *et al.* 1989) and offshore Oregon and Washington (Pearcy *et al.* 1982; Alton 1972). Sablefish adults and juveniles occur on the continental shelf (Study Area 2 and adjacent sites; Table 3.3.3-3), but adults tend to be highest in abundance and biomass on the upper to middle slope (at depths from approximately 200 to 1,200 m; shallow parts of Study Areas 3 and 4), particularly off the Oregon coast where they accounted for approximately 75% of the total fish biomass at depths between approximately 500 to 1,000 m (Alton 1972). Their abundance is somewhat lower (10% to 25% of the total fish biomass) off California at middle slope depths (SAIC 1992b; Wakefield 1990; Butler *et al.* 1989). The commercial trawl catch of sablefish occurs in the deeper part of Study Area 2, in depths ranging between 110 and 183 m and in the shallower parts of Study Areas 3 and 4 in depths between 457 and 1,372 m and between 1,006 to 1,280 m depth, respectively (Jow 1992). SAIC (1992b) found that sablefish densities were highest at depths between 200 to 500 m. Sablefish are known to inhabit depths of up to 1,800 m (Miller and Lea 1972) and can reach lengths to one meter. Juvenile sablefish often can be found at or near the surface, while larger adults occupy deeper depths (Cailliet *et al.* 1988).

Rattails

Rattails, such as the Pacific grenadier and the giant grenadier (*Albatrossia pectoralis*), dominated the deepest sampling depths (depths greater than approximately 1,200 m) within Study Areas 3 and 4 and Study Area 5 (SAIC 1992b; Cailliet *et al.* 1992; Bence *et al.* 1992; Eschmeyer and Herald 1983). Rattails are commercially important in many parts of the world; however, these fishes have been lightly exploited along the Pacific Coast due to the difficulties of deep-water trawling in the region. (Matsui *et al.* 1990). For example, some rattails are landed in California which are caught as part of the deep-water Dover sole fishery (Oliphant *et al.* 1990). Rattails are currently fished in Alaska as an alternative fishery to the declining pollock fishery (Jacobson 1991; Matsui *et al.* 1990).

Other Species

Other fishes with commercial value (Table 3.3.3-3), including hagfish, are utilized primarily for their skin. In Study Area 3, SAIC (1992b) collected only a few black hagfish (*Eptatretus deanii*). Low abundances of hagfish collected by SAIC (1992b) is probably due to gear selectivity and avoidance of nets due to their burrowing. Additional information concerning commercially and recreationally targeted species such as tunas, mackerels, and salmon are discussed in Section 3.4.1.

3.3.4 Marine Birds

This section presents information on marine birds of the study region. Information on the distribution, abundance, and ecology of key representative species is presented in Section 3.3.4.1. A summary of the birds' usage of the LTMS study areas is presented in Section 3.3.4.2.

Marine birds are defined as those species that obtain most of their food from the ocean and are found over water for more than half of the year (Briggs *et al.* 1987b). The Gulf of the Farallones is the most important marine bird breeding area on the West Coast of the United States (Sowls *et al.* 1980). Many of the 74 species of birds recorded by Briggs *et al.* (1987b) off the California coast occur in the Gulf of the Farallones during their migration and/or breeding seasons. The Farallon Islands and vicinity are used throughout the year by some 350,000 marine birds of 122 species (Ainley and Boekelheide 1990). The islands support the world's largest breeding colonies of ashy storm-petrels (*Oceanodroma homochroa*, 85% of the world population), Brandt's cormorants (*Phalacrocorax penicillatus*, 10% of the world population), and western gulls (*Larus occidentalis*, 50% of the world population) (DeSante and Ainley 1980; Ainley and Boekelheide 1990). Additionally, an estimated one million sooty shearwaters (*Puffinus griseus*) use the Gulf of the Farallones, especially during their breeding season from March to July (DeSante and Ainley 1980; Ainley *et al.* 1987).

Studies of marine birds near the Farallon Islands have been conducted for over a century. More recent studies emphasize the biology of twelve species that nest on the Farallon Islands (Ainley and Boekelheide 1990) and the distributions of birds that forage in the Gulf of the Farallones (Briggs *et al.* 1987b). In June of 1985 through 1991, the Point Reyes Bird Observatory (PRBO) conducted surveys that covered the general study region, including LTMS Study Areas 2 through 5 (Ainley and Allen 1992). Data from these surveys provide a long-term record of the distribution of marine birds during the breeding season, although no comparable studies were conducted during other seasons. Five additional surveys were conducted by EPA (Jones and Szczepaniak 1992) during all seasons over a one year period, using methods similar to those used by PRBO. However, this study was limited in duration. Neither study provided uniform coverage of the four LTMS study areas. However, collectively they provide sufficient data to characterize the marine bird communities of the region.

Ainley and Allen (1992) list a total of 63 marine bird species which occur regularly in the study region (i.e., are present each year, either year-round or seasonally) or have special status (i.e., species that are threatened, endangered, or of special concern) (Table 3.3.4-1). Of these 63 species, 14 are breeding species, 37 are seasonal visitors, and 12 are passage migrants.

The distribution, abundance, and ecology of ten key species is described in this section as representative of the range of natural history patterns that occur within the four study areas and which potentially could be affected by dredged material disposal activities. Special status species are discussed in more detail in Section 3.3.6. Because of the importance of the Gulf of the Farallones to many marine bird species, one or more of the following criteria were used to select key species:

Table 3.3.4-1. Species and General Characteristics of Marine Birds Observed Off California in the Vicinity of the Gulf of the Farallones.

Those species having legal status including Federally Endangered (FE), Federally Threatened (FT), State Endangered (SE), State Threatened (ST), and State Species of Special Concern (SSC) are shown in bold.

Species are listed according to their occurrence within the study region, such as breeding, seasonal visitor, or passage migrant, and alphabetically by common name within these groups. Relative abundances refer to the following: Abundant = over 25,000 individuals, Common = between 1,000–25,000 individuals, Uncommon = between 100–1,000 individuals, and Rare = up to 99 individuals. Habitat areas refer to occurrences over the following water depths: shelf = < 200 m, slope = 200–1999 m, pelagic = > 1999 m.

Primary source: Ainley and Allen (1992)

Scientific Name	Common Name	Occurrence Within Study Region	Seasonal Status	Relative Abundance	Predominant Habitat
Pandion haliaetus	American Osprey	Breeding	Year-round	Uncommon	Shelf
Oceanodroma homochroa	Ashy Storm-petrel	Breeding	Year-round	Common	Pelagic
Phalacrocorax penicillatus	Brandt's Cormorant	Breeding	Year-round	Abundant	Shelf
Ptychoramphus aleuticus	Cassin's Auklet	Breeding	Year-round	Abundant	Slope
Uria aalge	Common Murre	Breeding	Year-round	Abundant	Shelf, slope
Phalacrocorax auritus	Double-crested Cormorant	Breeding	Summer	Uncommon	Shelf
Oceanodroma leucorhoa	Leach's Storm-petrel	Breeding	Summer	Uncommon	Pelagic
Brachyramphus marmoratus (FT, SE)	**Marbled Murrelet**	**Breeding**	**Year-round**	**Rare**	**Shelf**
Phalacrocorax pelagicus	Pelagic Cormorant	Breeding	Year-round	Common	Shelf
Falco peregrinus (FE, SE)	**Peregrine Falcon**	**Breeding**	**Year-round**	**Rare**	**Shelf, slope**
Cepphus columba	Pigeon Guillemot	Breeding	Summer	Common	Shelf

Table 3.3.4-1. Continued.

Scientific Name	Common Name	Occurrence Within Study Region	Seasonal Status	Relative Abundance	Predominant Habitat
Cerorhinca monocerata	Rhinoceros Auklet	Breeding	Year-round	Abundant	Shelf, slope, pelagic
Fratercula cirrhata	Tufted Puffin	Breeding	Year-round	Uncommon	Slope
Larus occidentalis	Western Gull	Breeding	Year-round	Abundant	Shelf, slope
Synthliboramphus antiquus	Ancient Murrelet	Seasonal Visitor	Winter	Uncommon	Shelf
Melanitta nigra	Black Scoter	Seasonal Visitor	Winter	Uncommon	Shelf
Oceanodroma melania	Black Storm-petrel	Seasonal Visitor	Winter	Irregular (numerous at sporadic intervals)	Pelagic
Diomedea nigripes	Black-footed Albatross	Seasonal Visitor	Summer	Common	Slope, pelagic
Rissa tridactyla	Black-legged Kittiwake	Seasonal Visitor	Winter	Common	Slope, pelagic
Puffinus opisthomelas	Black-vented Shearwater	Seasonal Visitor	Winter	Irregular (numerous at sporadic intervals)	Shelf, slope
Pelecanus occidentalis (FE, SE)	**Brown Pelican**	**Seasonal Visitor**	**Winter**	**Common**	**Shelf**
Larus californicus	California Gull	Seasonal Visitor	Winter	Abundant	Shelf, slope
Sterna caspia	Caspian Tern	Seasonal Visitor	Winter	Uncommon	Shelf
Gavia immer	Common Loon	Seasonal Visitor	Winter	Uncommon	Shelf
Pterodroma cookii	Cook's Petrel	Seasonal Visitor	Summer	Uncommon	Pelagic

Table 3.3.4-1. Continued.

Scientific Name	Common Name	Occurrence Within Study Region	Seasonal Status	Relative Abundance	Predominant Habitat
Podiceps nigricollis	Eared Grebe	Seasonal Visitor	Winter	Uncommon	Shelf
Sterna elegans	Elegant Tern	Seasonal Visitor	Winter	Common	Shelf
Oceanodroma furcata	Fork-tailed Storm-petrel	Seasonal Visitor	Winter	Irregular (numerous at sporadic intervals)	Pelagic
Sterna forsteri	Forster's Tern	Seasonal Visitor	Year-round	Common	Shelf
Larus glaucescens	Glaucous-winged Gull	Seasonal Visitor	Winter	Common	Shelf, slope
L. heermanni	Heermann's Gull	Seasonal Visitor	Winter	Common	Shelf
L. argentatus	Herring Gull	Seasonal Visitor	Winter	Common	Slope, pelagic
Fratercula corniculata	Horned Puffin	Seasonal Visitor	Summer	Uncommon	Slope, pelagic
Podiceps auritus	Horned Grebe	Seasonal Visitor	Winter	Uncommon	Shelf
Diomedea immutabilis	Laysan Albatross	Seasonal Visitor	Winter	Uncommon	Slope, pelagic
Larus canus	Mew Gull	Seasonal Visitor	Winter	Uncommon	Shelf
Pterodroma ultima	Murphy's Petrel	Seasonal Visitor	Summer	Uncommon	Pelagic
Fulmarus glacialis	Northern Fulmar	Seasonal Visitor	Winter	Abundant	Slope, pelagic
Stercorarius parasiticus	Parasitic Jaeger	Seasonal Visitor	Winter	Uncommon	Shelf, slope, pelagic
Puffinus creatopus	Pink-footed Shearwater	Seasonal Visitor	Summer	Common	Shelf, slope

Table 3.3.4-1. Continued.

Scientific Name	Common Name	Occurrence Within Study Region	Seasonal Status	Relative Abundance	Predominant Habitat
Stercorarius pomarinus	Pomarine Jaeger	Seasonal Visitor	Winter	Uncommon	Shelf, slope, pelagic
Mergus serrator	Red-breasted Merganser	Seasonal Visitor	Winter	Uncommon	Shelf
Gavia stellata	Red-throated Loon	Seasonal Visitor	Winter	Uncommon	Shelf
Larus delawarensis	Ring-billed Gull	Seasonal Visitor	Winter	Common	Shelf
Diomedea albatrus (FE)	**Short-tailed Albatross**	**Seasonal Visitor**	**Winter**	**Rare**	**Shelf, slope**
Puffinus tenuirostris	Short-tailed Shearwater	Seasonal Visitor	Winter	Uncommon	Shelf, slope
P. griseus	Sooty Shearwater	Seasonal Visitor	Summer	Abundant	Shelf, slope
Catharacta mccormicki	South Polar Skua	Seasonal Visitor	Summer	Rare	Shelf, slope, pelagic
Larus thayeri	Thayer's Gull	Seasonal Visitor	Winter	Uncommon	Slope, pelagic
Aechmophorus occidentalis	Western Grebe	Seasonal Visitor	Winter	Abundant	Shelf
Endomychura hypoleuca (SSC)	**Xantus' Murrelet**	**Seasonal Visitor**	**Winter**	**Rare**	**Slope, pelagic**
Gavia pacifica	Arctic (Pacific) Loon	Passage Migrant	Winter	Abundant	Shelf, slope
Sterna paradisaea	Arctic Tern	Passage Migrant	Winter	Common	Slope, pelagic
Branta bernicla	Black Brant	Passage Migrant	Winter	Abundant	Shelf
Larus philadelphia	Bonaparte's Gull	Passage Migrant	Winter	Abundant	Shelf
Puffinus bulleri	Buller's Shearwater	Passage Migrant	Winter	Common	Slope, pelagic

Table 3.3.4-1. Continued.

Scientific Name	Common Name	Occurrence Within Study Region	Seasonal Status	Relative Abundance	Predominant Habitat
Sterna hirundo	Common Tern	Passage Migrant	Winter	Uncommon	Shelf, slope
Stercorarius longicaudus	Long-tailed Jaeger	Passage Migrant	Winter	Rare	Slope, pelagic
Phalaropus fulicarius	Red Phalarope	Passage Migrant	Winter	Abundant	Shelf, slope, pelagic
P. lobatus	Red-necked Phalarope	Passage Migrant	Winter	Abundant	Shelf
Xema sabini	Sabine's Gull	Passage Migrant	Winter	Uncommon	Pelagic
Melanitta perspicillata	Surf Scoter	Passage Migrant	Winter	Abundant	Shelf
M. fusca	White-winged Scoter	Passage Migrant	Winter	Abundant	Shelf

- Species that breed in the area, or which occur year-round, or are common to abundant within the study region;

- Species having a narrow geographical range with population centers located in the Gulf of the Farallones; and

- Species which forage in shelf, slope, or pelagic areas similar to those of the LTMS study areas.

Based on these criteria, the following ten species were selected: ashy storm-petrel, Brandt's cormorant, western gull, common murre (*Uria aalge*), pigeon guillemot (*Cepphus columba*), sooty shearwater, Cassin's auklet (*Ptychoramphus aleuticus*), rhinoceros auklet (*Cerorhinca monocerata*), pink-footed shearwater (*Puffinus creatopus*), and tufted puffin (*Fratercula cirrhata*) (Table 3.3.4-2). With the exception of the sooty and pink-footed shearwaters, which occur in high abundances within the LTMS study areas during the summer (Briggs *et al.* 1987b; Jones and Szczepaniak 1992), all of these species breed within the Gulf of the Farallones. Other marine bird species recorded in the Gulf of the Farallones, including seasonal visitors and passage migrants, are listed with their estimated densities in Jones and Szczepaniak (1992) and Ainley and Allen (1992).

Density estimates of all marine bird species surveyed during June are presented for the years 1986, 1987, and 1991 (Figures 3.3.4-1 through 3.3.4-3) (Ainley and Allen 1992). These years represent a broad range in different foraging conditions, based on pelagic juvenile rockfish abundance, from poor (1986) to good (1987) to intermediate (1991) rockfish years. Ainley and Boekelheide (1990) concluded that the feeding range of pigeon guillemots, Cassin's and rhinocerus auklets, tufted puffins, sooty shearwaters, and many other resident species primarily is a response to food availability as opposed to nesting activities. Further, at least in the summertime, the natural history of breeding marine birds of the Gulf of the Farallones, including visitors such as the sooty shearwater, is based on a "juvenile rockfish economy." When juvenile rockfish are available, foraging habits, behaviors, and diets of many species overlap extensively. The dominant juvenile rockfishes used as prey are yellowtail rockfish (*Sebastes flavidus*) and shortbelly rockfish (*S. jordani*). When rockfish are unavailable or in lower abundance (e.g., during warm-water years), they are replaced in the diet of many species by anchovies and a variety of other prey including cephalopods and zooplankton. Additional prey species include hake, smelt, and squid, all of which are considered either midwater-schooling species or species that avoid the surface. The distribution, abundance, and size classes of many fish species, including shortbelly rockfish, within the LTMS study areas are presented in Section 3.3.3. Figure 3.3.4-1 indicates that during a poor rockfish year (e.g., 1986) marine bird densities are spread relatively evenly throughout the Gulf of the Farallones. During a good rockfish year (e.g., 1987) densities are concentrated around breeding sites, such as the Farallon Islands (Figure 3.3.4-2). Marine bird densities for an intermediate rockfish year (1991) are more scattered over the region, with highest densities occurring within the GOFNMS (Figure 3.3.4-3).

Table 3.3.4-2. Relative Densities of the Ten Key Marine Bird Species Within the Four LTMS Study Areas.

Data from A (Ainley and Boekelheide 1990); B (Ainley and Allen 1992); and C (Jones and Szczepaniak 1992).

	Study Area 2			Study Area 3			Study Area 4			Study Area 5		
	A	B	C	A	B	C	A	B	C	A	B	C
Ashy storm-petrel	N	N	N	L to H	L	L	•	L	N	M	L	N
Brandt's cormorant	N	L	N	N	N	N	•	N	N	N	N	N
Western gull	L	M	L to M	L	L	L	•	N	L	L	L	L to M
Common murre	L to M	L	L	L to M	L	N	•	N	N	M to H	M	N
Pigeon guillemot	N	N	N	N	L	N	•	N	N	N	N	N
Sooty shearwater	L to H	L to H	L	L to H	L	L to H	•	L	L	M to H	M	L
Cassin's auklet	L	M	L	L to H	L	L	•	L	L	L to H	M	L
Rhinocerus auklet	H	M	M	H	L	L	•	L	L	L to M	L to M	L
Pink-footed shearwater	•	L to H	N	•	L	M	•	N	L	•	N	L
Tufted puffin	N	L	N	N	N	N	•	N	N	L	N	N

N = No birds observed
L = Low density
M = Moderate density
H = High density
• = No data collected

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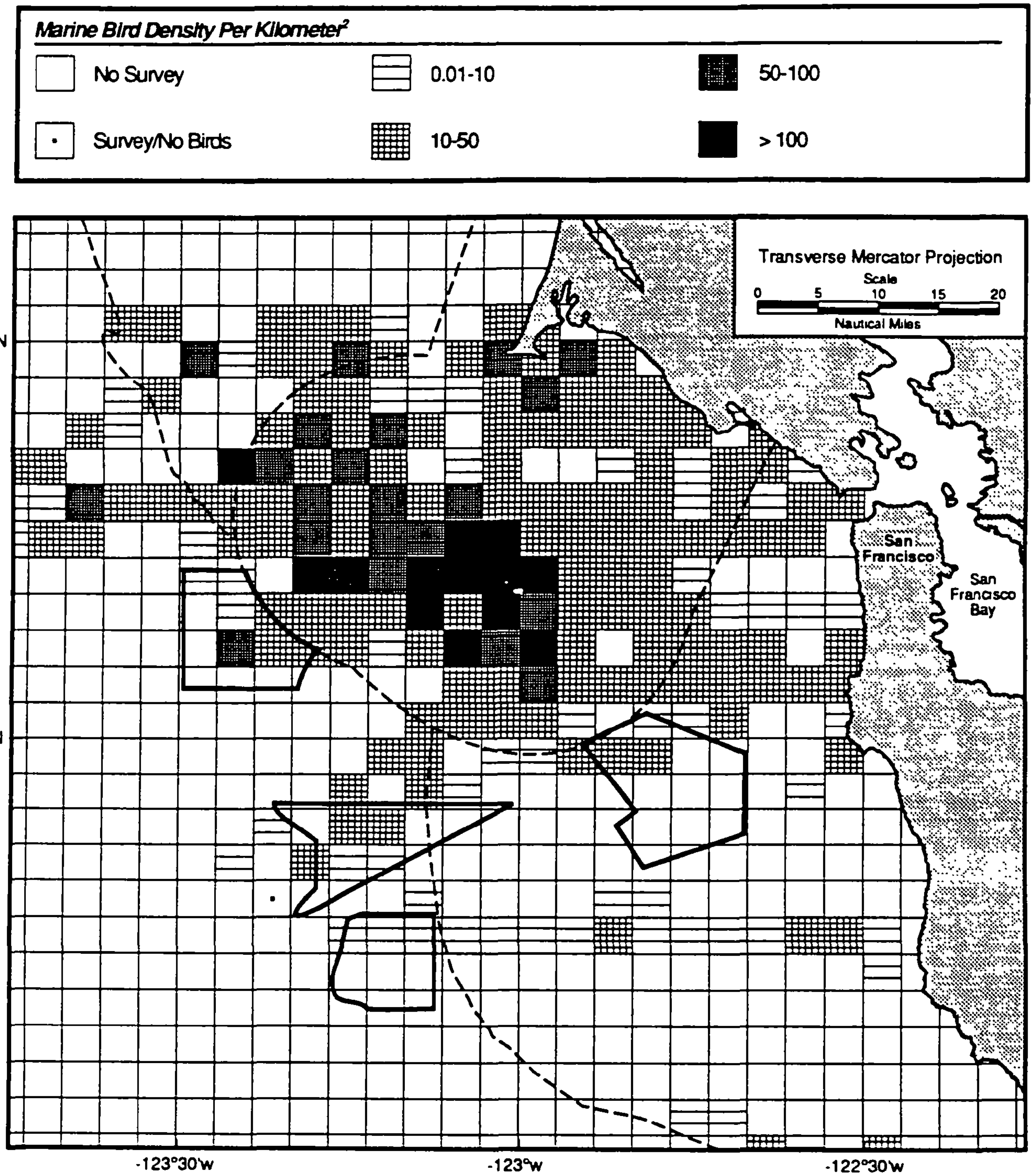

Figure 3.3.4-1. **Density Estimates for All Marine Bird Species During June 1986, a Poor Rockfish Year.**
Source: Ainley and Allen (1992).

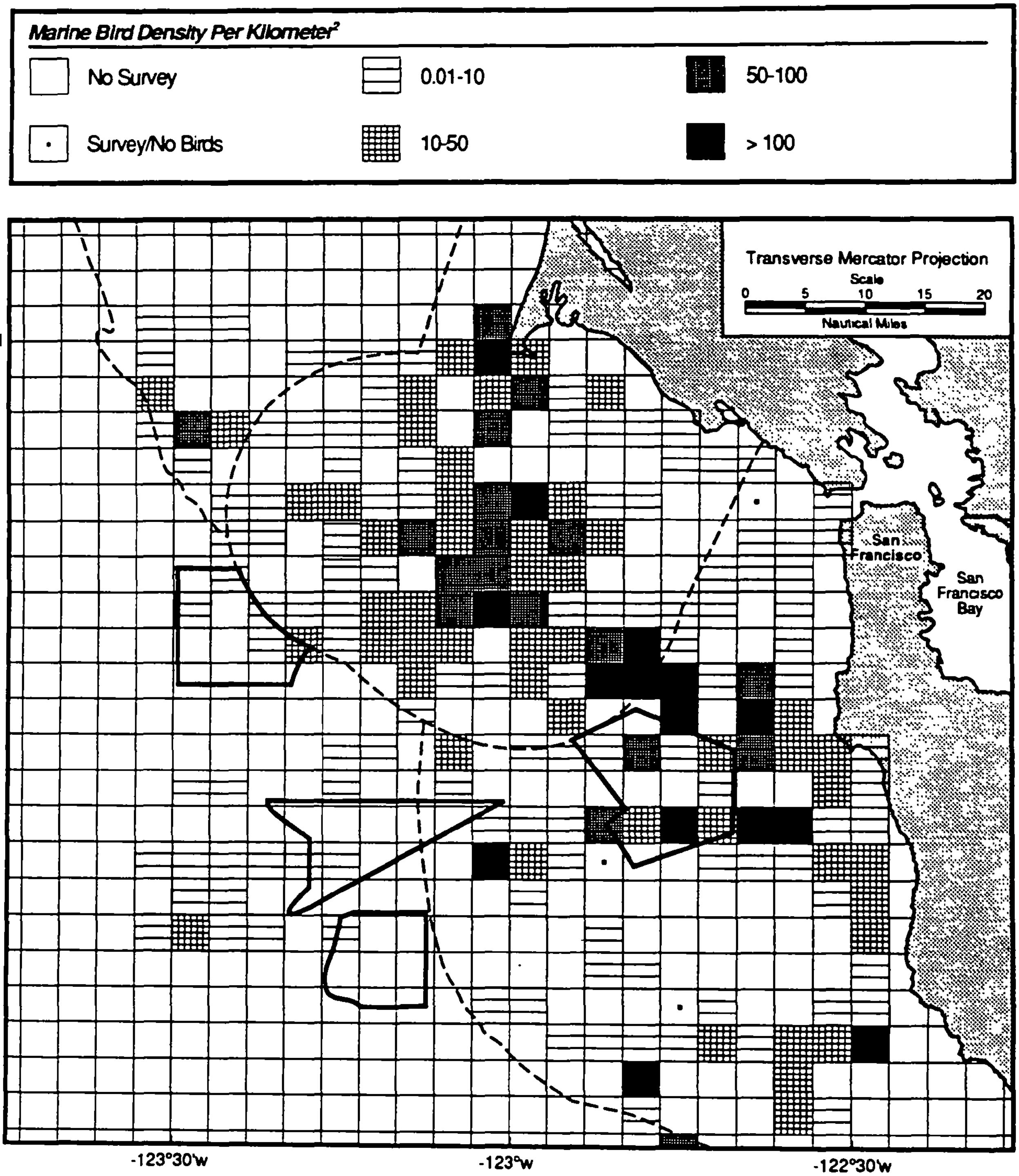

Figure 3.3.4-2. **Density Estimates for All Marine Bird Species During June 1987, a Good Rockfish Year.**
Source: Ainley and Allen (1992).

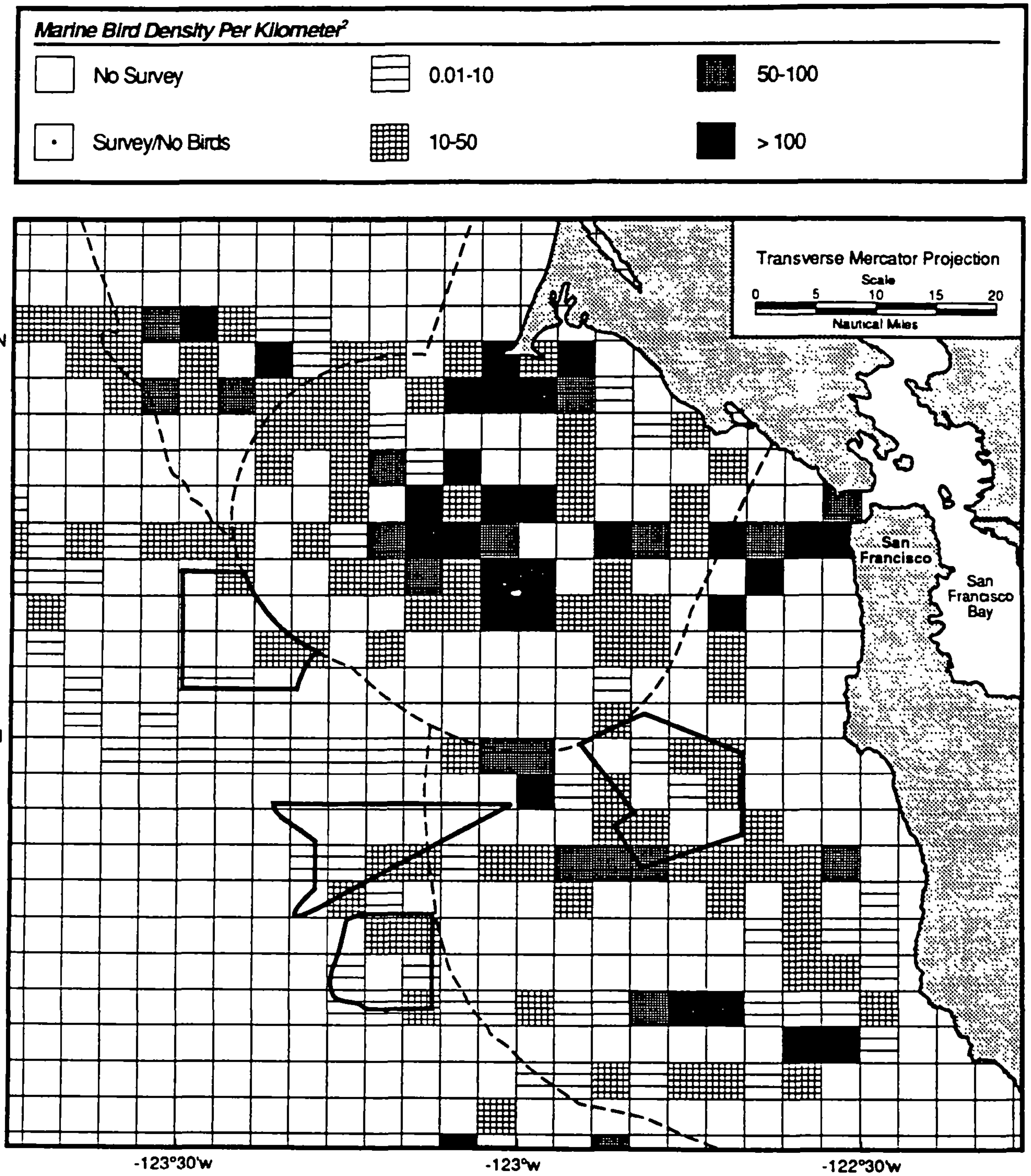

Figure 3.3.4-3. Density Estimates for All Marine Bird Species During June 1991, an Intermediate Rockfish Year.
Source: Ainley and Allen (1992).

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Estimated densities of the ten marine bird species were relatively greatest in LTMS Study Areas 2 and 5 (Ainley and Boekelheide 1990; Ainley and Allen 1992; Jones and Szczepaniak 1992). Tufted puffins were observed too rarely to derive density estimates for the three representative years; the only sighting of this species within a study area during the 1985–1991 surveys was recorded in 1985 within Study Area 2. The following sections provide detailed discussion of distributions, densities, and ecology of the ten representative species.

3.3.4.1 Distribution, Abundance, and Ecology of Representative Breeding Species

Ashy Storm-Petrel

Ashy storm-petrels are year-round residents that breed in the Gulf of the Farallones (Table 3.3.4-1). Eighty-five percent of the world population of ashy-storm petrels breed and reside there (Ainley and Allen 1992). They typically feed over pelagic waters at least 25 km from the Farallon Islands, but they also may feed over waters near the shelf break (~ 200 m bottom depth) where upwelling events are more frequent (Ainley and Boekelheide 1990). However, they often occur over mid-slope waters (Jones and Szczepaniak 1992), and are presumed to eat fish and crustaceans (Briggs *et al.* 1987a). A comparison of density estimates for this species within the Gulf of the Farallones indicates that of the four LTMS study areas, Study Areas 3 and 5 contain greatest abundances of ashy storm-petrels (Table 3.3.4-2).

Brandt's Cormorant

The Brandt's cormorant population in the Gulf of the Farallones represents approximately ten percent of the world population of this species (Ainley and Allen 1992). This species also is a breeding resident of the Gulf of the Farallones. Brandt's cormorants feed in San Francisco Bay in early spring, up to 80 km from nesting sites on the Farallon Islands. However, they may shift later in the season to feed near the Islands or in coastal waters (Ainley and Boekelheide 1990). Estimated densities of this species within the LTMS study areas are low (Table 3.3.4-2), probably due to their preferred feeding habitat in shallow waters over flat sand or mud. Populations of greater than 100 individuals/km^2 can be found in the immediate vicinity of the Farallon Islands (Ainley and Allen 1992). Brandt's cormorants often occur over shelf and upper slope waters where water depths range from a few hundred to 1,000 m (Jones and Szczepaniak 1992). Nearshore feeding areas range from 10–60 m in depth over flat sand or mud substrate to offshore rocky bottom sites up to 120 m. Their prey items include demersal fish species such as rockfish (*Sebastes flavidus* and *S. jordani*), flatfishes, tomcod (*Microgradus proximus*), midshipman (*Porichthys notatus*), and cusk eels (*Chilara taylori*) (Ainley and Boekelheide 1990).

Western Gull

Western gull populations are widespread throughout the study region and utilize the Gulf of the Farallones as an important breeding area (Ainley and Boekelheide 1990). Approximately 50 percent of the world population of this species nests in the Gulf of the Farallones (Ainley and Boekelheide 1990). Historic studies reported low densities in the vicinity of Study Areas 2, 3, and 5; no observations were made in Study Area 4 (Ainley and Boekelheide 1990). Recent censuses of all of the study areas recorded the highest densities in Study Areas 2 and 5 (Ainley and Allen 1992; Jones and Szczepaniak 1992). This probably is due to the relative proximity of these two study areas to nesting sites on the Farallon Islands in comparison to Study Areas 3 and 4. Jones and Szczepaniak (1992) observed the highest species densities near Southeast Farallon Island; low to moderate densities were observed in or near Study Areas 2, 3, 4, and 5. Western gulls have a wide diet which includes fish, predominantly juvenile rockfish (Ainley *et al.* 1987), but they also consume marine invertebrates. To a lesser extent, marine bird eggs and young, seal placenta, and other organic materials are scavenged by these gulls.

Common Murre

The common murre, a resident breeding species, occurs primarily over the continental shelf (Jones and Szczepaniak 1992; Ainley and Allen 1992). Breeding populations show considerable fluctuations, ranging from approximately 400,000 individuals in 1850 to a few hundred individuals in the early 1900s. The 1986 breeding population consisted of approximately 39,000 birds (Ainley and Boekelheide 1990). Observations of this species during the breeding seasons of 1986, 1987, and 1991, consistently indicated low densities (0.01–10 individuals/km^2) within Study Area 2 (Ainley and Allen 1992). Common murres also were observed at low densities (0.01-10 individuals/km^2) within Study Area 3 in 1986 (a poor rockfish year) and at moderate densities (10–50 individuals/km^2) during the same year within Study Area 5. This species was not observed within Study Area 4 during the three survey years. Similar densities (low to moderate in the region of Study Areas 2 and 3 and moderate to high in Study Area 5) were observed by Ainley and Boekelheide (1990). Seasonal surveys (Jones and Szczepaniak 1992) indicated that low densities of this species were observed over Study Area 2; no common murres were observed in any of the other LTMS study areas. Common murres exhibit great variation in feeding habitats. In early spring, they occur over the outer continental shelf. In the spring and summer of cool-water (i.e., good rockfish years), their feeding range is somewhat constricted to shallower water closer to the Farallon Islands. At that time, murres feed heavily on rockfish, northern anchovy (*Engraulis mordax*), market squid (*Loligo opalescens*), and euphausiids. In warmer years, they occur farther from the Farallon Islands, especially over the shelf towards the mainland, where they feed heavily on anchovies, and secondarily over slope waters (e.g., Study Area 5). By July, they begin to move toward the coast. However, when juvenile rockfish are abundant, they remain offshore longer (Ainley and Boekelheide 1990).

Pigeon Guillemot

The pigeon guillemot is a common (estimated population of 1,000 to 25,000 individuals) summer-breeding species within the Gulf of the Farallones (Ainley and Allen 1992). The majority of the resident population appears to occur around the Farallon Islands and in areas to the north. This species forages in relatively shallow waters over rocky substrate, and rarely feeds in waters farther than 15 km from the Farallon Islands (Ainley and Boekelheide 1990). Recent surveys conducted by the PRBO during the spring of 1986, 1987, and 1991 indicated that no pigeon guillemots were observed within Study Areas 2, 4, or 5; however, low densities occurred in Study Area 3 in June 1991 (Ainley and Allen 1992). EPA surveys (1992) recorded sightings in February, May, and August of 1991, although no sightings were made within any of the LTMS study areas and actual counts or densities were not reported.

Sooty Shearwater

Sooty shearwaters typically are non-breeding, summer visitors to the study region, and occur throughout the shelf and slope waters of the Gulf of the Farallones (Table 3.3.4-1). An estimated one million sooty shearwaters are present between May and August of cool-water (high productivity) years (KLI 1991). Of the four LTMS study areas, Study Area 2 supported the highest densities of sooty shearwaters, especially during 1987, a good rockfish year (Ainley and Allen 1992). However, in May 1991, high densities of sooty shearwaters were reported in the vicinity of Pioneer Canyon (between Study Areas 3 and 4) (Jones and Szczepaniak 1992). Surveys conducted by Ainley and Boekelheide (1990) recorded low to high densities of sooty shearwaters in Study Areas 2 and 3, and moderate to high densities in the region of Study Area 5. Sooty shearwaters are pursuit divers, preying on anchovies, market squid, euphausiids, and juvenile rockfish.

Cassin's Auklet

Cassin's auklets are year-round, breeding residents of the Gulf of the Farallones, typically foraging over slope waters (Table 3.3.4-1). They are the most abundant marine bird on the Farallon Islands (Sowls *et al.* 1980), and are distributed widely throughout the study region. Cassin's auklets occurred at low densities (0.01–10 individuals/km^2) in Study Area 3 and moderate densities (10–50 individuals/km^2) in Study Areas 2 and 5 (Ainley and Allen 1992). No birds were observed in Study Area 4 during the three survey years, except in 1991, when low densities (0.01–10 individuals/km^2) were recorded (Ainley and Allen 1992). Surveys conducted by EPA (Jones and Szczepaniak 1992) indicated an absence or low densities of 0.01–10 individuals/km^2 within all study areas. Ainley and Boekelheide (1990) reported that Cassin's auklets occurred in low densities near Study Area 2, and from low to high densities in the region of Study Areas 3 and 5. No surveys were conducted in Study Area 4. Cassin's auklets can dive to depths of 35 m for their prey. Ninety percent of their diet is composed of euphausiids (*Thysanoessa* sp. and *Euphausia* sp.) and larval fish.

Rhinoceros Auklet

Rhinoceros auklets also are year-round, breeding residents of the Gulf of the Farallones and are found over shelf, slope, and pelagic waters. The highest overall species densities (10–50 individuals/km^2) occurred within Study Area 2 (Ainley and Allen 1992; Jones and Szczepaniak 1992) although similar densities were recorded for Study Area 5 during 1987 (Ainley and Allen 1992). Rhinoceros auklets occurred at relatively low densities over Study Areas 3 and 4. Ainley and Boekelheide (1990) reported similar results, except for Study Area 3: rhinoceros auklets were observed in relatively high densities in Study Areas 2 and 3, and low to moderate densities in Study Area 5. Rhinoceros auklets are pursuit divers (KLI 1991) that feed primarily on fish (Briggs *et al.* 1987b).

Pink-footed Shearwater

Pink-footed shearwaters are non-breeding, summer visitors to the region, occurring over shelf and slope waters (Table 3.3.4-1). PRBO surveys indicated a relatively low occurrence of this species in all of the study areas, except for Study Area 2 where high densities of over 100 individuals/km^2 were recorded in 1987 (Ainley and Allen 1992). Similarly, EPA surveys conducted during August 1990 recorded low densities (0.01–10 individuals/km^2) within LTMS Study Areas 4 and 5. However, no sightings of pink-footed shearwaters were made within Study Area 2 and moderate densities (10–50 individuals/km^2) were observed over Study Area 3 (Jones and Szczepaniak 1992).

Tufted Puffin

Tufted puffins are breeding residents of the Gulf of the Farallones; less than 50 breeding pairs occur on the Farallones (Table 3.3.4-1). Breeding season censuses conducted from 1985 through 1991 indicated that tufted puffins rarely occurred within any of the study areas (Ainley and Allen 1992). Only a single individual was recorded within Study Area 2 (Figure 3.3.4-4); no tufted puffins were observed within any of the other study areas during the seven survey years. These surveys also indicated that the majority of tufted puffins occurred to the north and west of the Farallon Islands, close to the eastern boundary of Study Area 5 (Figure 3.3.4-4). Although Jones and Szczepaniak (1992) recorded sightings of tufted puffins during four of five surveys, counts were determined to be too low for inclusion in species density estimates. Ainley and Boekelheide (1990) recorded low densities of tufted puffins in Study Area 5. Tufted puffins forage in deeper waters of the continental shelf (Ainley and Boekelheide 1990). Juvenile blackcod (sablefish) are an important prey item (Ainley and Allen 1992).

Brown Pelican

In addition to the ten representative breeding species considered, one migratory species, the brown pelican (*Pelecanus occidentalis*), occurs in significant numbers within the region and is listed by both State and Federal agencies as endangered. The nesting range for brown pelicans extends from the Santa Barbara Channel to Mexico. Two major roosting sites are Año Nuevo Island and Southeast Farallon Island (Briggs *et al.* 1983). Daytime surveys of these areas recorded 500 animals, whereas nocturnal censuses recorded several thousand individuals (Briggs *et al.* 1983). Surveys conducted from 1985–1991 indicated that California brown pelican populations were centered along the coastline and over shelf waters including Study Area 2 (Figure 3.3.4-5) (Ainley and Allen 1992). EPA surveys (Jones and Szczepaniak 1992) also recorded the highest numbers of brown pelicans over the continental shelf, particularly near the periphery of Study Area 2. Brown pelicans typically forage in shallow waters, and feed primarily on the northern anchovy (*Engraulis mordax*) (Anderson *et al.* 1980; Anderson *et al.* 1982), but

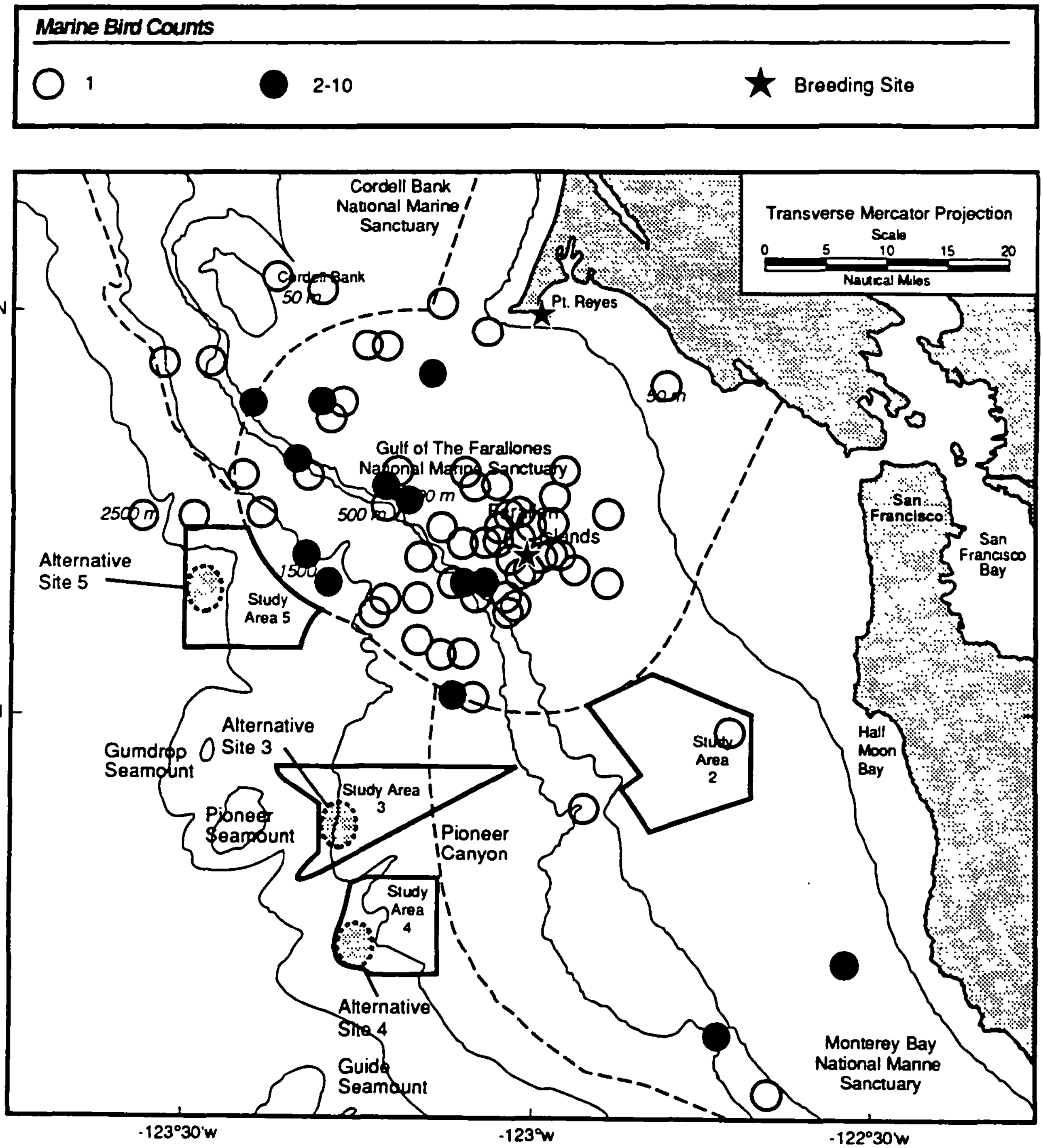

Figure 3.3.4-4. Tufted Puffin Counts in the Gulf of the Farallones Region, 1985–1991.
Source: Ainley and Allen 1992.

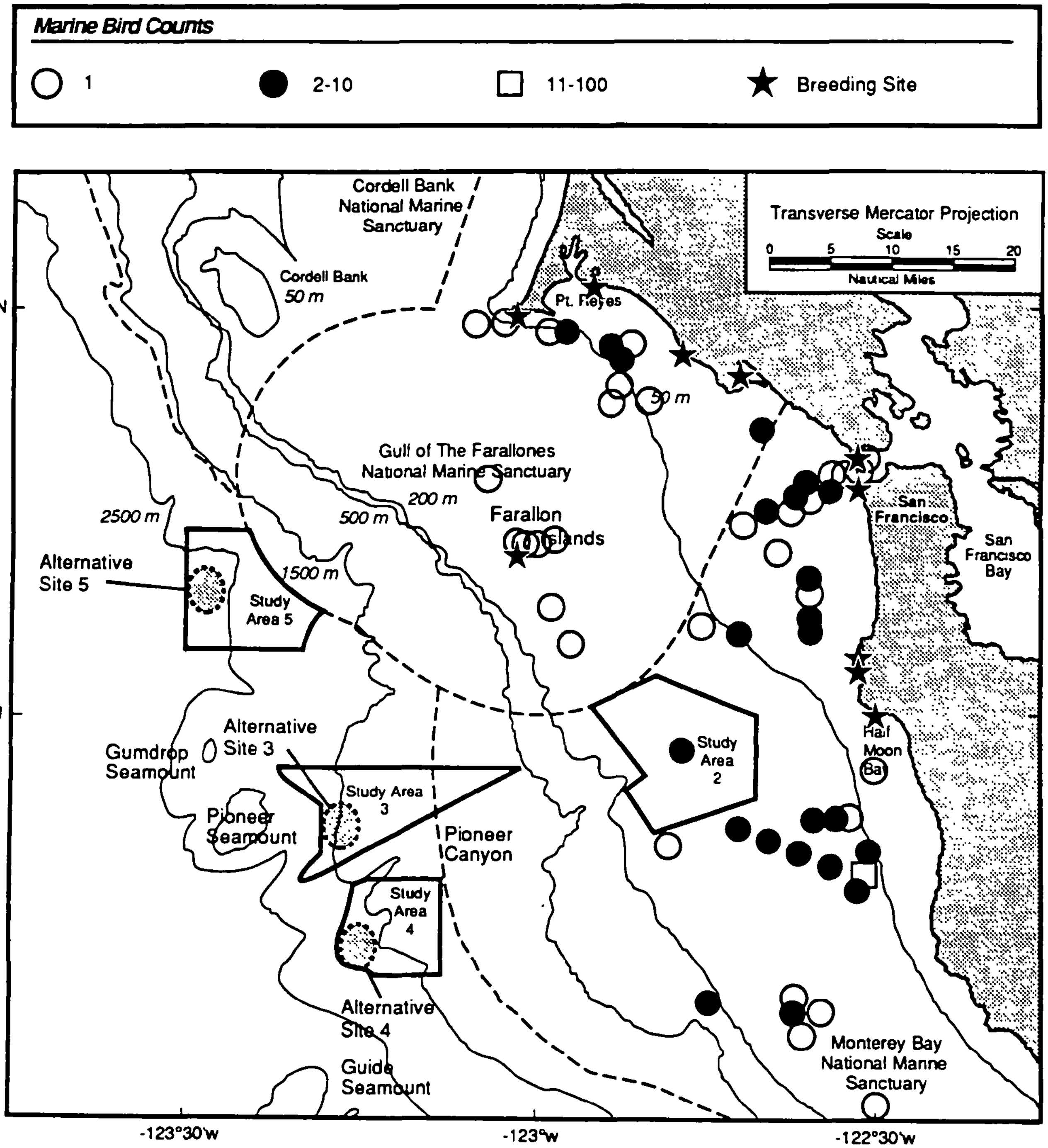

Figure 3.3.4-5. **California Brown Pelican Counts in the Gulf of the Farallones Region, 1985–1991.**
Source: Ainley and Allen 1992.

they can be found during calm weather in waters over the continental slope (Briggs *et al.* 1983; Jones and Szczepaniak 1992).

3.3.4.2 Summary of Study Area Usage by Marine Bird Species

In general, assessments of densities of the ten representative species indicate that of the four areas, Study Areas 2 and 5 support the largest number of marine birds (Table 3.3.4-2). Study Area 2 is the only site located over shelf waters; these waters represent a more productive area for foraging marine birds (Ainley and Allen 1992; Jones and Szczepaniak 1992). Of the remaining three study areas, Study Area 5 is located closest to nesting sites of breeding species on the Farallon Islands, and thus is likely to be a more convenient feeding ground for breeding individuals. Ainley and Allen (1992) suggested that due to limited prey availability and prevailing northerly winds, marine birds forage less often to the south than to the north, west, or east of the Farallon Islands. An upwind return flight for an adult bird with prey is estimated to be relatively more difficult energetically. Thus, during the May/June breeding season, regions south of the Farallon Islands (such as Study Areas 3 and 4) may be less preferred as feeding grounds due to relatively lower prey availability (as compared to shelf waters) and the higher energy expenditure required to return to upwind nesting sites rather than downwind sites (e.g., Study Area 5) (Ainley and Allen 1992). Density estimates of all marine birds during poor, good and intermediate rockfish years (Figures 3.3.4-1 through 3.3.4-3, respectively) also indicate that the greatest abundances of marine birds are found within Study Areas 2 and 5 (Ainley and Allen 1992).

Based on known habitats from the literature, the total number of bird species potentially utilizing the different study areas decreases as the distance from shore increases (Briggs *et al.* 1987b). This trend is consistent for breeding species, seasonal visitors, and passage migrants and tends to indicate that offshore areas such as LTMS Study Area 5 should have low utilization as bird habitats. Although Study Area 5 is far from shore, it lies in close proximity to a land source: the Farallon Islands. The relatively close distance between Study Area 5 and the Farallon Islands may explain the higher use of this area by marine birds. Thus, based on actual surveys (Ainley and Boekelheide 1990, Ainley and Allen 1992, Jones and Szczepaniak 1992), LTMS Study Areas 2, 3, and 5 show the highest utilization by species which breed in the Gulf of the Farallones, are common residents, are geographically limited, and/or have legal status.

3.3.5 Marine Mammals

This section presents information on marine mammals of the study region including cetaceans (Section 3.3.5.1), pinnipeds (Section 3.3.5.2), and fissipeds (Section 3.3.5.3).

Twenty-one species of cetaceans (dolphins, porpoises, and whales), six species of pinnipeds (sea lions and seals), and one species of fissiped (sea otter) comprise the marine mammal fauna of central California (KLI 1991). Twenty-six of these species (twenty cetaceans, five pinnipeds, and the fissiped) are frequently observed in the Gulf of the Farallones region (Table 3.3.5-1). All marine mammals are protected by the Marine Mammal Protection Act (MMPA 1972, amended

Table 3.3.5-1. **Marine Mammals Observed in the Vicinity of the Gulf of the Farallones.**

Those species having legal status including Federally Endangered (FE), Federally Threatened (FT), and Federal Species of Special Concern (SSC) are shown in bold. Species are listed according to their occurrence within the study region, such as breeding (breed in area), seasonal visitor (seasonal residents, feed in area), migrant (migrate through area but may feed as moving through area), or incidental. Relative occurrences refer to the following: Abundant = over 5,000 individuals, Common = between 1,000-5,000 individuals, Uncommon = between 100-1,000 individuals, and Rare = less than 100 individuals. Habitat areas refer to occurrences over the following water depths: shelf = < 200 m, slope = 200-1999 m, pelagic = > 1999 m. Species are listed according to their activity within the study region, such as breeding, seasonal visitor, or migrant.

Primary source: Ainley and Allen (1992)

Scientific Name	Common Name	Activity Within Study Region	Seasonal Status	Relative Occurrence	Predominant Habitat
Cetaceans					
(Approximately 4 spp.)	Beaked Whale	?	Year-round	Rare	Pelagic
***Balaenoptera musculus* (FE)**	**Blue Whale**	**Seasonal Visitor**	**Summer**	**Uncommon**	**Shelf, slope**
Delphinus delphis	Common Dolphin	Seasonal Visitor	Summer	Rare	Shelf
Phocoenoides dalli	Dall's Porpoise	Breeding	Year-round	Abundant	Shelf, slope
***Balaenoptera physalus* (FE)**	**Finback Whale**	**Migrant**	**Summer**	**Rare**	**Shelf, slope, pelagic**
Eschrichtius robustus	Gray Whale	Seasonal Visitor/ Migrant	Year-round	Common	Shelf, slope
Phocoena phocoena	Harbor Porpoise	Breeding	Year-round	Common	Shelf
***Megaptera novaeangliae* (FE)**	**Humpback Whale**	**Seasonal Visitor**	**Summer**	**Common**	**Shelf, slope**
Orcinus orca	Killer Whale	?	Year-round	Uncommon	Shelf, slope
Balaenoptera acutorostrata	Minke Whale	Seasonal Visitor	Summer	Common	Shelf, slope

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Table 3.3.5-1. Continued.

Scientific Name	Common Name	Activity Within Study Region	Seasonal Status	Relative Occurrence	Predominant Habitat
Lissodelphis borealis	Northern Right Whale Dolphin	Breeding	Year-round	Common	Shelf, slope
Lagenorynchus obliquidens	Pacific White-sided Dolphin	Breeding	Year-round	Abundant	Slope, pelagic
Globicephala spp.	Pilot Whale	Migrant	Winter	Uncommon	Slope, pelagic
Eubalaena glacialis **(FE)**	**Right Whale**	**Incidental**	**?**	**Rare**	**?**
Grampus griseus	Risso's Dolpin	Seasonal Visitor	Year-round	Abundant	Shelf, slope
Balaenoptera borealis **(FE)**	**Sei Whale**	**Incidental**	**Summer**	**Rare**	**Pelagic**
Physeter macrocephalus (FE)	**Sperm Whale**	**Incidental**	**Year-round**	**Common**	**Slope, pelagic**
Pinnipeds					
Zalophus californianus	California Sea Lion	Seasonal Visitor	Year-round	Abundant	Shelf
Phoca vitulina	Harbor Seal	Breeding	Year-round	Common	Shelf
Mirounga angustirostris	Northern Elephant Seal	Breeding/Seasonal Visitor	Year-round	Common	Shelf, slope, pelagic
Callorhinus ursinus **(SSC)**	**Northern Fur Seal**	**Seasonal Visitor**	**Year-round**	**Abundant**	**Slope, pelagic**
Eumetoplas jubatus **(FT)**	**Northern Sea Lion**	**Breeding**	**Year-round**	**Uncommon**	**Shelf**
Fissipeds					
Enhydra lutris **(FT)**	**Southern Sea Otter**	**Seasonal Visitor**	**Year-round**	**Common**	**Shelf**

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1988), administered by NOAA/NMFS and the United States Fish and Wildlife Service (USFWS). In addition, humpback, blue, finback, sei, right, and sperm whales are Federally listed as endangered species and thereby protected by the Endangered Species Act (ESA 1973, amended 1978). Gray whales have recently been de-listed from Federally endangered status due to increased population numbers (Marine Mammal Commission 1993). The northern sea lion and the sea otter are designated as threatened species under Federal law and fully protected under California law. Northern fur seals are designated as a depleted species by the Marine Mammal Commission and have special status under the MMPA. Because marine mammals are protected, evaluation of the study areas for this EIS includes consideration of the extent to which the areas are used by marine mammals for breeding, weaning, feeding, or migration. Seasonal patterns of distribution in the LTMS study areas may suggest alternative disposal strategies that would minimize impacts to these species.

Broad-scale surveys of marine mammals off central and northern California, including the Gulf of the Farallones and the Farallon Islands, were conducted by Dohl *et al.* (1983) and Bonnell *et al.* (1983). Dohl *et al.* focused on the seasonal occurrence of cetaceans while Bonnell *et al.* studied pinnipeds and sea otters during a three-year (1980–1983) research program. Both of these historical studies provide seasonal estimates of the relative abundance of marine mammals for waters encompassing each of the study areas. In addition, a three-year (1986–88) photo-identification study on humpback and blue whales within and near the Gulf of the Farallones provides information on movements and site fidelity for these two endangered whale species common to the region (Calambokidis *et al.* 1990a,b). More recent marine mammal surveys by PRBO (Ainley and Allen 1992) and EPA (Jones and Szczepaniak 1992) have focused on the LTMS study region. The Ainley and Allen (1992) surveys provide information on study area use by marine mammals; this information was collected during seven cruises conducted each June from 1985–91. Thus, seasonal events within the study region, such as the spring and fall migrations of gray whales and the late summer concentrations of humpback whales, are not represented in these survey results. In contrast, Jones and Szczepaniak (1992) conducted five cruises between August 1990 and November 1991 on marine mammal use of the region. Although coverage of the four study areas was not uniform, these surveys supply incidental information on seasonal occurrence. Therefore, site-specific data (historical and recent) exist for marine mammals of the region and may be used to determine relative marine mammal use of the four study areas.

3.3.5.1 Cetaceans

In general, cetaceans are most common in continental slope waters (e.g., over water depths of 200–2,000 m). Dohl *et al.* (1983) recorded five times as many sightings in slope waters as in continental shelf waters (less than 200 m), and three times the numbers sighted in deep waters (greater than 2,000 m).

During the 1980–83 surveys, Dohl *et al.* (1983) counted 116,800 cetaceans comprising 18 species. The most abundant odontocetes (i.e., toothed cetaceans) were the Pacific white-sided dolphin, followed by the northern right whale dolphin, Risso's dolphin, Dall's porpoise, and the harbor porpoise. The most common baleen whales were the California gray whale followed by the humpback whale. Sperm, blue, minke, and killer whales also were sighted, although their abundances were lower. Overall, the highest densities of cetaceans occurred in autumn and winter.

Results from Dohl *et al.* (1983) indicate that for all cetaceans combined, abundance estimates were highest near the Gulf of the Farallones. According to this study, all slope and deep-water study areas contained cetaceans during March through May with moderate to high densities (0.301–1.2/km^2) in Study Area 5, moderate densities (0.301–0.60/km^2) in Study Area 3, and low densities (0.01–0.15/km^2) in Study Areas 2 and 4.

Recent censuses indicated similar marine mammal occurrences and species within the Gulf of the Farallones region (Ainley and Allen 1992; Jones and Szczepaniak 1992). Similar to results from Dohl *et al.* (1983), during the June 1985–91 surveys (Ainley and Allen 1992), a higher incidence of cetaceans was reported in slope and deep waters. Of the four study areas, the deep waters of Study Area 5 had the highest counts for a single species (22 Pacific white-sided dolphin) (Ainley and Allen 1992). However, the highest number of cetacean species and the highest counts for some species, including 15 Pacific white-sided dolphin, 7 humpback whales, 2 Risso's dolphin, and 1 minke whale, were reported for the slope waters of Study Area 4. Cetaceans observed within Study Area 3 included 12 Risso's dolphin, 3 Pacific white-sided dolphin, and 1 Dall's porpoise. In contrast, only three cetaceans (2 harbor porpoises and 1 humpback whale) were observed in shelf waters within Study Area 2.

In surveys during June 1985–91, Dall's porpoise, Pacific white-sided dolphin, and harbor porpoise were the most abundant odontocetes within the study region (Ainley and Allen 1992). Of the larger cetaceans, humpback whales were the most abundant, followed by minke and gray whales. Seasonal surveys conducted by the EPA (Jones and Szczepaniak 1992) also reported Dall's porpoise and Pacific white-sided dolphin as the most frequently observed cetaceans, although only two harbor porpoise were observed during the entire study. In contrast to the findings of Dohl *et al.* (1983), no gray whales were observed during EPA surveys; instead, humpback whales were the most frequently sighted baleen whale (Jones and Szczepaniak 1992).

Ainley and Allen (1992) suggest that Study Area 5 may have the relatively greatest importance to marine mammals based on the number of individuals observed there. However, seasonal surveys suggested that marine mammal abundances within Study Area 3 were greater than expected (Jones and Szczepaniak 1992). Also, during these surveys, numbers observed within Study Area 5 were less than expected and no marine mammals were observed within Study Area 4.

The seven species of large whales that occur within the study region are classified as seasonal visitors or migrants (Table 3.3.5-1). Gray, humpback, and blue whales are listed as seasonal visitors because they likely feed opportunistically in, as well as migrate through, the Gulf of the Farallones region. Conversely, finback, sperm, sei, and right whales are listed as migrants or incidentals because they appear to pass through the area during seasonal migrations, rarely stopping to feed. Periods of likely occurrence in the Gulf of the Farallones region for the seven species are shown in Figure 3.3.5-1. The occurrence of these seven species within the study areas warrants special attention because all of these species except for the gray whale are Federally listed as endangered (see Section 3.3.6, Endangered Species).

Pacific White-Sided Dolphin

Pacific white-sided dolphin were the most abundant cetacean observed off the central California coast, comprising 40% of all animals sighted (Dohl *et al.* 1983). These dolphin generally occur in waters over and seaward of the continental slope, except during spring when they occur in continental shelf waters from Half Moon Bay to Monterey Bay (Dohl *et al.* 1983). They feed on northern anchovy, whiting, saury, and squid at depths in excess of 120 m (Dohl *et al.* 1983). Juvenile animals were observed from July through October with the highest number of sightings between Point Conception and Point Reyes including heavy use of the Gulf of the Farallones region (Dohl *et al.* 1983). Counts of this species over five years indicated moderate numbers (11–100 individuals) observed within Study Area 4 and in close proximity to Study Areas 3 and 5 (Figure 3.3.5-2) (Ainley and Allen 1992). During the EPA surveys, this species was seen in low to moderate abundances in Study Area 3 and low abundances in Study Area 5 during August 1990 and 1991 (Jones and Szczepaniak 1992). These results verify that slope and deep-water habitats are used more often than shelf waters, as reported by Dohl *et al.* (1983).

Northern Right Whale Dolphin

Northern right whale dolphin comprised 35% of all animals sighted by Dohl *et al.* (1983), and usually were observed over deep waters. They feed primarily on squid, lanternfish, and other mesopelagic fishes at depths greater than 250 m (Leatherwood and Reeves 1982; Dohl *et al.* 1983). Sixty-two percent of all juveniles were sighted between Point Piedras Blancas and Point Piños, south of the Gulf of the Farallones (Dohl *et al.* 1983). There was a tendency for northern right whale dolphin to be found over deeper waters in autumn (1,440 m) than in spring (862 m), although this pattern was not consistent from year to year (Dohl *et al.* 1983). Overall, the species' distribution appears to shift south and inshore from October through June, then north and offshore from July through September (Leatherwood and Reeves 1982). During the PRBO surveys (Ainley and Allen 1992), most northern right whale dolphin were seen near the eastern boundary of Study Area 5, with fewer sighted near Study Area 3 (Figure 3.3.5-3). EPA sightings of this species were over slope waters between Study Areas 3 and 4 (Jones and Szczepaniak 1992). All EPA sightings occurred during August and October surveys, confirming the suggestion by Dohl *et al.* (1983) that northern right whale dolphin tend to be found over slope waters during autumn. Thus, like Pacific white-sided dolphin, with which they commonly co-occur, northern right whale dolphin prefer slope and deep-water habitats rather than continental shelf waters.

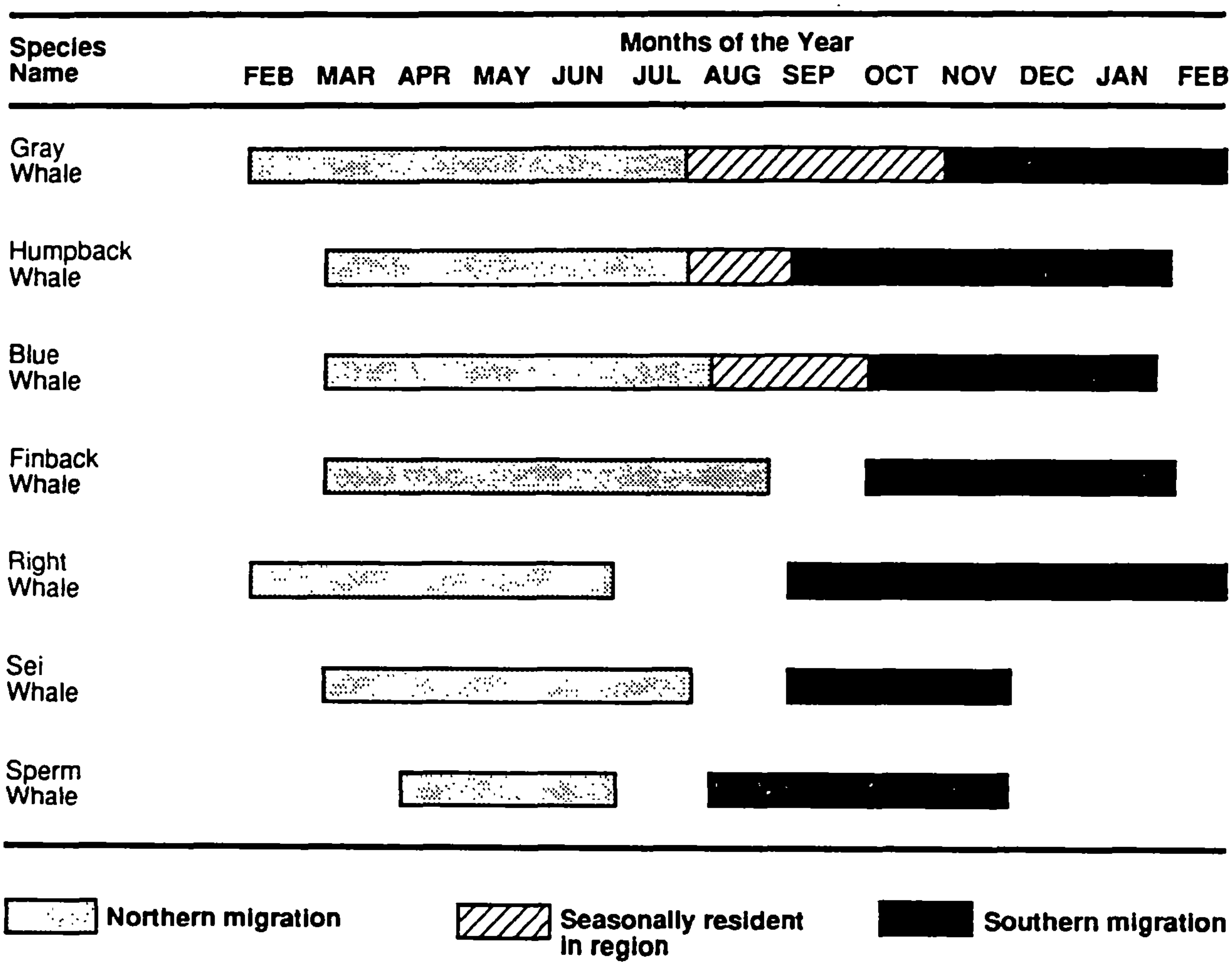

Figure 3.3.5-1. Whale Migrations (Northern and Southern) and Times During Which Each Species May Occur in the Study Region.

Modified from Dohl *et al.* 1983.

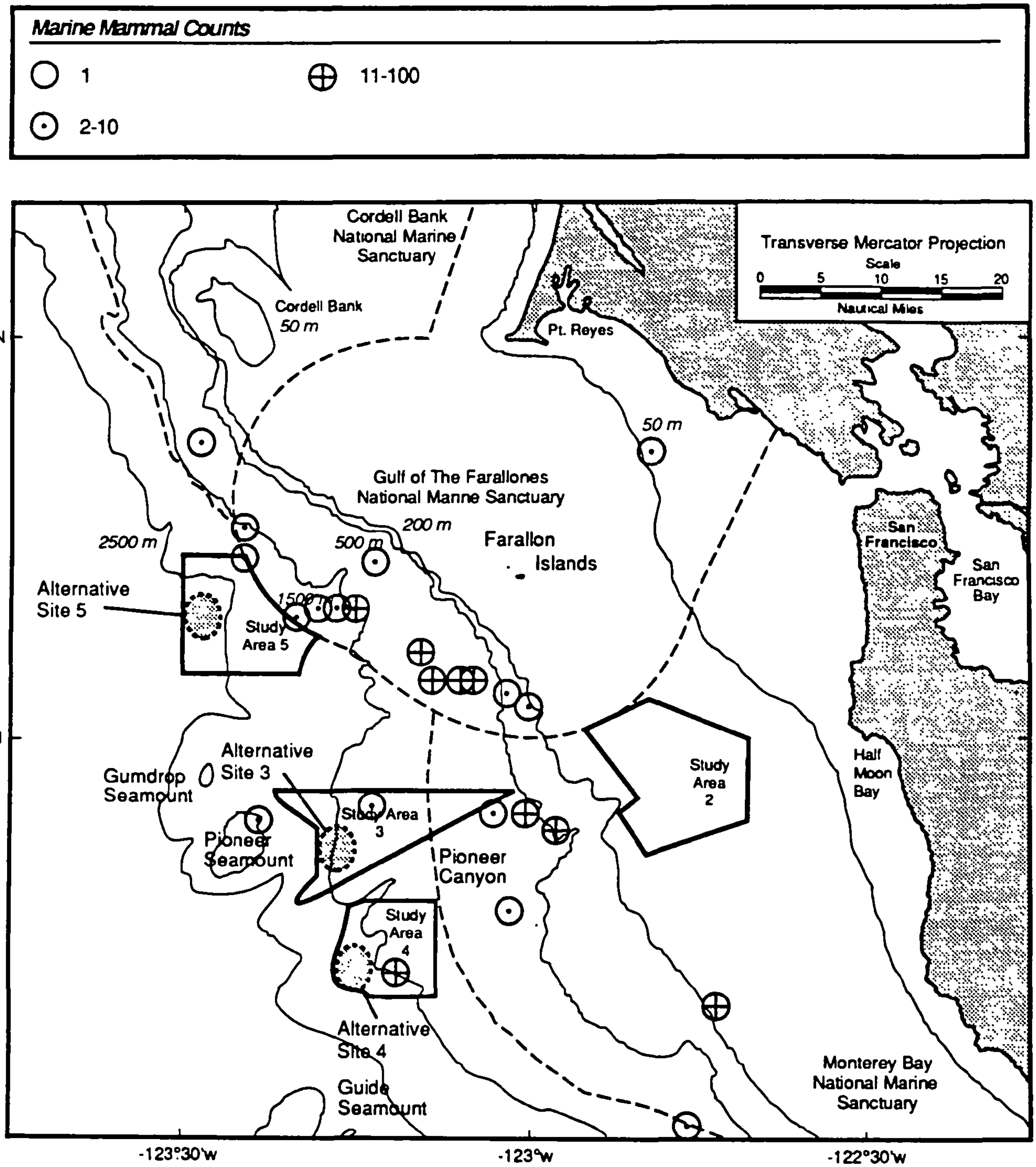

Figure 3.3.5-2. **Pacific White-Sided Dolphin Counts in the Gulf of the Farallones Region, 1985–1991.**

Source: Ainley and Allen 1992.

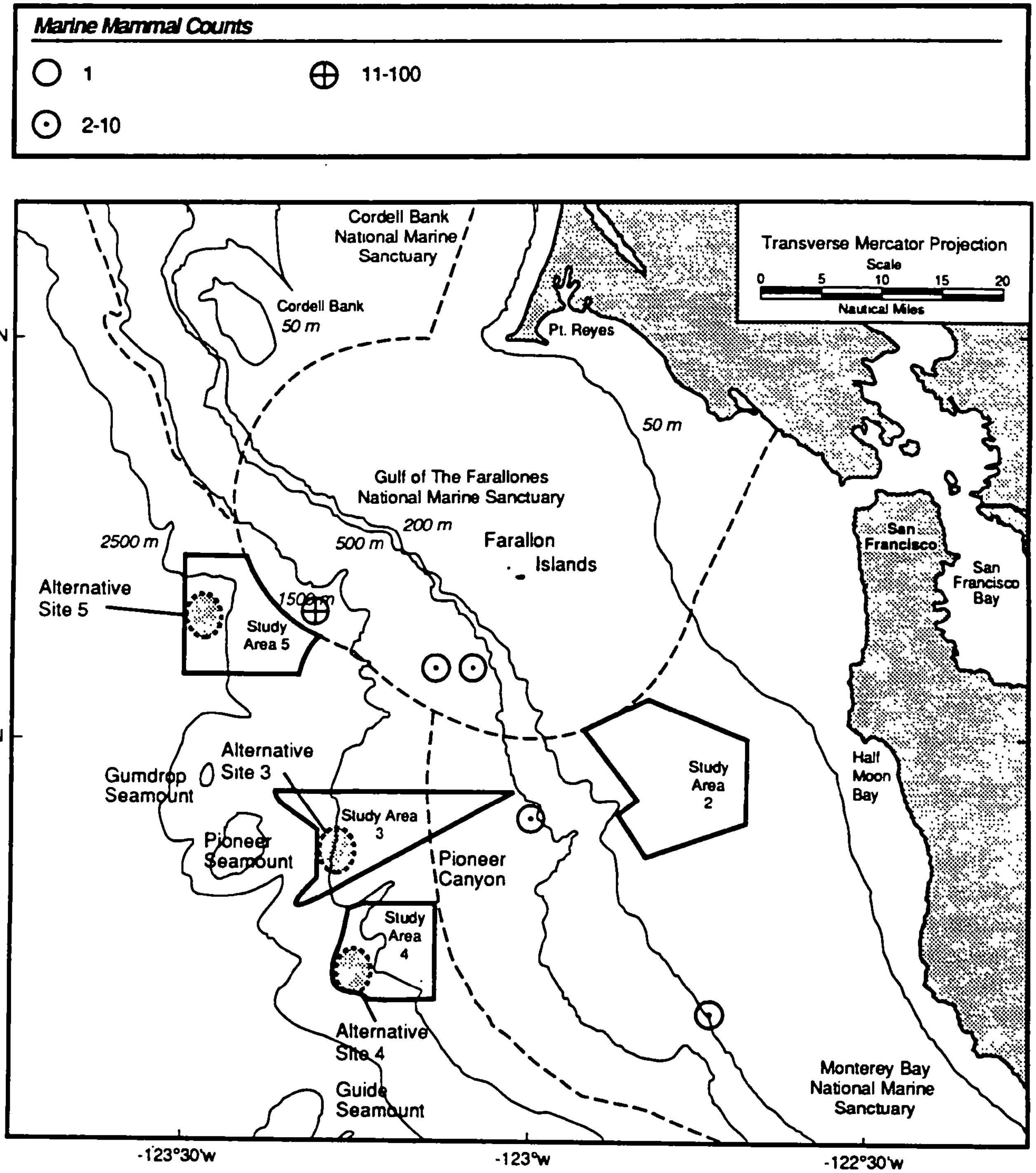

Figure 3.3.5-3. **Northern Right Whale Dolphin Counts in the Gulf of the Farallones Region, 1985–1991.**

Source: Ainley and Allen 1992.

Risso's Dolphin

Risso's dolphin comprised 18% of the cetaceans sighted by Dohl *et al.* (1983). This species often is found offshore in deep temperate and tropical waters where it feeds primarily on squid (Leatherwood and Reeves 1982). The few Risso's dolphin that were seen within the study region during the PRBO surveys were near or within Study Areas 3 and 4 (Ainley and Allen 1992) (Figure 3.3.5-4). Although Risso's dolphin occur regularly in the Gulf of the Farallones, the population reportedly is concentrated in southern California waters (Dohl *et al.* 1983). Jones and Szczepaniak (1992) recorded a single sighting of Risso's dolphin within Study Area 4.

Dall's Porpoise

Dall's porpoise numerically represented only 2% of the cetaceans seen, but were the most frequently encountered species during the 1980–83 surveys (Dohl *et al.* 1983). Abundance indices were highest from mid-summer through autumn, and lowest in winter.

Similarly, Dall's porpoise were the cetaceans observed most often within the study region during the PRBO (1992) surveys, although sightings within specific study areas were rare (Figure 3.3.5-5). During the EPA (1992) surveys, this species occurred in the study region most often in summer, especially within Study Area 3 (Jones and Szczepaniak 1992). The greatest numbers occurred along the seaward edge of the continental shelf and slope waters (Ainley and Allen 1992; Jones and Szczepaniak 1992). Dall's porpoise are nocturnal feeders, primarily consuming anchovies, squid, crustaceans, and deep-water fishes (Morejohn 1979; Jones 1981; Ainley and Allen 1992). Preferred prey abundance may significantly affect the foraging range of the species. For example, the highest densities of Dall's porpoise were observed around the Farallon Islands coincident with unusually high numbers of anchovies (Ainley and Allen 1992).

Harbor Porpoise

Harbor porpoise are the most common nearshore cetaceans in the central California region (Leatherwood *et al.* 1982; Dohl *et al.* 1983). Seasonal movements seem to be inshore-offshore rather than north-south and may be determined by prey availability. Harbor porpoise feed on juvenile rockfish, herring, mackerel, sardines, pollack, and whiting (Leatherwood and Reeves 1982). Dohl *et al.* (1983) estimated a peak central California population of 3,000 porpoises in the fall season, although recent observations suggest the species is present year-round in the Gulf of the Farallones (Szczepaniak and Webber 1985). Harbor porpoise rarely are seen in waters deeper than 180 m, and usually occur within the 18 m isobath (Caldwell and Caldwell 1983). Sightings during the PRBO and EPA (1992) surveys support this observation. All animals were seen in continental shelf waters with only one animal sighted in Study Area 2 (Ainley and Allen 1992) (Figure 3.3.5-6).

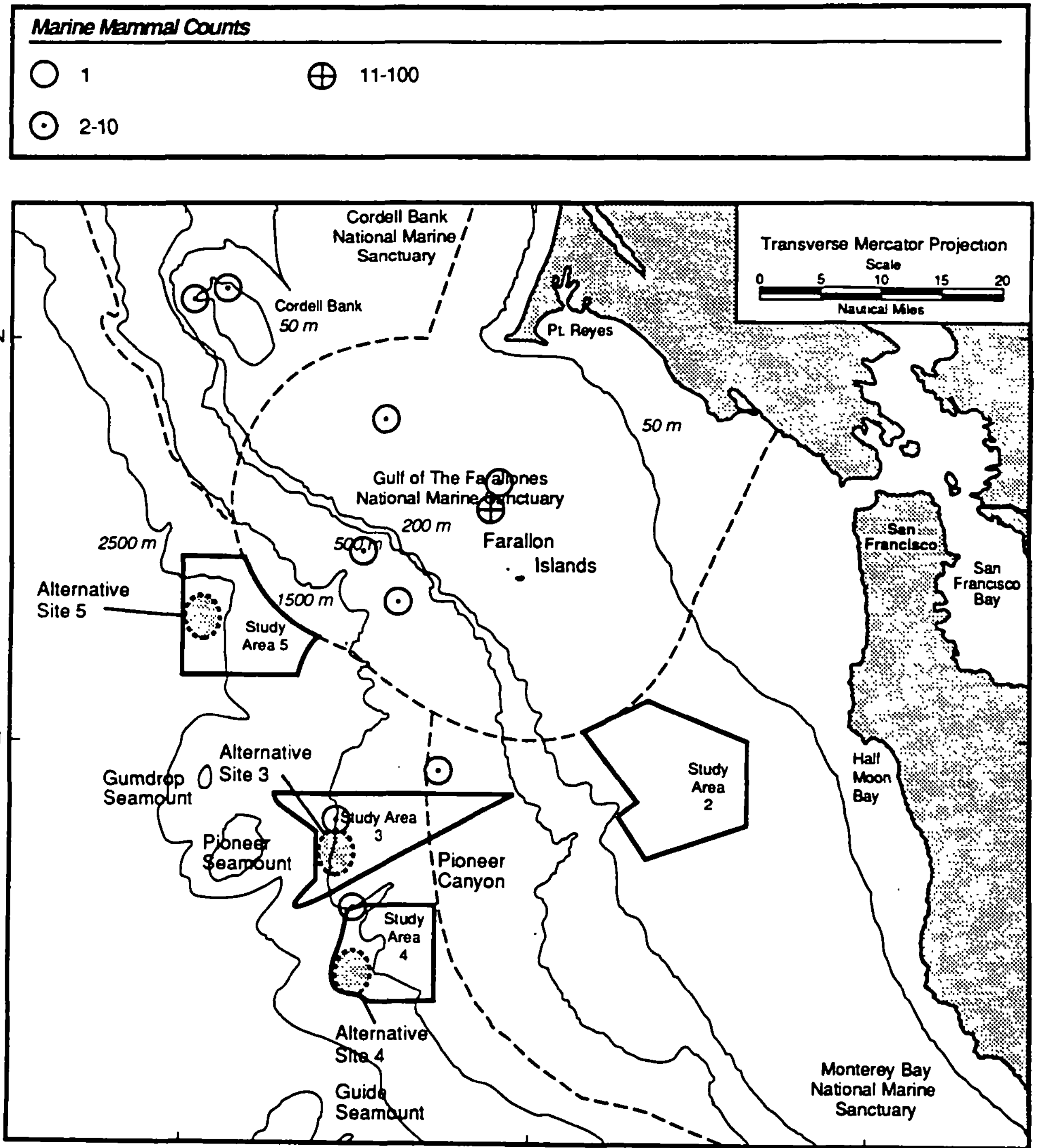

Figure 3.3.5-4. **Risso's Dolphin Counts in the Gulf of the Farallones Region, 1985–1991.**

Source: Ainley and Allen 1992.

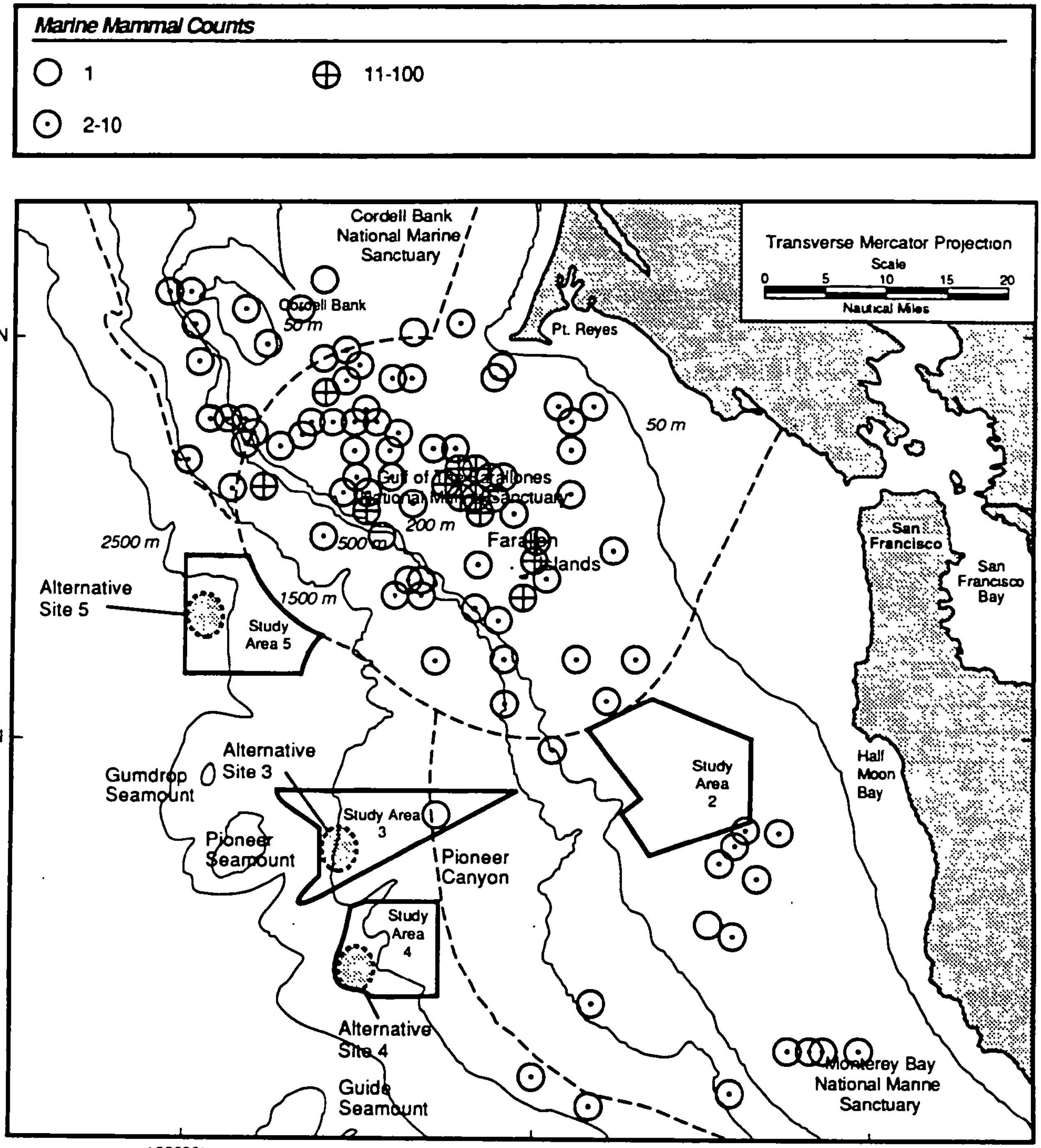

Figure 3.3.5-5. **Dall's Porpoise Counts in the Gulf of the Farallones Region, 1985–1991.**

Source: Ainley and Allen 1992.

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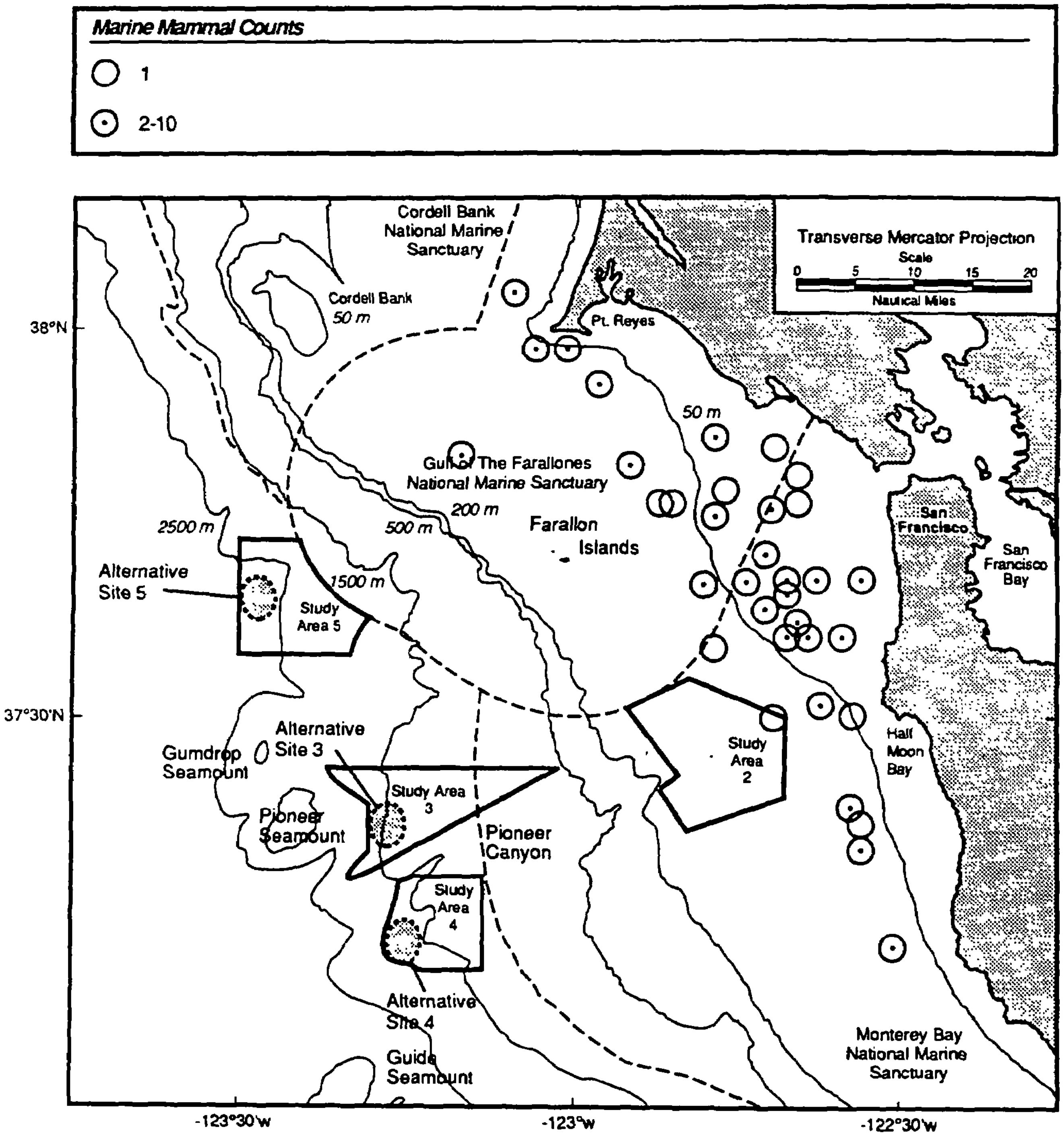

Figure 3.3.5-6. **Harbor Porpoise Counts in the Gulf of the Farallones Region, 1985–1991.**

Source: Ainley and Allen 1992.

Gray Whales

The eastern Pacific population of gray whales is currently estimated at 21,113 individuals and is considered to be essentially recovered from historical reductions attributable to commercial whaling (IWC 1990; Marine Mammal Commission 1993). Migrations occur twice annually between winter breeding lagoons in Baja California and summer feeding grounds in the Bering and Chukchi seas (Moore *et al.* 1986; Swartz 1986; Clarke *et al.* 1989). There is recent evidence of year-round residency of some gray whales in the Gulf of the Farallones (PRBO, unpubl. data).

Southbound whales may appear as early as October, with the majority of animals occurring in late December-early January (Dohl *et al.* 1983). Individuals generally tend to avoid turbid waters, such as those receiving run-off following extensive rainfall, and usually pass west of the Farallon Islands on their way south from Point Reyes (Dohl *et al.* 1983). Newborn whales have been observed in northern, central, and southern California waters (Jones and Swartz 1990), suggesting that whales do not calve solely in the lagoons of Baja California. In addition, the year-round residency of some gray whales in the Gulf of the Farallones indicates that some breeding/calving of gray whales may occur in the study region.

The northward migration period is less well defined, but generally occurs from mid-January through June (Dohl *et al.* 1983; Herzing and Mate 1984). Northbound animals tend to stay closer to shore. Poole (1984) described two migration corridors for northbound whales off San Simeon (Piedras Blancas): a route 200 m to 3.2 km offshore used by whales not accompanied by calves, and a route less than 200 m from shore used primarily by females with calves. The cow/calf pairs closely followed the coastal contour, while whales using the "offshore" route often followed a nearly straight line from one coastal promontory to the next. The route(s) used by northbound whales in the Gulf of the Farallones region is unknown.

Few gray whale sightings were recorded during the PRBO surveys, although moderately high counts were made near the northeast boundary of Study Area 5 (Figure 3.3.5-7) (Ainley and Allen 1992). This overall scarcity of sightings could be due to limitation of the field effort (May/June surveys only). However, no gray whales were observed during the EPA seasonal surveys (Jones and Szczepaniak 1992). In recent years, 3 to 8 gray whales summered in the vicinity of the Farallon Islands (Dohl *et al.* 1983; Huber *et al.* 1986).

Gray whales feed on infaunal crustaceans, primarily ampeliscid amphipods, and there are incidental reports of gray whales associated with sediment trails (which indicate feeding) near the Farallon Islands and off Point Reyes (Nerini 1984; PRBO, unpubl. data). Gray whales summering off Vancouver Island are principally engaged in feeding (Oliver *et al.* 1984), and there is some evidence that gray whales feed opportunistically near the Farallon Islands as well (P. Jones, EPA, pers. comm. 1992).

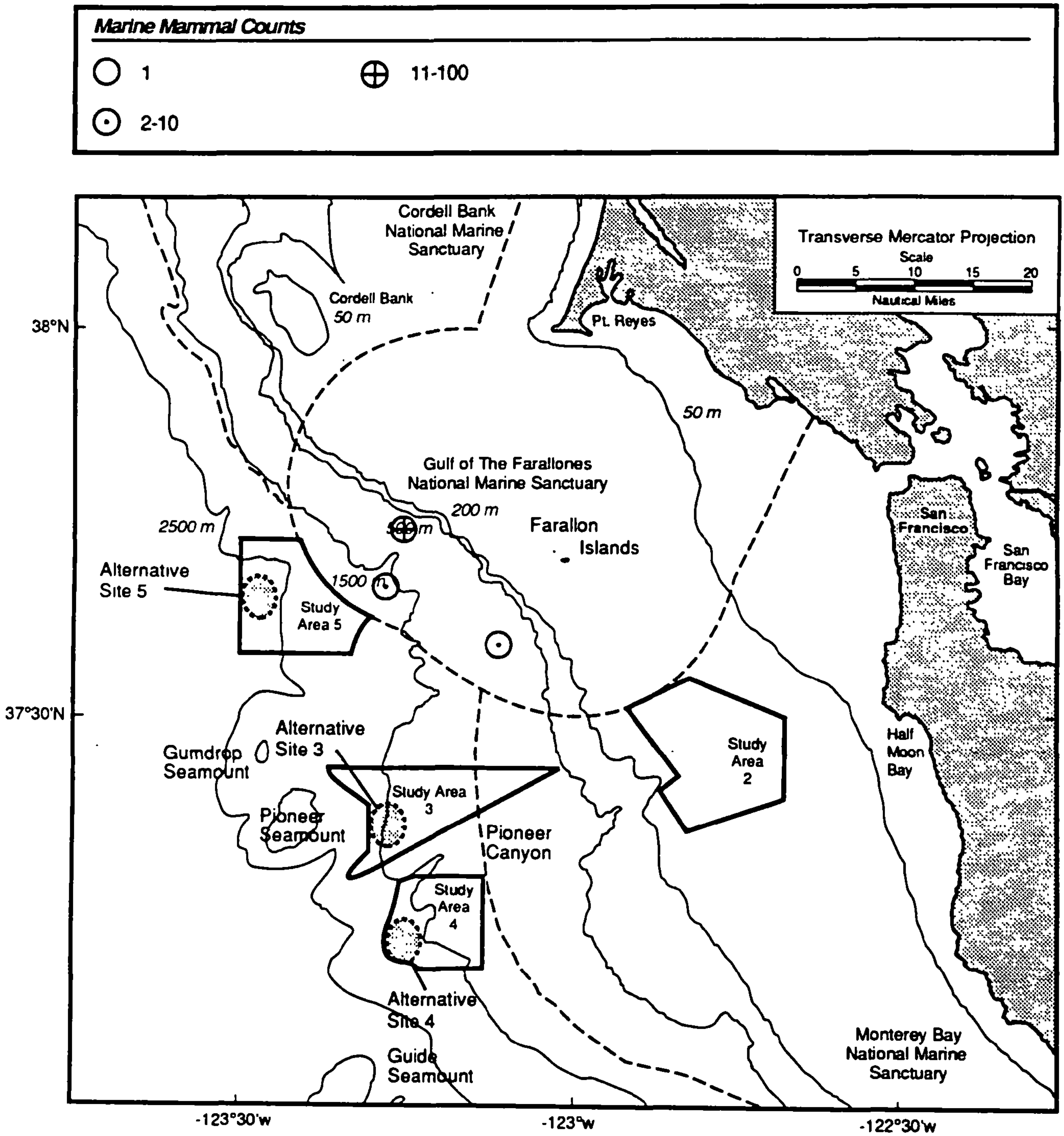

Figure 3.3.5-7. **Gray Whale Counts in the Gulf of the Farallones Region, 1985–1991.**

Source: Ainley and Allen 1992.

Humpback Whales

The eastern north Pacific population of humpback whales migrates from summer feeding areas in southern Alaskan waters to winter breeding areas in waters near Hawaii and Mexico (Johnson and Wolman 1984; Baker *et al.* 1986). Humpbacks occur along northern and central California from March through January, with the greatest numbers in waters near the Farallon Islands from mid-August through October (Dohl *et al.* 1983; Calambokidis *et al.* 1990a). During summer months, central California populations may reach 500 animals (Dohl *et al.* 1983). Annual local populations have been estimated at roughly 150–200 whales in the region for the years 1986–88 (Calambokidis *et al.* 1990a). Humpbacks feed on baitfish, euphausiids, pelagic crabs, and a variety of other prey in the Gulf of the Farallones in summer and early fall. Highest abundance was observed in August between Study Areas 2 and 3 during EPA (1992) surveys (Figure 3.3.5-8a), while data from the multi-year June surveys (Ainley and Allen 1992) suggested higher relative abundance further south between Study Areas 3 and 4 (Figure 3.3.5-8b). Calambokidis *et al.* (1990a) describe movement of humpbacks between feeding aggregations in the Gulf of the Farallones and along the California coast, particularly Monterey Bay. Differences in sighting distributions from the PRBO and EPA surveys could result from differences in survey timing, or movement of the whales between Monterey Bay and Gulf of the Farallones feeding areas.

Blue Whales

Blue whales occur from the Chukchi Sea to waters off Costa Rica in the eastern north Pacific, although specific migration patterns and feeding areas are poorly defined (Mizroch *et al.* 1984). Like humpbacks, blue whales use the Farallon Basin for feeding in summer and early fall, but occur in lower numbers (Dohl *et al.* 1983). A total of 179 blue whales were identified photographically in the Gulf of the Farallones over three years (1986–88), with some movement of individual whales between the Farallones and feeding aggregations in Monterey Bay documented in 1987 and 1988 (Calambokidis *et al.* 1990b). In 1986, a single sighting of 41 blue whales was recorded near Southeast Farallon Island (PRBO, unpubl. data), the same year that unusually large aggregations of blue whales fed on euphausiids in Monterey Bay (Schoenherr 1991). During the EPA (1992) surveys, blue whales were seen in Study Area 3 and near Study Area 2 in August, with most seen along the continental shelf break (Figure 3.3.5-9). No blue whales were observed within survey transects during the June 1985–91 surveys (Ainley and Allen 1992).

Minke Whales

Minke whales are widely distributed in tropical, temperate, and polar waters (Leatherwood and Reeves 1982). In the north Pacific, minkes winter from central California to near the equator, with distribution shifting northward in summer from central California to waters off Alaska. Minke whales appear to segregate by age/sex classes in all areas, which limits attempts to make unbiased estimates of population size. There is evidence that minke whales are year-round residents in Monterey Bay (Stern 1990) and the Gulf of the Farallones (PRBO, unpubl. data).

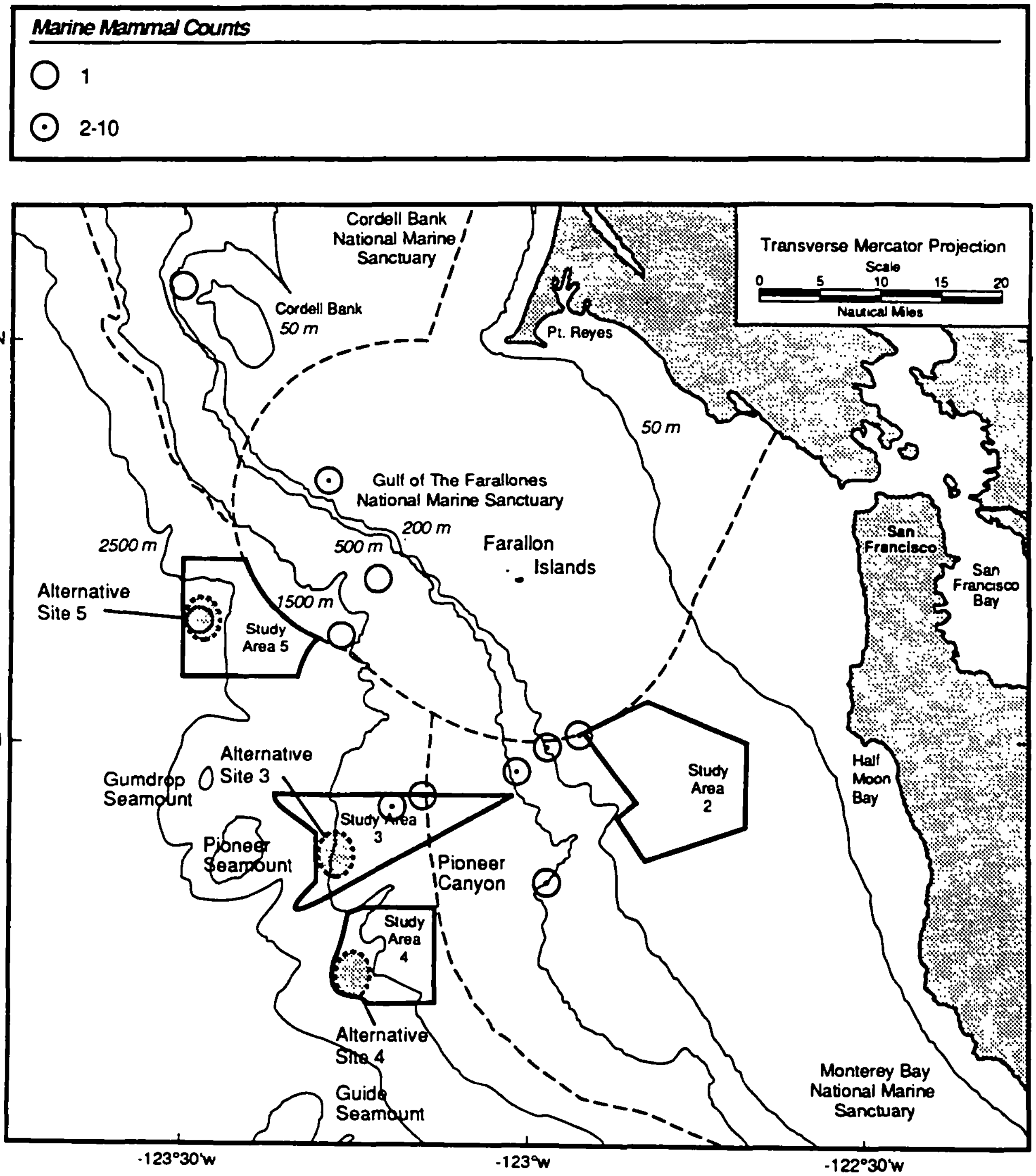

Figure 3.3.5-8a. **Humpback Whale Counts in the Gulf of the Farallones Region, August 1990 and 1991.**

Source: Jones and Szczepaniak 1992.

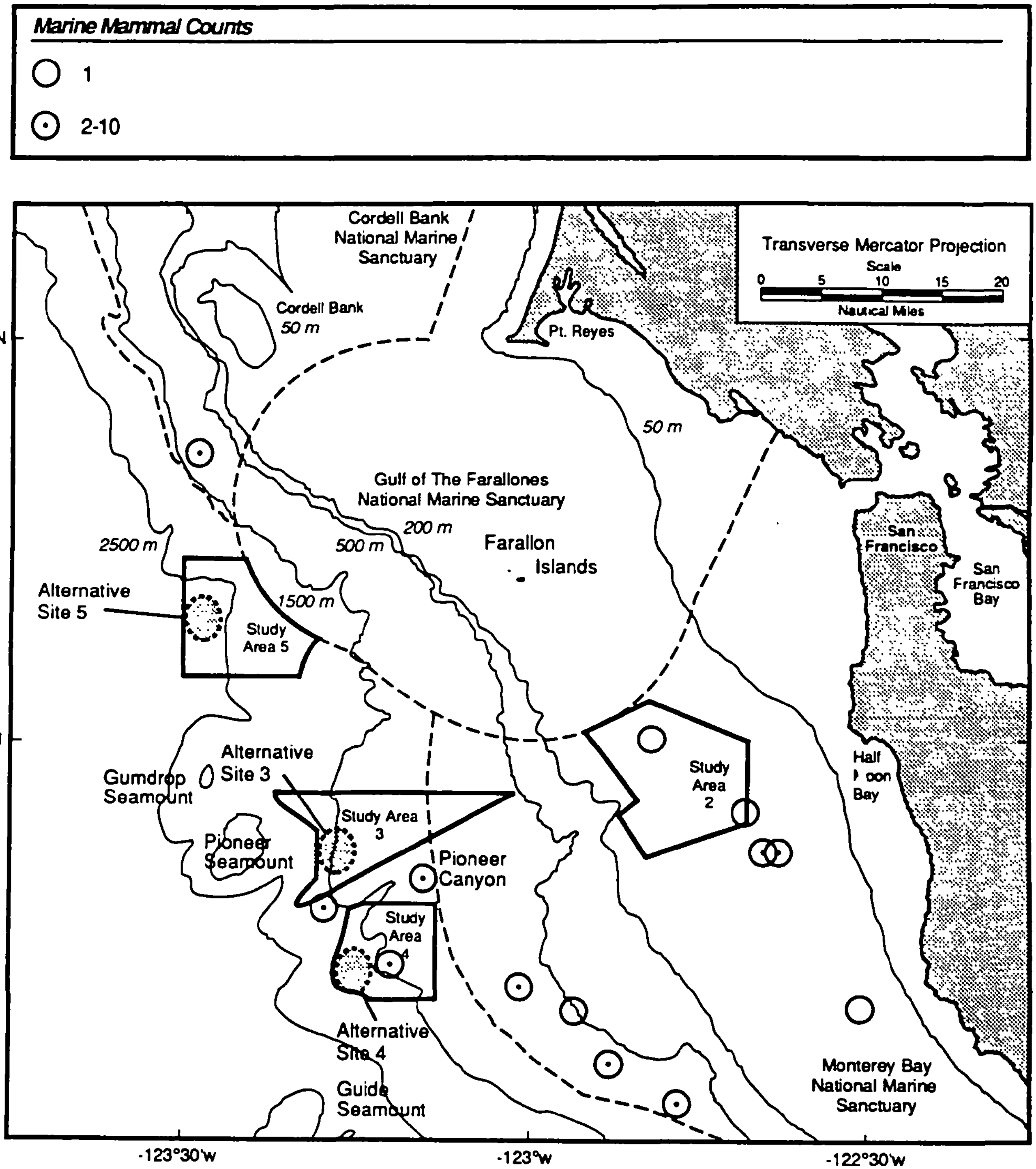

Figure 3.3.5-8b. **Humpback Whale Counts in the Gulf of the Farallones Region, 1985–1991.**

Source: Ainley and Allen 1992.

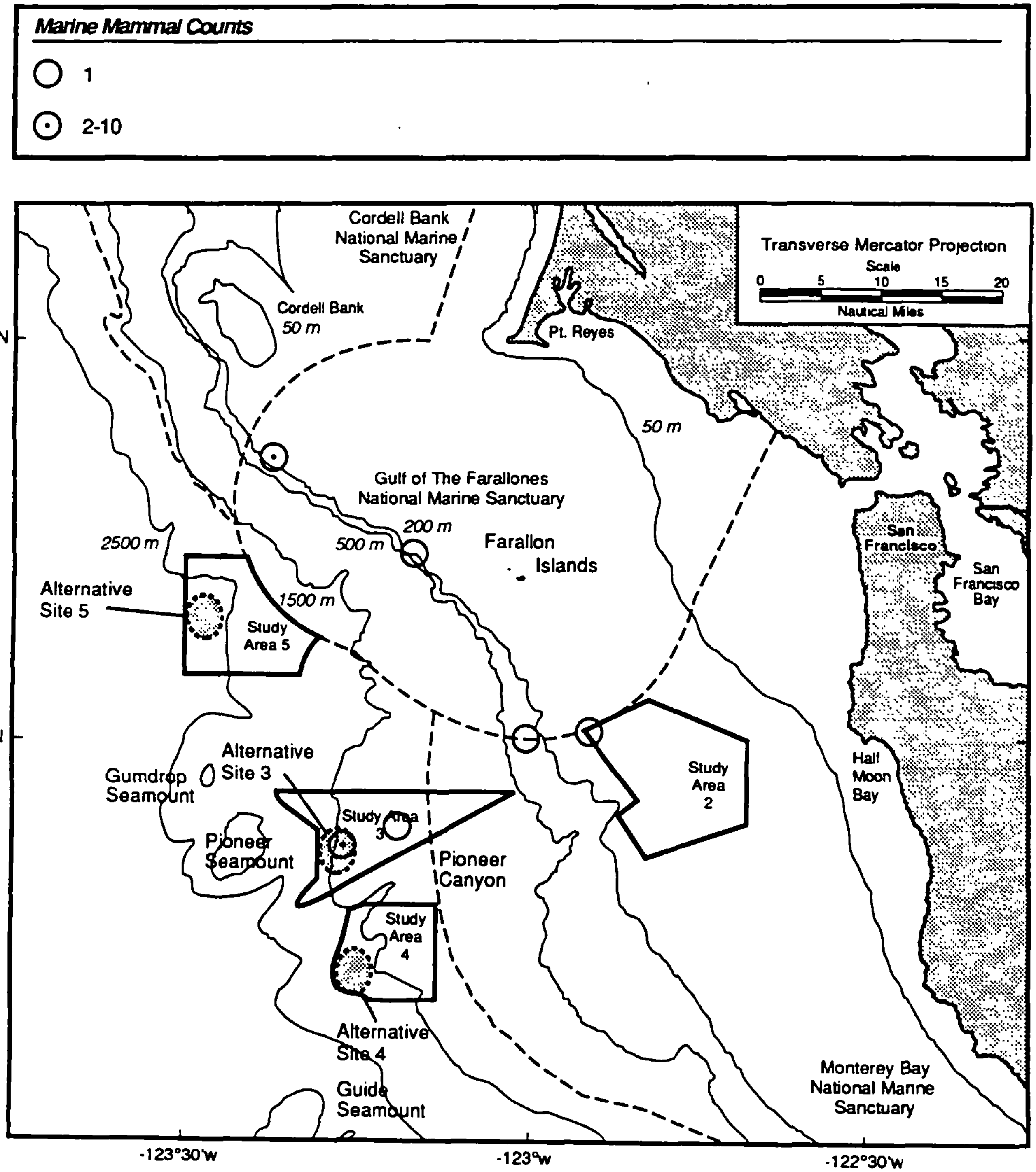

Figure 3.3.5-9. **Blue Whale Counts in the Gulf of the Farallones Region, August 1990 and 1991.**

Source: Jones and Szczepaniak 1992.

The sexes of resident populations in the Gulf and off Monterey migrate separately (Stern 1990). Dohl *et al.* (1983) sighted 16 minke whales over 3 years, with only one animal seen near the Farallon Islands in 1981. A single minke whale was observed within Study Area 4 during the June PRBO (1992) surveys. The majority of minke whales observed during these surveys were along the northern coastline of the study region (Ainley and Allen 1992) (Figure 3.3.5-10). EPA surveys observed only two minke whales shoreward of the 100-m isobath (Jones and Szczepaniak 1992).

Finback, Sperm, Sei, and Right Whales

Endangered finback, sperm, sei, and right whales rarely occur in the study region (Dohl *et al.* 1983), and none were observed during the PRBO (Ainley and Allen 1992) and EPA (Jones and Szczepaniak 1992) surveys. Thirty sightings of a total of 56 finback whales were recorded from 1980–83 (Dohl *et al.* 1983), with 70% of the sightings occurring in continental shelf and slope waters. One finback whale was seen about 20 km west of Point Reyes, and a group of 5 to 8 whales was observed just south of the Farallon Islands in 1981. Sperm whales are commonly found off central California, with peaks of abundance in mid-May and mid-September, suggesting a northward migration in the spring and a southward migration in fall. From November to April, breeding groups are sighted over the continental slope off California between 33° to 38°N latitude (Gosho *et al.* 1984). There were 66 sightings of a total of 218 sperm whales from 1980–83 (Dohl *et al.* 1983), with 68% of the sightings in waters having depths greater than 1,700 m. Four sperm whales were observed in Study Area 5 in 1983. Although the Gulf of the Farallones lies within the distributional range of sei and right whales (Caldwell and Caldwell 1983), none were recorded during recent (Ainley and Allen 1992; Jones and Szczepaniak 1992) or historical (Dohl *et al.* 1983) surveys.

Other Cetaceans

Other species of cetaceans either have been sighted in the region, stranded along the mainland coast, or have the potential for occurring in the region (Dohl *et al.* 1983). Killer whales are widespread throughout the eastern north Pacific (Leatherwood and Reeves 1982). Dohl *et al.* (1983) reported that killer whales ranged along the entire California coastline, occurring most frequently over the continental slope north of Monterey Bay. A group of 5 to 8 killer whales was seen west of the Farallon Islands near Study Area 5 in 1981 (Dohl *et al.* 1983). Beaked whales, including ***Mesoplodon*** spp. and ***Berardius bairdi***, are oceanic and occur worldwide. There are at least three species of ***Mesoplodon*** that could occur in the area: Hubb's beaked whale (***M. carlhubbsi***), Blainville's beaked whale (***M. densirostris***), and Stejneger's beaked whale (***M. stejnegeri***). Some species of ***Mesoplodon*** are recognized as deep divers (***M. carlhubbsi*** in particular) and feed on squid and midwater fishes. Baird's beaked whales (***B. bairdi***) occur from the Bering Sea to Baja California, Mexico. Dohl *et al.* (1983) suggested that Baird's beaked whales move onto the continental slope off central and northern California during June, then move offshore in November; none were seen near the Gulf of the Farallones during the 1980–83 surveys. This species also is deep-diving and feeds on squid and octopuses as well as crustaceans, sea cucumbers, and a variety of deep-sea and midwater fishes (Caldwell and

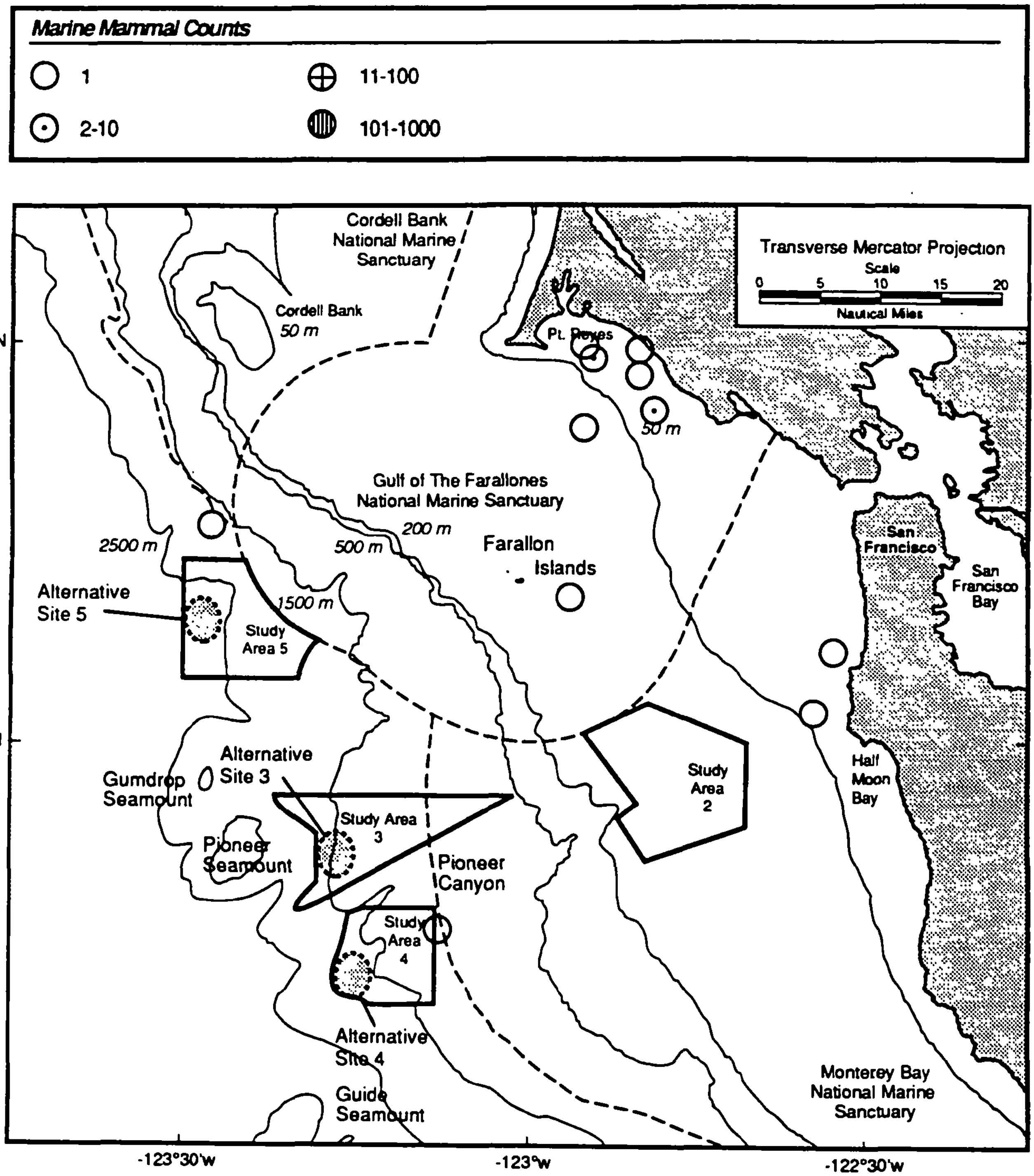

Figure 3.3.5-10. **Minke Whale Counts in the Gulf of the Farallones Region, 1985–1991.**

Source: Ainley and Allen 1992.

Table 3.3.5-2. **Relative Densities of Marine Mammal Species Within the Four LTMS Study Areas.**
Data from A (Ainley and Allen 1992) and B (Jones and Szczepaniak 1992).

	Study Area 2		Study Area 3		Study Area 4		Study Area 5	
Cetacean Species	A	B	A	B	A	B	A	B
Pacific white-sided dolphin	N	N	L	M	M	N	L	L
Northern right whale dolphin	N	N	N	N	N	N	N	N
Risso's dolphin	N	N	L	N	L	L	N	N
Dall's porpoise	L	L	L	M	N	N	N	L
Harbor porpoise	L	N	N	N	N	N	N	N
Gray whale	N	N	N	N	N	N	N	N
Humpback whale	L	L	N	L	L	N	N	N
Blue whale	N	L	N	L	N	N	N	N
Minke whale	N	N	N	N	L	N	N	N
Pinniped Species								
California sea lion	L	N	N	M	N	N	N	L
Northern elephant seal	L	N	L	N	N	N	L	N
Northern sea lion	N	N	N	L	N	N	N	L
Northern fur seal	L	N	L	L	L	N	L	N
Harbor seal	L	N	N	N	N	N	N	N

N = No mammals observed
L = Low density
M = Moderate density

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Caldwell 1983). Beaked whales generally avoid vessels, which may in part explain their reduced numbers during surveys.

In summary, results from historical surveys (Dohl *et al.* 1983) indicated that for all cetaceans combined, highest species densities occurred in Study Area 5. Moderate species densities occurred in Study Area 3, and low densities were found in Study Areas 2 and 4. In contrast, results from long-term marine mammal censuses (Ainley and Allen 1992) and recent seasonal surveys (Jones and Szczepaniak 1992) indicated that more cetaceans occurred in Study Areas 3 and 4 (Table 3.3.5-2). In general, cetacean abundances within the study region appear highest in slope and deeper waters.

3.3.5.2 Pinnipeds

Bonnell *et al.* (1983) censused the pinnipeds (and southern sea otters) of central and northern California by means of monthly aerial transects and quarterly coastal censuses. They estimated that the five predominant pinniped species, the California sea lion (*Zalophus californianus*), harbor seal (*Phoca vitulina*), northern elephant seal (*Mirounga angustirostris*), northern fur seal (*Callorhinus ursinus*), and northern sea lion (*Eumetopias jubatus*), had combined populations of approximately 50,000 animals. Peak numbers at sea occurred in winter and spring with the arrival of migrant northern fur seals from the Bering Sea. Northern sea lions, northern elephant seals, and harbor seals had large populations of approximately 3,000, 4,000, and 12,000 individuals, respectively.

The Farallon Islands are among the most important pinniped haul-out grounds in California (Bonnell *et al.* 1983). The primary pinniped foraging grounds are the shallow shelf waters from Point Reyes south in summer and fall, and deeper continental slope waters in winter and spring. California sea lions and northern fur seals are present seasonally either along the coast or offshore, and the northern elephant seal, harbor seal, and northern sea lion breed in the area (Table 3.3.5-1). The Guadalupe fur seal (*Arctocephalus townsendi*) is considered an occasional visitor to the area (Bonnell *et al.* 1983).

California Sea Lion

The California sea lion is the most common pinniped at California haul-out areas and in continental shelf waters (KLI 1991). A few pups have been born on Southeast Farallon Island (Pierotti *et al.* 1977; Huber *et al.* in prep.) and on Año Nuevo Island (Keith *et al.* 1984) but viable rookeries have not been established at either site. At sea, California sea lion relative abundance is characterized by two peaks (May-June and September-October) which correspond to peaks in abundance in haul-out areas. These peaks are due to the arrival and subsequent departure of transient northern populations, with the highest at-sea mean seasonal density ($0.18/km^2$) recorded in fall (Bonnell *et al.* 1983). During this period, California sea lions feed over Pioneer Canyon (between Study Areas 3 and 4) and Cordell Bank. Primary prey items include crabs, squid, herring, hake, and mackerel (Ainley and Allen 1992). During the EPA (Jones and Szczepaniak 1992) surveys, California sea lions were the most abundant pinniped in all seasons; the greatest number of individuals were observed during August in slope waters near Study Area 3 (Figure 3.3.5-11a). PRBO (Ainley and Allen 1992) reported California sea lions as the second most common pinniped of the region (following northern fur seals) occurring primarily along the continental shelf including Study Area 2 (Figure 3.3.5-11b).

Northern Elephant Seals

Northern elephant seals are present year-round in the study region and reach peak numbers in haul-out areas during the spring (Bonnell *et al.* 1983). Their breeding range extends from Point Reyes to Isla Cedros in Baja California (Le Boeuf *et al.* 1978) and includes a breeding colony on Southeast Farallon Island. The greatest numbers of elephant seals near the study areas were sighted near the Año Nuevo and Farallon rookeries and in areas over the continental slope from Point Reyes to Monterey Bay (Bonnell *et al.* 1983) where they feed primarily on squid, octopus, hagfish, anchovies, and rockfish (Ainley and Allen 1992). The few northern elephant seals seen during PRBO (Ainley and Allen 1992) surveys were primarily over slope waters (Figure 3.3.5-12); EPA (Jones and Szczepaniak 1992) censuses recorded five sightings over slope waters although no northern elephant seals were observed in the LTMS study areas. Northern elephant seals may dive to depths of 1,500 m (Ainley and Allen 1992) and often remain at the surface for less than one minute when feeding. This may account for the few species sightings within the region (Le Boeuf *et al.* 1978). Conversely, other pinniped species such as northern fur seals may rest at the surface for hours (Gentry and Kooyman 1986) making them more likely to be observed during censusing.

Northern Sea Lion

Northern sea lion populations have declined since the 1940s and currently include about 3,000 individuals statewide (KLI 1991). They are currently listed as a threatened species by the Federal government. Northern sea lions usually are sighted in shallow waters from less than 1 km to 55 km offshore. Most are found in four areas within 45 km of the coast: (1) Cape Mendocino to the Klamath River; (2) Cordell Bank; (3) north of Point Arena; and (4) the continental slope between the Farallon Islands and Año Nuevo Island. The largest northern sea lion rookery in California is on Año Nuevo Island and includes over 1,000 animals. A rookery of about 200 animals exists on Southeast Farallon Island; however, fewer than 30 pups are reported born per year (Huber *et al.* in prep.). There is a minor haul-out area for this species at Point Reyes Headland. Northern sea lions feed primarily on squid, octopus, and fish such as smelt, flatfishes, and rockfishes (Ainley and Allen 1992). Northern sea lions were observed twice during seasonal studies: once each in Study Areas 3 and 5 (Figure 3.3.5-13a) (Jones and Szczepaniak 1992). Two individuals were observed during the PRBO surveys, one northwest of the Gulf of the Farallones National Marine Sanctuary and one along the coast south of Point Reyes (Figure 3.3.5-13b) (Ainley and Allen 1992).

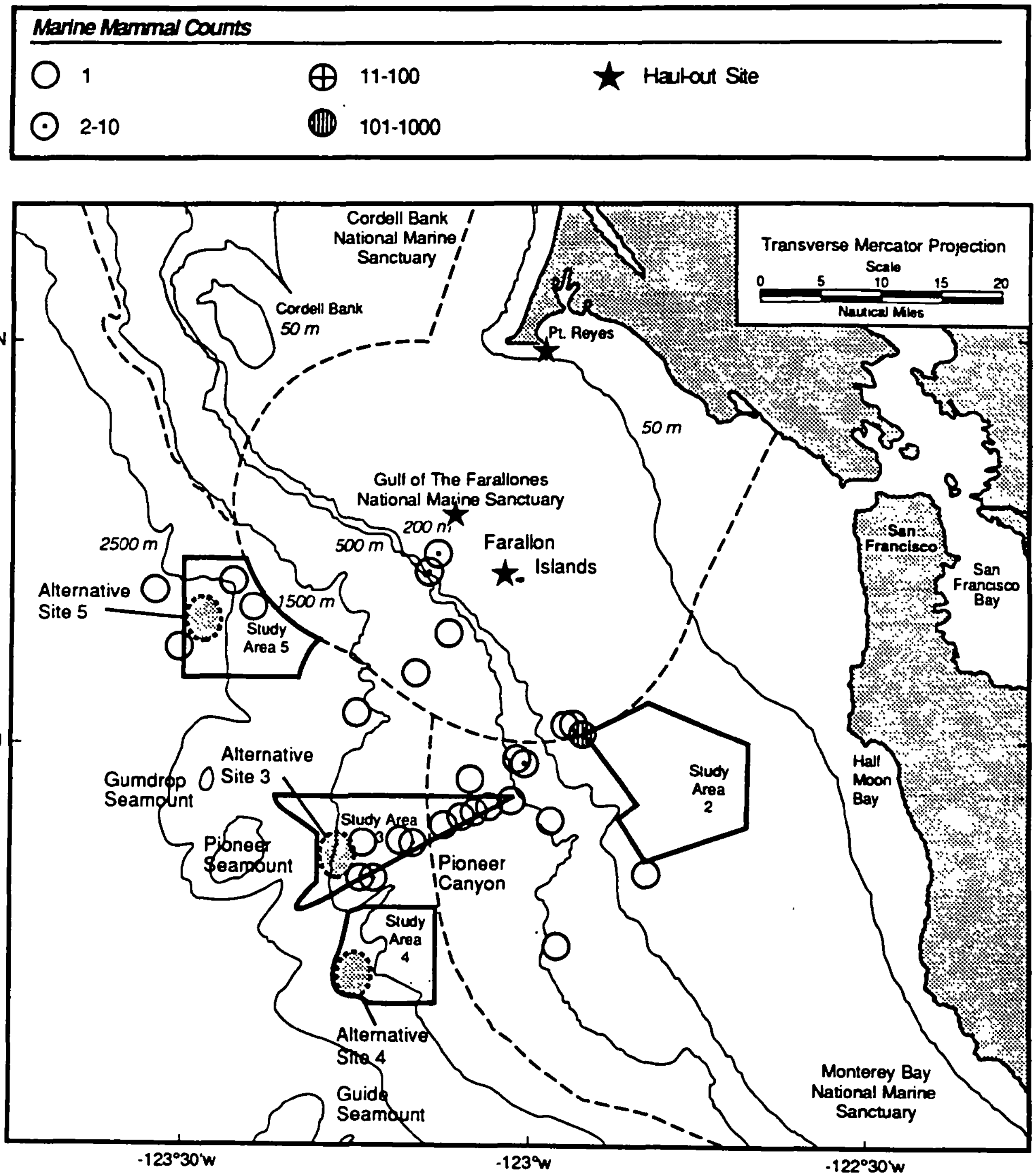

Figure 3.3.5-11a. **California Sea Lion Counts in the Gulf of the Farallones Region, August 1990 and 1991.**

Source: Jones and Szczepaniak 1992.

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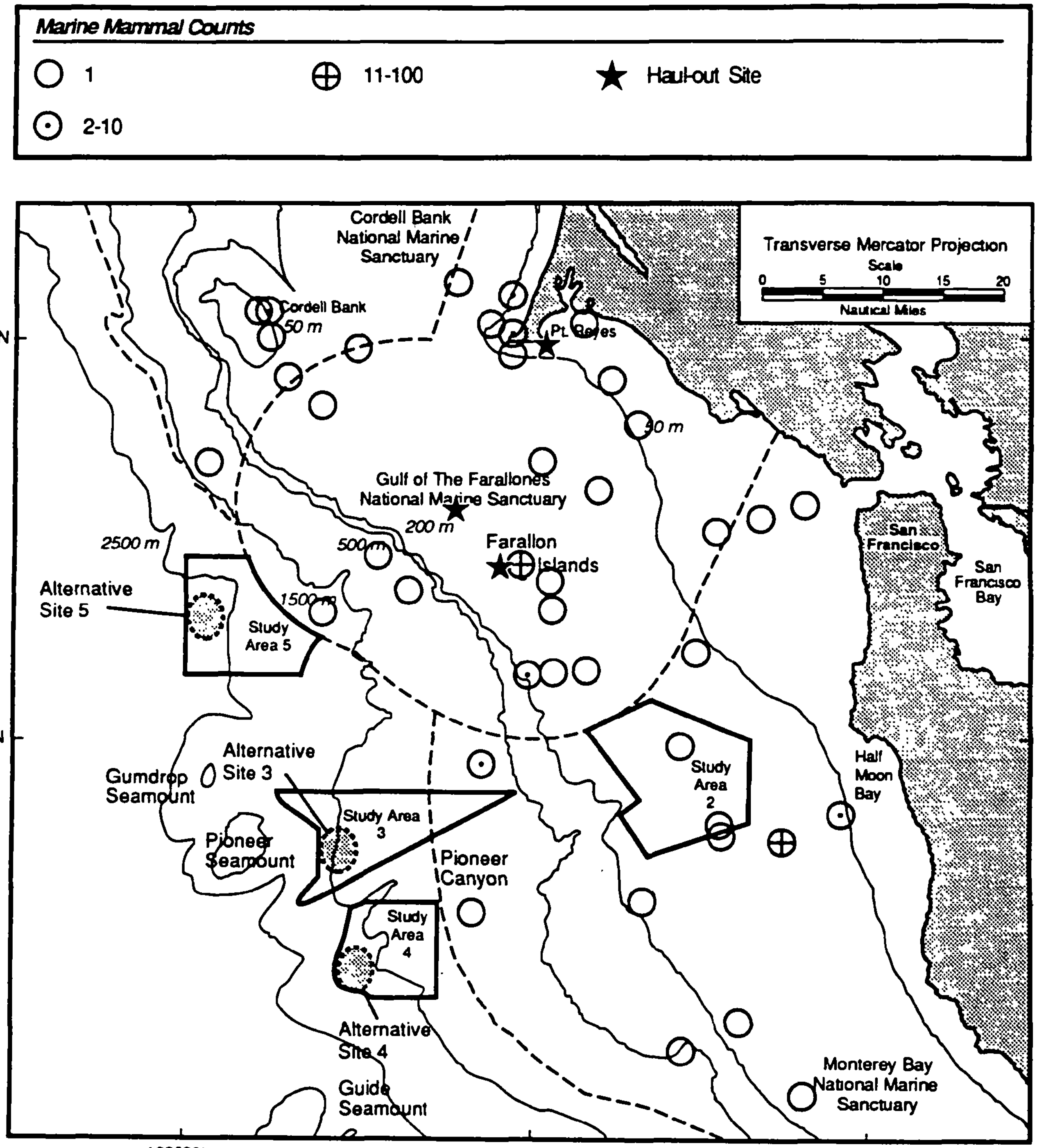

Figure 3.3.5-11b. **California Sea Lion Counts in the Gulf of the Farallones Region, 1985–1991.**

Source: Ainley and Allen 1992.

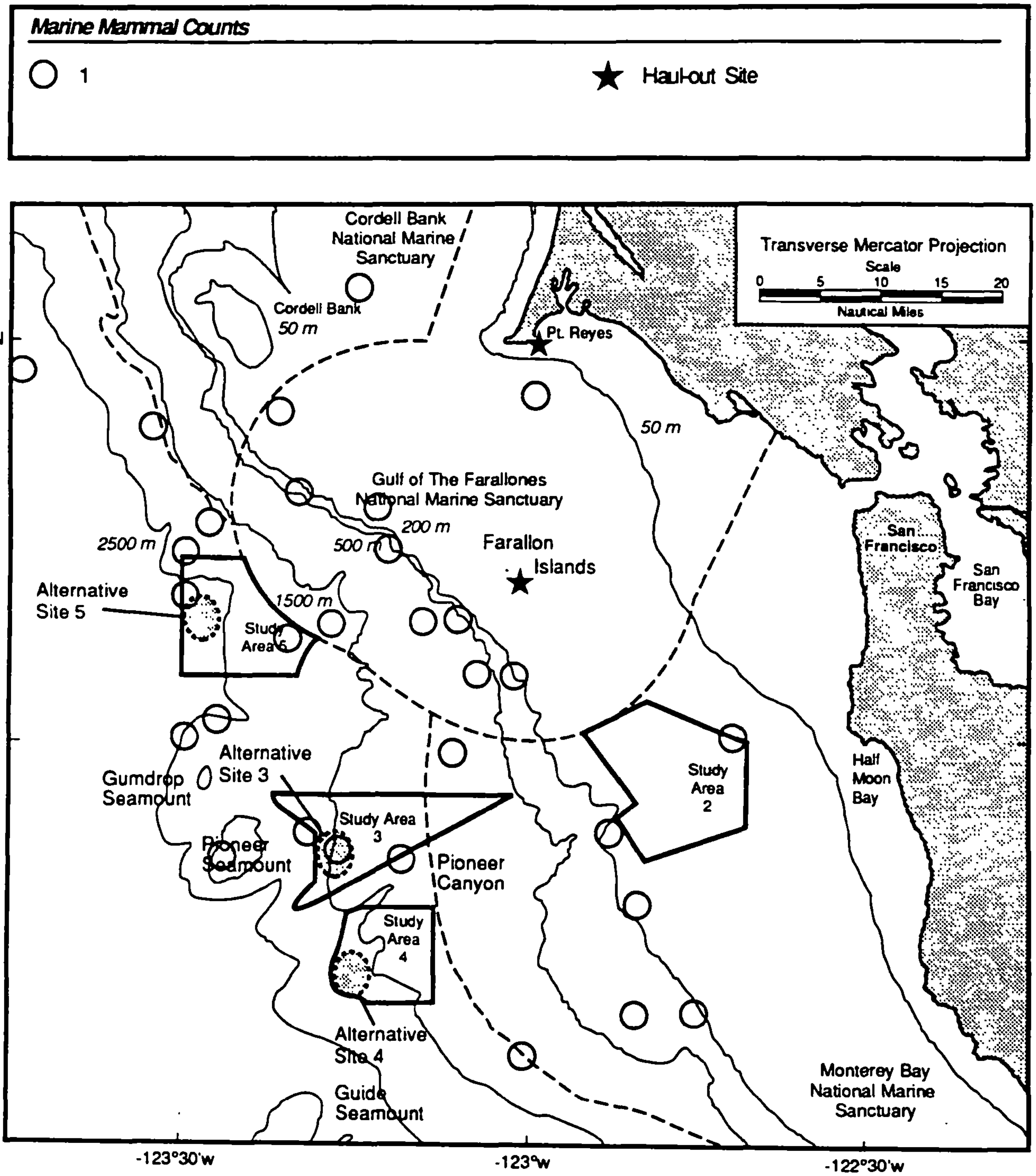

Figure 3.3.5-12. **Northern Elephant Seal Counts in the Gulf of the Farallones Region, 1985–1991.**

Source: Ainley and Allen 1992.

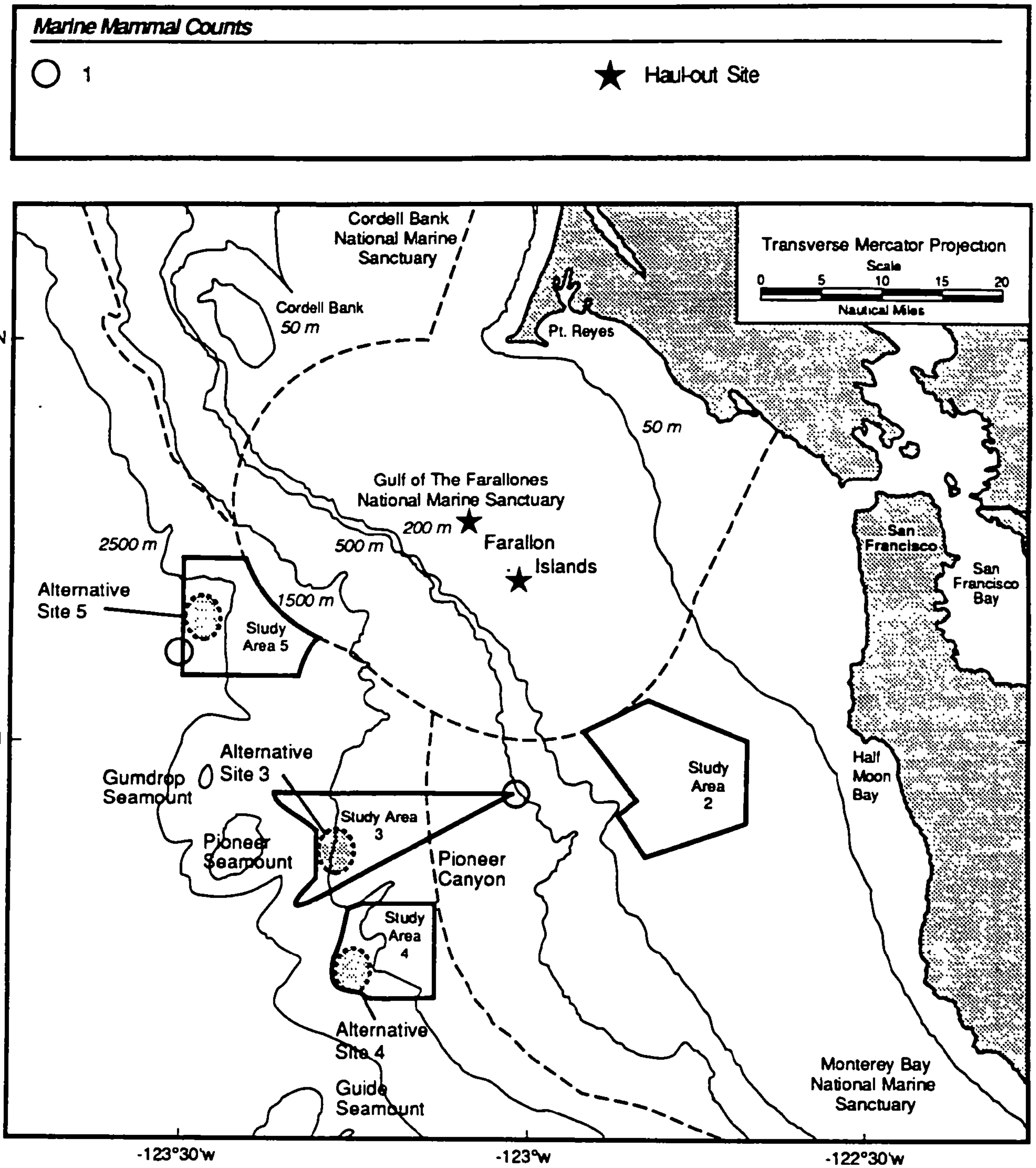

Figure 3.3.5-13a. **Northern Sea Lion Counts in the Gulf of the Farallones Region, August 1990 and 1991.**

Source: Jones and Szczepaniak 1992.

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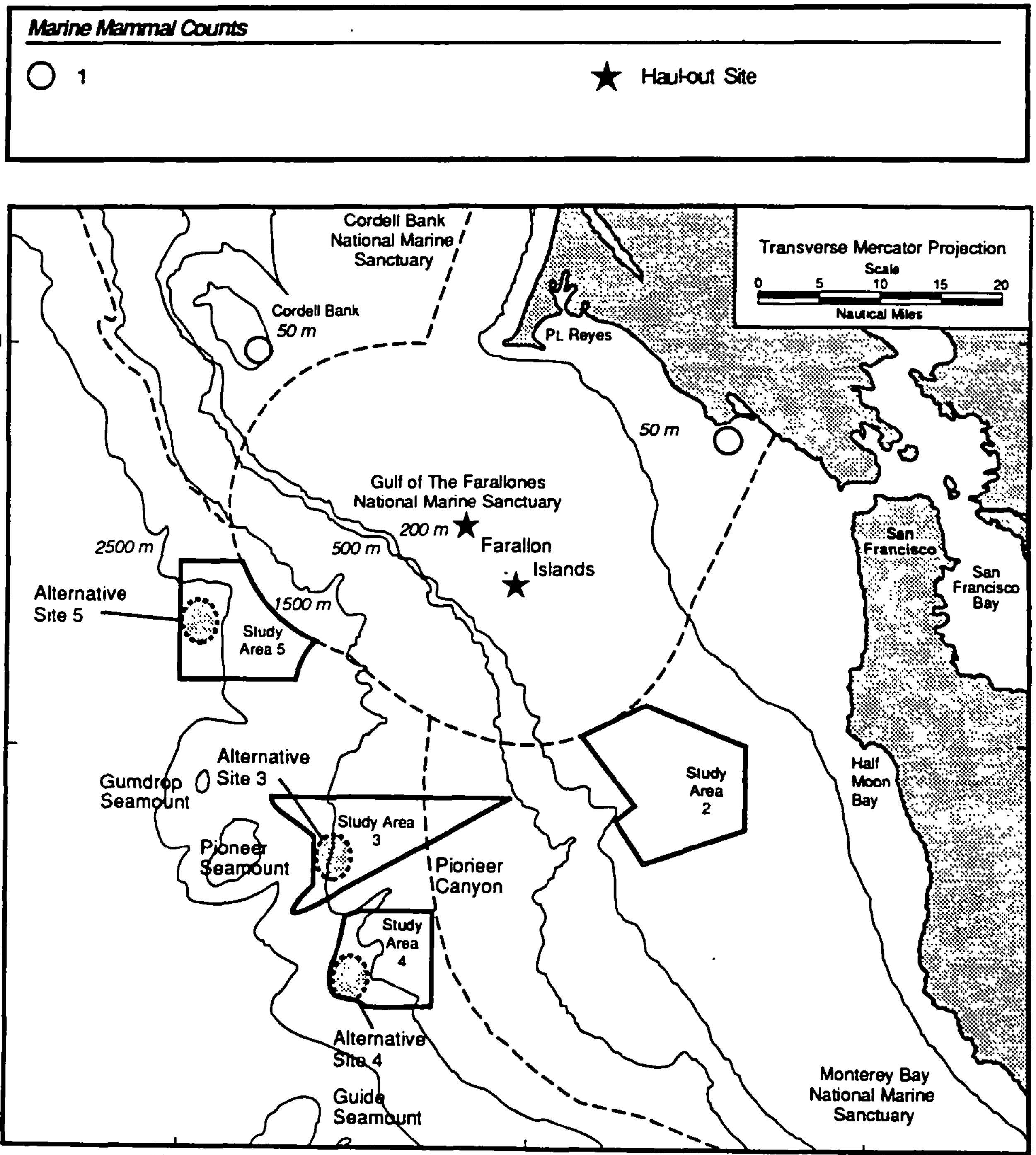

Figure 3.3.5-13b. **Northern Sea Lion Counts in the Gulf of the Farallones Region, 1985–1991.**

Source: Ainley and Allen 1992.

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Northern Fur Seals

Northern fur seals are the predominant pinnipeds in waters seaward of the continental shelf (greater than 200 m) in winter and spring, with an estimated 25,000–30,000 animals present off central and northern California (Bonnell *et al.* 1983). They are designated as a depleted species by the Marine Mammal Commission. A few individuals haul out on Año Nuevo Island and the Farallon Islands (Le Boeuf and Bonnell 1980; Huber *et al.* in prep.). Although the species occurs year-round in the study region, it is considered primarily a winter-spring pelagic visitor to the area (Bonnell *et al.* 1983; KLI 1991). Their numbers increase in abundance offshore with the arrival of northern migrants in the winter. Most return to their Bering Sea rookeries in late spring (York 1987) or to rookeries on San Miguel Island in southern California. Northern fur seals consume a variety of prey including crabs, squid, sablefish, anchovies, and rockfish (Ainley and Allen 1992). Within the study region, northern fur seals were the second most frequently observed pinniped during seasonal surveys (Jones and Szczepaniak 1992) and the most common pinniped during June 1985–91 surveys (Ainley and Allen 1992). Northern fur seals were seen within Study Area 3 and near Study Areas 4 and 5 during EPA (Jones and Szczepaniak 1992) surveys (Figure 3.3.5-14a). During June 1985–91, northern fur seals were seen in low numbers within all of the study areas, although the greatest concentrations were found north and west of Study Area 5 (Figure 3.3.5-14b).

In general, pinniped sightings were rare within the study areas (Ainley and Allen 1992; Jones and Szczepaniak 1992). Table 3.3.5-2 presents a summary of pinniped occurrences within the four study areas. These results, in conjunction with actual sightings as shown in Figures 3.3.5-11a through 3.3.5-15, indicate that the slope waters of Study Areas 3 and 5 support the highest concentration of pinnipeds. Of the five pinnipeds cited, four occurred most often in Study Area 3. The remaining pinniped was the harbor seal which is rarely seen in deeper, slope waters (KLI 1991).

Harbor Seals

Harbor seals are year-round residents of the central California coast, and haul out at islands, secluded beaches, estuaries, and offshore rocks between Año Nuevo and Point Reyes (Allen and Huber 1983, 1984; Bonnell *et al.* 1983; Allen *et al.* 1987a; Hanan *et al.* 1986). They forage close to shore, feeding on crabs, squid, smelt, mackerel, and rockfish (Ainley and Allen 1992), and rarely are seen in waters deeper than 180 m (KLI 1991). Harbor seals are locally migrant and are seasonally most abundant onshore during the spring breeding season (March–June) and the summer molt (June–August). They rest onshore almost daily but spend more time on land during early spring and winter months, averaging 17 hours per day on land (Allen *et al.* 1987b). During PRBO surveys (Ainley and Allen 1992), most harbor seals (80%) were seen over continental shelf waters, in and around Study Area 2 (Figure 3.3.5-15). No harbor seals were observed during the seasonal survey effort (Jones and Szczepaniak 1992).

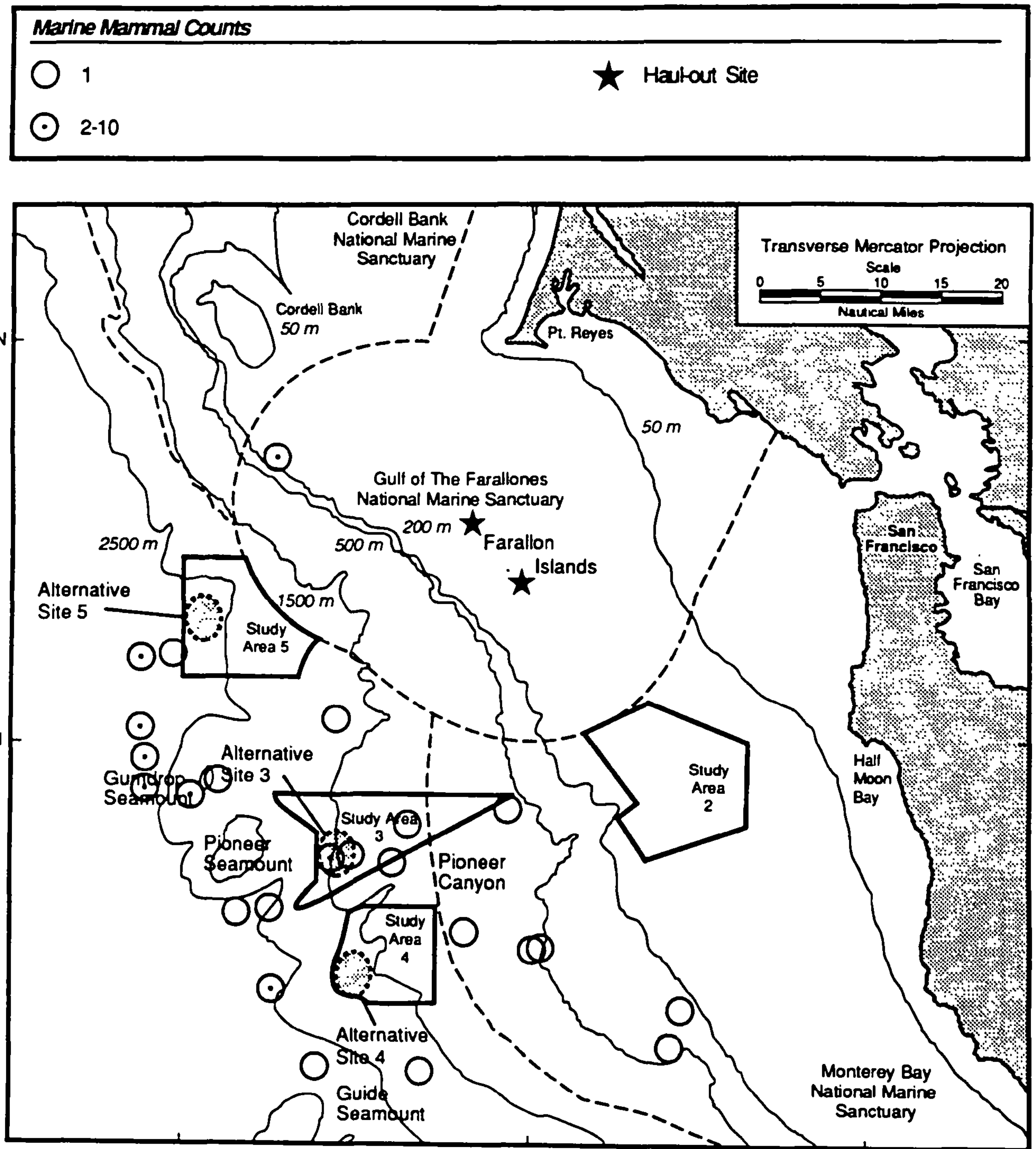

Figure 3.3.5-14a. **Northern Fur Seal Counts in the Gulf of the Farallones Region, August 1990, February, May, August, November 1991.**

Source: Jones and Szczepaniak 1992.

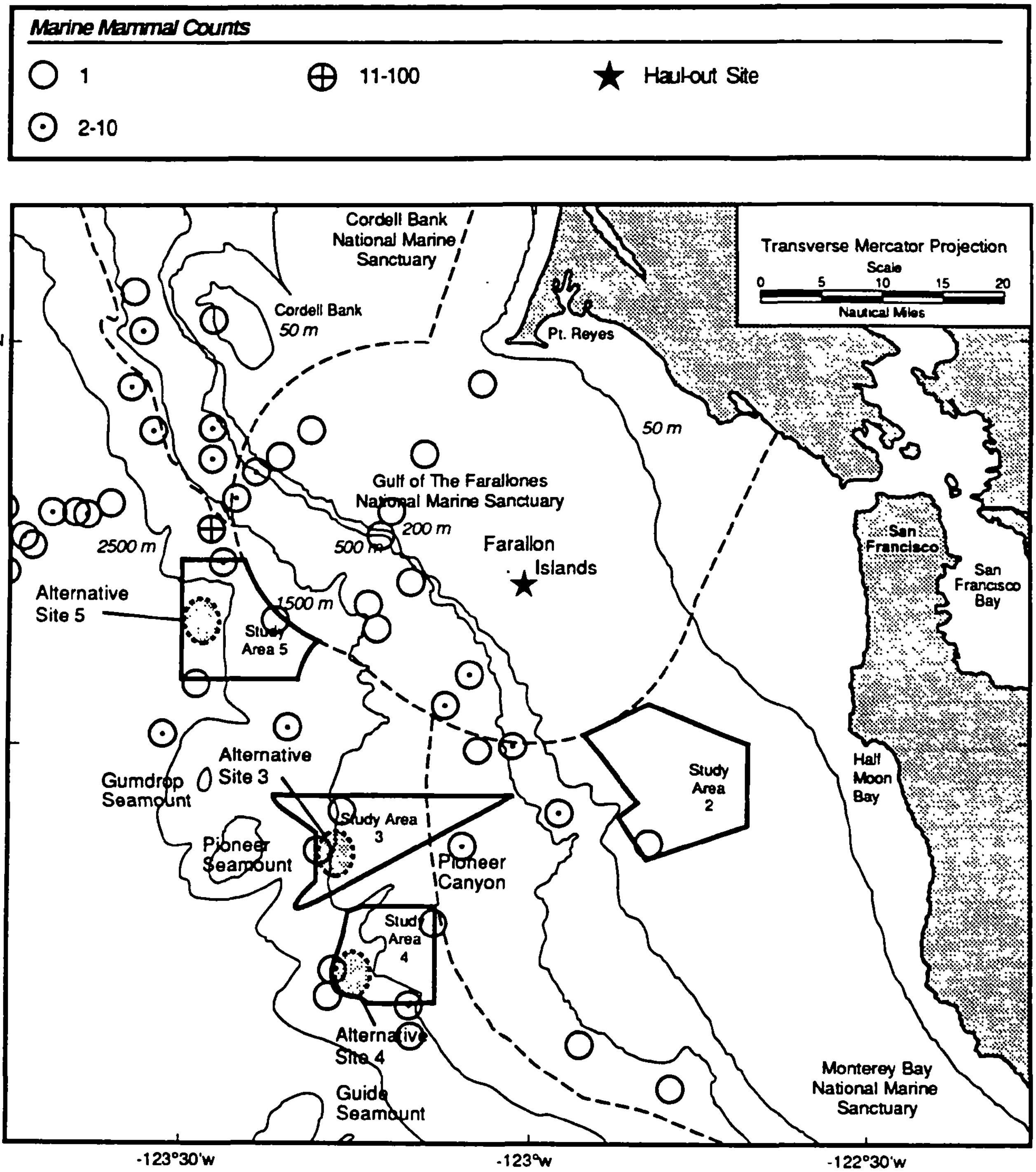

Figure 3.3.5-14b. Northern Fur Seal Counts in the Gulf of the Farallones Region, 1985–1991.

Source: Ainley and Allen 1992.

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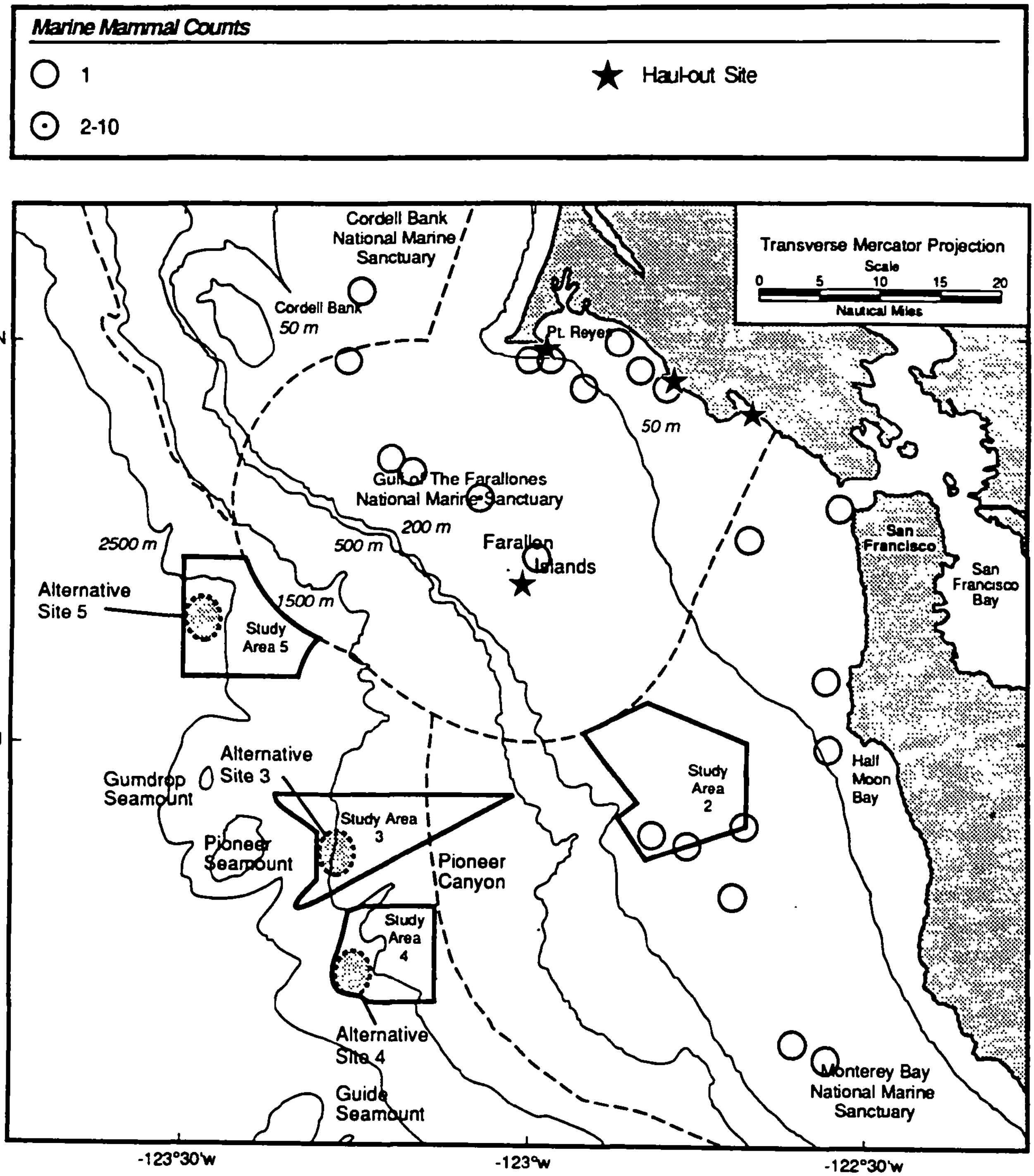

Figure 3.3.5-15. Harbor Seal Counts in the Gulf of the Farallones Region, 1985–1991.

Source: Ainley and Allen 1992.

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3.3.5.3 Fissipeds

Southern sea otters are common to the general study region, but occur primarily along the mainland south of Point Año Nuevo to Point Conception (Bonnell *et al.* 1983). Sea otters normally reside nearshore (within 2,000 feet of shore) and feed on shellfish and fish (Siniff and Ralls 1988). Recently, there have been major, unpredictable shifts in their distribution along the coast. According to CDFG, a group of 11 to 25 otters was observed several times north of Año Nuevo between September 1986 and April 1987. In October 1986, a single sea otter was observed for a four-day span at the Southeast Farallon Island (PRBO, unpubl. data). Incidental sightings also occur annually along the Point Reyes peninsula (PRBO, unpubl. data). Sea otters were not observed near any of the proposed study areas during recent survey efforts (Ainley and Allen 1992; Jones and Szczepaniak 1992). Their typical habitat is rocky intertidal and kelp bed areas (Ainley and Allen 1992) which suggests that their presence is unlikely within any of the deep, slope waters of the LTMS study areas.

3.3.6 Threatened, Endangered, and Special Status Species

This section presents information on threatened, endangered, and special status species that occur within the LTMS study region. Species that occur regularly, and species that occur rarely in the study region are discussed in separate sections.

3.3.6.1 Species Observed Regularly Within the Study Region

Eight known threatened or endangered species regularly occur in the general study region. These include four whale species (humpback, blue, finback, and sperm), one pinniped (northern sea lion), two bird species (peregrine falcon and California brown pelican), and one fish species (winter-run chinook salmon). The current status of these species under the Federal Endangered Species Act (ESA) and the State of California endangered or protected species list is summarized in Table 3.3.6-1. The ESA coordination process occurred concurrently with the review of the Draft EIS and the preparation of the Final EIS. Coordination information is included in Chapter 5. Formal consultation letters (see Chapter 5) requesting advisement of (1) the presence of any listed or candidate, threatened, or endangered species, and (2) any critical habitat of these species that may be impacted by dredged material disposal, within the four LTMS study areas were submitted to the U.S. Fish and Wildlife Service and National Marine Fisheries Service as required by the Endangered Species Act Section 7(c). In addition, the California Department of Fish and Game was consulted voluntarily to ensure project cooperation with the state CZMA.

The species listed in Table 3.3.6-1 are subject to full protection under the Federal ESA (see Section 1.6.2.7). The ESA prohibits the take of any listed species, generally defined as prohibiting any harassment, harm, pursuit, hunting, shooting, wounding, killing, trapping, capture, collection, or attempts at such conduct. In addition to the ESA, marine mammals are protected by the Marine Mammal Protection Act which established a moratorium on the taking or importing of marine mammals or marine mammal products. One of the Act's management

Table 3.3.6-1. Threatened or Endangered Species Occurring in the Study Areas (modified from KLI 1991).

Common Name	Scientific Name	Status
Cetaceans		
Humpback Whale	*Megaptera novaeangliae*	FE
Blue Whale	*Balaenoptera musculus*	FE
Finback Whale	*Balaenoptera physalus*	FE
Sperm Whale	*Physeter macrocephalus*	FE
Pinnipeds		
Northern Sea Lion	*Eumetopias jubatus*	FT
Marine Birds		
Peregrine Falcon	*Falco peregrinus*	SE, FE
California Brown Pelican	*Pelecanus occidentalis californicus*	SE, FE
Marine Fishes		
Winter-run Chinook Salmon	*Oncorhyncus tshawytscha*	SE, FT

FE = Federally listed endangered
ST = State listed threatened
FT = Federally listed threatened
SE = State listed endangered

Note: Additional threatened, endangered, or candidate species that occur rarely within the study region are discussed later in Section 3.3.6.

requirements seeks to attain an "optimum sustainable population" for all marine mammal species, including additional protection of those populations considered depleted.

NMFS is responsible for the protection of Federally endangered, threatened, and special status cetaceans, pinnipeds, and fishes. FWS is responsible for protection of birds having Federal legal status. CDFG has jurisdiction over State endangered or threatened species found in State waters.

Details on the biology and distributions of the eight species observed within the study region are provided in Sections 3.3.5 (Marine Mammals), 3.3.4 (Marine Birds), and 3.4.1. (Commercial Fisheries). A brief summary of species occurrence (based on historic surveys and recent annual and seasonal censuses) within the four Study Areas is presented below.

Cetaceans

Humpback whales typically are found in the study region from March through January with greatest concentrations occurring from mid-August through October (Dohl *et al.* 1983; Baker *et. al.* 1986; Calambokidis *et al.* 1990a). Annual surveys conducted June 1985–1991 (Ainley and Allen 1992) recorded the greatest abundances (2–10 individuals) near the southeast corner of Study Area 2 and between Study Areas 3 and 4 (Figure 3.3.5-8b). In contrast, August surveys (Jones and Szczepaniak 1992) recorded similar numbers of individuals within Study Area 3 and the region between Study Areas 2 and 3 (Figure 3.3.5-8a).

Similar to humpback whales, the greatest abundances of blue whales within the Farallon Basin occur in summer and early fall, although overall numbers are lower than those of humpback whales (Dohl *et al.* 1983). Studies conducted from 1986–1989 identified a total of 179 blue whales within the Gulf of the Farallones (Calambokidis 1990b). In 1986, an aggregation of 41 blue whales was sighted near Southeast Farallon Island (National Marine Sanctuary Program 1987). Recent seasonal studies (Jones and Szczepaniak 1992) recorded blue whales between Study Areas 2 and 3 and within Study Area 3, with greatest abundances along the continental shelf break (Figure 3.3.5-9).

During their 1980–83 survey, Dohl *et al.* (1983) recorded 30 sightings for a total of 56 finback whales, primarily over continental shelf and slope waters. In addition, this survey observed a group of five to eight finbacks just south of the Farallon Islands, and a single individual approximately 20 km west of Point Reyes. No finback whales were sighted within the region during recent annual (Ainley and Allen 1992) and seasonal surveys (Jones and Szczepaniak 1992).

Dohl *et al.* (1983) characterized sperm whales as regular visitors to the Gulf of the Farallones, with records of 66 sightings for a total of 218 individuals from 1980–83. Most of the sightings occurred in deeper waters (> 1,700 m); four individuals were sighted in Study Area 5. Although sperm whales historically were listed as the sixth most common cetacean in the region, recent surveys recorded no sightings of this species (Ainley and Allen 1992; Jones and Szczepaniak 1992).

Pinnipeds

Due to a recent reduction in their numbers, northern sea lions were listed as threatened under the ESA. Although this species is one of three pinniped species that breeds in the region, few sightings were made during recent surveys (Ainley and Allen 1992; Jones and Szczepaniak 1992). Ainley and Allen (1992) recorded two sightings of single individuals, one near Cordell Bank and one nearshore within the eastern boundary of the GOFNMS. Similarly, Jones and Szczepaniak (1992) sighted only two individuals, one on the eastern boundary of Study Area 3 and one at the western boundary of Study Area 5.

Although currently not listed as endangered or threatened, the northern fur seal is considered depleted under the Marine Mammal Protection Act. It is found primarily over the continental slope and was the most abundant pinniped species in the study region during June surveys (Ainley and Allen 1992). During these surveys, low densities of northern fur seals (0.01–10 seals/km^2) were observed in all of the study areas, but mostly in Study Areas 3 and 5. Jones and Szczepaniak (1992) listed northern fur seals as the second most frequently sighted pinniped. Similar to Ainley and Allen (1992), most sightings occurred over the continental slope, although almost half of the sightings occurred west of the study areas (Jones and Szczepaniak 1992).

Birds

Peregrine falcons are Federally and State listed as endangered species. They are considered rare in the region, but historically bred on the Farallon Islands (DeSante and Ainley 1980). Currently, a relatively high number of individuals (5–8) continue to winter on the Islands (PRBO, unpubl. data). During winter/spring NMFS cruises, two peregrine falcons were observed foraging over waters north and west of the Farallon Islands (PRBO, unpubl. data). No peregrine falcons were observed during annual or seasonal surveys (Ainley and Allen 1992; Jones and Szczepaniak 1992).

Although currently Federally and State listed as endangered, California brown pelican populations appear to be recovering (Ainley and Allen 1992). Large numbers of pelicans roost at various sites within the general study region including the Farallon Islands (Pyle and Henderson 1991) and coastal mainland sites (Shuford *et al.* 1989). Recent annual surveys (Ainley and Allen 1992) suggest that pelican populations are concentrated nearshore, over waters shallower than 180 m (Figure 3.3.4-5). Seasonal surveys (Jones and Szczepaniak 1992) also concluded that abundances were greatest over continental shelf and upper slope waters.

Fishes

A dramatic reduction in winter-run chinook populations over the past two decades has led to its listing as a threatened species by the Federal government and as an endangered species by the State of California.

Winter-run chinook salmon are an anadromous species that pass through the Delta, San Pablo Bay, and San Francisco Bay during their upstream and downstream migrations (J. Turner, CDFG, pers. comm. 1991). Although this species is the least abundant Pacific salmon, it has the highest value per pound and is fished commercially in North America from Kotzebue Sound, Alaska, to Santa Barbara, California (Emmett *et al.* 1991). Ocean-dwelling juveniles occur primarily over continental shelf waters (Fredin *et al.* 1977). Commercial fish block data for the study region (MMS/CDFG Commercial Fisheries Database 1992) indicate highest abundances of salmon, including winter-run chinook, are caught within shelf regions such as Study Area 2 (Figure 3.4-3).

3.3.6.2 Species Occurring Irregularly Within the Study Region

In addition to the species listed in Table 3.3.6-1, several other species that are currently listed as endangered, threatened, or are candidates for special legal status occur irregularly within the study region.

Cetaceans

Sei and right whales currently are listed as endangered under the Federal ESA. Although the Gulf of the Farallones lies within the distributional range of both species (Caldwell and Caldwell 1983), neither were observed during historic surveys (Dohl *et al.* 1983) or during recent survey efforts (Ainley and Allen 1992; Jones and Szczepaniak 1992).

Pinnipeds

The Guadalupe fur seal (*Arctocephalus townsendi*) is considered a threatened species by Federal and State agencies. Currently, this species is known to breed only at Guadalupe Island, Baja, Mexico; sightings have been restricted to waters south of the Channel Islands (Bonnell *et al.* 1978). Historic estimates include approximately 2,000 individuals (Fleischer 1978). Guadalupe fur seals are believed to be pelagic throughout most of the year except during the summer breeding season. Although this species was not observed during recent annual and seasonal surveys (Ainley and Allen 1992; Jones and Szczepaniak 1992), it may be a rare visitor to regional waters (KLI 1991).

Fissipeds

The southern sea otter is a geographic variant of the Alaskan otter (Kenyon 1987), and was Federally listed as threatened in 1977. Its distribution ranges from Point Año Nuevo south to Pismo Beach (Jameson 1989). Although no sightings of the Southern sea otter were made within any of the study areas (Ainley and Allen 1992; Jones and Szczepaniak 1992), one was recorded near Point Año Nuevo, the northern extent of its range (Ainley and Allen 1992). Southern sea otters typically inhabit rocky intertidal and kelp bed areas (Ainley and Allen 1992). Thus, it is unlikely that they would be present within any of the deep, slope waters of the LTMS study areas.

Birds

The short-tailed albatross is also a Federally endangered species. According to Ainley and Allen (1992), only two individuals have been sighted in the study region, although historically the short-tailed albatross was a common species in offshore waters of the North American West Coast. Of the two individuals sighted within the region, one was seen at Cordell Bank and the other in Monterey Bay (PRBO, unpubl. data).

The marbled murrelet (*Brachyramphus marmoratus*) is a Federally threatened and State endangered species. This species rarely forages farther than three to five kilometers offshore (Ainley and Allen 1992) and was not observed within any of the study areas during annual or seasonal surveys (Ainley and Allen 1992; Jones and Szczepaniak 1992).

Turtles

The leatherback sea turtle (*Dermochelys coriacea*) is the most frequently sighted marine turtle within northern and central California (Dohl *et al.* 1983). This species currently is Federally listed as endangered. During recent seasonal surveys (Jones and Szczepaniak 1992), two sightings, each of a single leatherback turtle, were made. The first sighting occurred in shallow water (54 m depth) north of Study Area 2, while the second observation was at approximately 1,000 m depth, northeast of Study Area 4. Both sightings occurred in August, consistent with Dohl *et al.* (1983) findings of highest leatherback abundances during summer and fall months.

3.3.7 Marine Sanctuaries and Special Biological Resource Areas

Six areas are designated as marine sanctuaries, refuges, or special biological resource areas within the vicinity of the LTMS study areas. Four of these are Federally protected (GOFNMS, CBNMS, MBNMS, and the Farallon National Wildlife Refuge), and two are protected by the State of California (Farallon Islands Area of Special Biological Significance and the Farallon Islands Game Refuge) (Figures 3.3.7-1 and 3.3.7-2). Collectively, these six areas contain a wide diversity of sensitive habitats and biological resources, including threatened or endangered species.

3.3.7.1 Federally Protected Areas

Sanctuaries

The Marine Protection, Research, and Sanctuaries Act of 1972 (MPRSA) was designed to protect and manage discrete areas having special ecological, recreational, historical, and aesthetic resources. The Gulf of the Farallones, Cordell Bank, and Monterey Bay National Marine Sanctuaries (Figure 3.3.7-1) are three of eleven designated national marine sanctuaries. All national marine sanctuaries are administered by NOAA's Sanctuaries and Reserves Division (NOAA 1992).

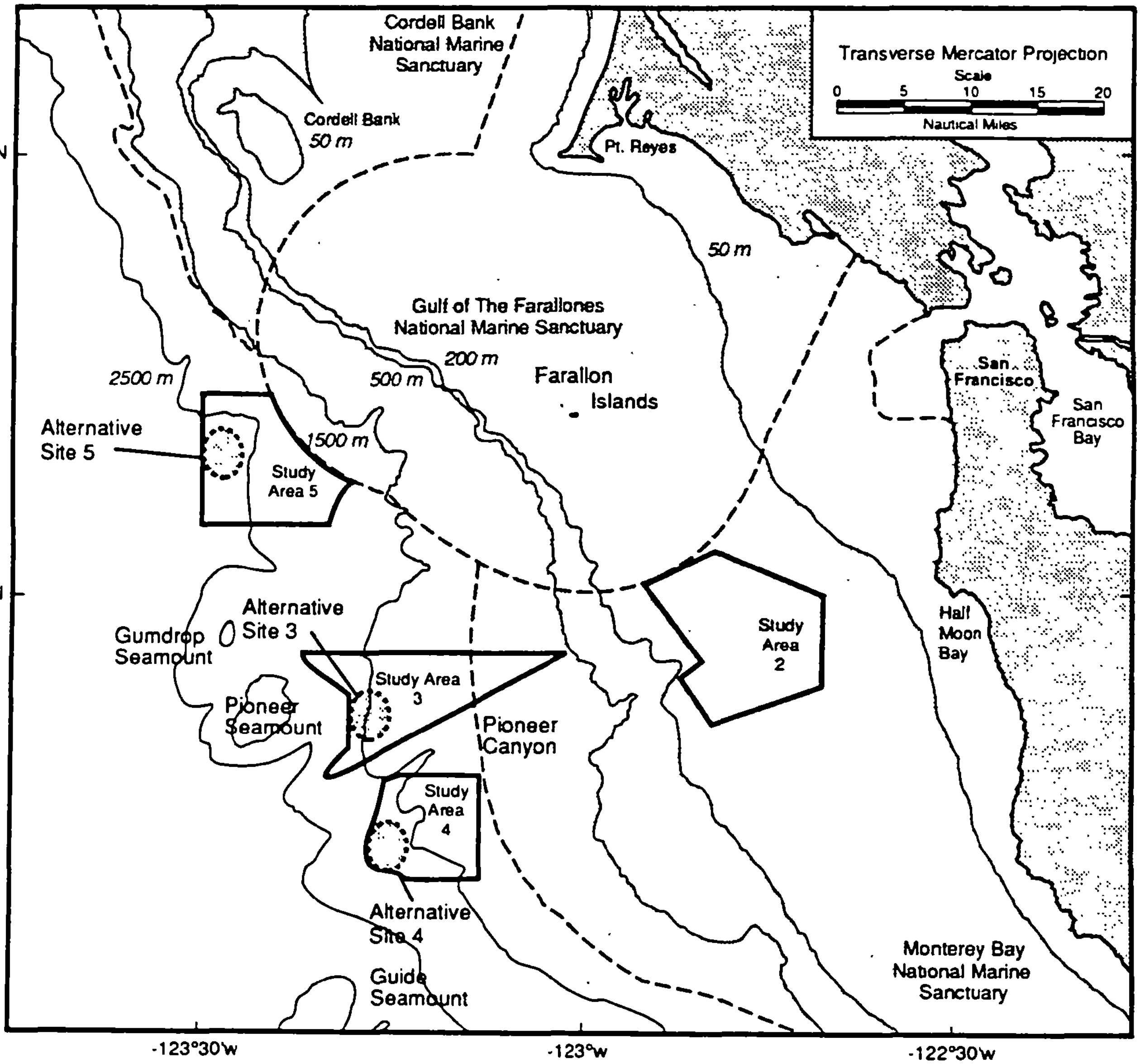

Figure 3.3.7-1. **National Marine Sanctuaries in the LTMS Study Region.**

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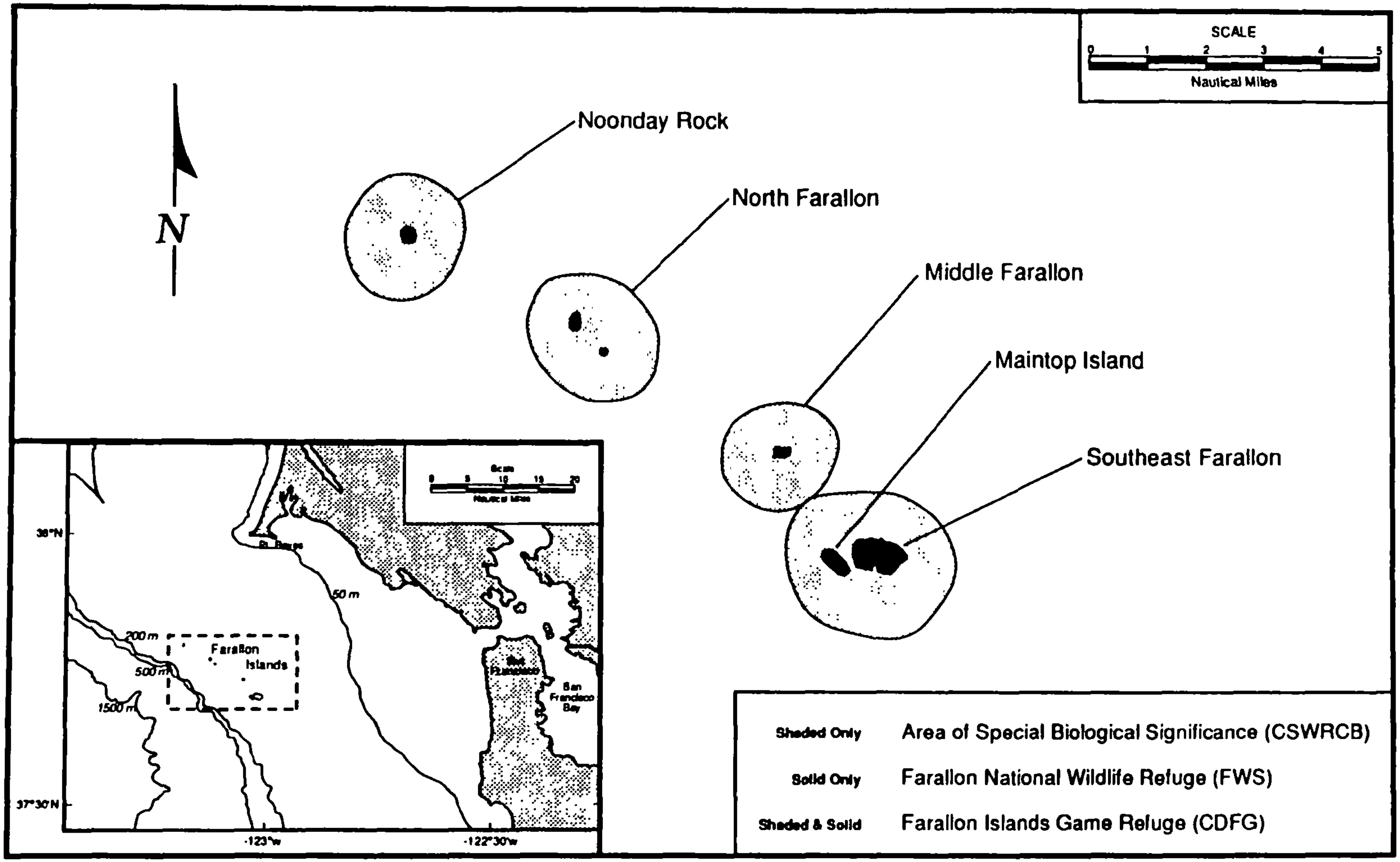

Source Smith and Johnson 1989.

Figure 3.3.7-2. Farallon National Wildlife Refuge, Farallon Islands Area of Special Biological Significance, and Farallon Islands Game Refuge.

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Gulf of the Farallones National Marine Sanctuary. The GOFNMS encompasses 948 nmi^2 of nearshore and offshore waters, most of which lie in the Gulf of the Farallones. The Sanctuary extends from approximately the western edge of the continental shelf (35 nmi offshore) to the coasts of Marin and Sonoma Counties. Alternative Site 3 is over 10 nmi southwest of the Sanctuary and more than 25 nmi southwest of the nearest Farallon Island. While Study Area 5 adjoins the western boundary of the Sanctuary, Alternative Site 5 lies nearly 25 nmi west of the Farallon Islands. Study Area 2 begins at the southern boundary of the Sanctuary and lies entirely within the MBNMS (Figure 3.3.7-1).

The selection of the GOFNMS as a sanctuary (January 16, 1981; Title XV CFR Part 936) was based on the high concentration of biological resources living within or migrating through its boundaries. These resources include: (1) marine vegetation (particularly kelp, eelgrass, and salt marsh species); (2) benthic fauna; (3) fish; (4) marine birds; and (5) marine mammals (NOAA 1980).

One of GOFNMS' most extensive resources is its marine bird population. The Farallon Islands are the most important marine bird breeding site on the west coast of the continental United States (Sowls *et al.* 1980; Briggs *et al.* 1987b). There are sixteen species of marine birds known to breed along the Pacific coast. Twelve of these species, including the American black oystercatcher, ashy storm-petrel, Brandt's cormorant, Cassin's auklet, common murre, double-crested cormorant, Leach's storm-petrel, pelagic cormorant, pigeon guillemot, rhinoceros auklet, tufted puffin, and western gull, have colonies on the Farallon Islands (Ainley and Lewis 1974). The Farallon Islands serve as the nesting grounds for a significant portion (up to 85%) of the world populations of ashy storm-petrels, Brandt's cormorants, and western gulls (Ainley and Allen 1992) as well as eighty percent of California's nesting Cassin's auklets (California Coastal Commission 1987). In addition, large numbers of California brown pelicans roost on the Farallon Islands regularly during summer and autumn. Endangered peregrine falcons also winter on the islands (NOAA 1980; Ainley and Allen 1992).

Aquatic birds also are found within the Sanctuary's lagoon, coastal bay, and four estuaries. Breeding species include the American coot, cinnamon teal, gadwall, great blue heron, great egret, killdeer, mallard, pied-billed grebe, and snowy plover. An additional twenty aquatic bird species summer in the region, and seven species occur as spring and fall migrants (KLI 1991).

Marine mammals also are a significant part of the Sanctuary's biological resources. Twenty species of whales and dolphins have been sighted in the Sanctuary, occurring either as migrants or regular inhabitants (Table 3.3.5-1). Of these, Dall's porpoise, harbor porpoise, and Pacific white-sided dolphin are considered common resident species (Ainley and Allen 1992). Large baleen cetaceans including gray whales and endangered blue and humpback whales are important migratory species (Dohl *et al.* 1983).

The Farallon Islands also serve as one of the most important pinniped haul-out grounds in California (Bonnell *et al.* 1983). California's largest mainland breeding population of harbor seals occurs within the Sanctuary, along with breeding herds of northern elephant seals and northern sea lions (Ainley and Allen 1992). The threatened southern sea otter is an occasional visitor to the Sanctuary (KLI 1991).

Cordell Bank National Marine Sanctuary. CBNMS encompasses 397 nmi^2 of ocean water overlying the northernmost submerged seamount on the California continental shelf. The CBNMS was designated a National Marine Sanctuary on May 24, 1989 (Title XV CFR Part 942). Ocean depths within the Sanctuary range from 35 m (at the peak of the Bank) to 1,830 m. Alternative Site 5 is located within approximately 10 nmi of Sanctuary boundaries (Figure 3.3.7-1); however, the Bank itself is located over 20 nmi from the site. Alternative Site 3 is located 30 nmi to the south of the Sanctuary.

The combination of upwelling, underwater topography, and the wide range of depths at Cordell Bank provides for a highly productive environment with unique associations between subtidal and deep-water species (NOAA 1989). Further, endangered or threatened marine mammal and reptile species, including blue, right, finback, sei, sperm, and humpback whales, Guadalupe fur seals, northern sea lions, and green, loggerhead, leatherback, and Pacific Ridley sea turtles, as well as the depleted northern fur seal, often are found at Cordell Bank. Due to its rich biological diversity, Cordell Bank is visited frequently by divers and fishermen (NOAA 1989).

Monterey Bay National Marine Sanctuary. The MBNMS (Figure 3.3.7-1) encompasses 4,024 nmi^2, ranging from Marin County to Cambria (NOAA 1992). It was designated a National Marine Sanctuary on September 18, 1992 (Title XV CFR Part 944). Portions of Study Area 3 and all of Study Area 2 lie within the Sanctuary boundaries.

The MBNMS supports a high diversity of marine resources. Monterey Canyon and its associated topographic features promote seasonal upwelling of nutrient-rich waters which support diverse biological assemblages of plankton, algae, invertebrates, fishes, marine birds, sea turtles, and marine mammals. Monterey Bay provides abundant prey items for many species of migratory marine birds. This area is an important habitat for winter populations of ashy storm-petrel and Cassin's auklet, among others. Several endangered species are observed regularly within the Sanctuary. The endangered California brown pelican is observed throughout the Sanctuary and along the coastline (Figure 3.3.4-5) (Ainley and Allen 1992; Jones and Szczepaniak 1992). Right whales, with a world-wide population estimated near 200, have been seen in waters off Half Moon Bay. A complete list of species present in the Sanctuary can be found in the Final Environmental Impact Statement and Management Plan for the Monterey Bay National Marine Sanctuary (NOAA 1992).

Highly sensitive nearshore and offshore resources within the Sanctuary include commercial fisheries, aquaculture operations, kelp harvesting, estuaries, sloughs, sandy beaches and rocky intertidal habitats, and nearshore littoral habitats (NOAA 1992). The commercially important Dungeness crab is harvested in local Sanctuary waters.

Wildlife Refuges

Farallon National Wildlife Refuge. The Farallon National Wildlife Refuge is maintained by the U. S. Fish and Wildlife Service (FWS) and includes Noonday Rock, North, Middle, and Southeast Farallon Islands, and Maintop Island (Figure 3.3.7-2). It is primarily a migratory refuge for 12 species of marine birds (including auklets, cormorants, guillemots, murres, puffins, and storm-petrels) but also serves as an important habitat for 5 species of pinnipeds (KLI 1991). The Wildlife Refuge is approximately 20 nmi due east of Alternative Site 5 and 25 nmi northeast of Alternative Site 3.

3.3.7.2 State Protected Areas

Areas of Special Biological Significance

Areas of Special Biological Significance (ASBSs) were designated under California State Water Resources Control Board Resolution No. 74-28 to provide special protection for biological communities and important marine species. Waste discharges within these areas are prohibited in order to preserve and maintain natural water quality.

Farallon Island Area of Special Biological Significance. The Farallon Island ASBS includes 2.2 nmi^2 of waters surrounding but not including Noonday Rock, North, Middle, and Southeast Farallon Islands (Figure 3.3.7-2), and Maintop Island (CSWRCB 1976). Within the ASBS are a highly diverse intertidal community and abundant marine mammal populations, including California and northern sea lions, elephant seals, and harbor seals. Rare and endangered species such as the California brown pelican, peregrine falcon, blue, finback, humpback, sei, and sperm whales also occur in the area (KLI 1991). The Farallon Island ASBS is approximately 20 nmi due east of Alternative Site 5.

Game Refuges

Farallon Islands Game Refuge. The Farallon Islands Game Refuge, under CDFG jurisdiction, encompasses the Farallon Islands and Noonday Rock and their surrounding waters extending 1 nmi from the coastline of each island (Smith and Johnson, 1989). It has an area similar to the combined areas of the Farallon National Wildlife Refuge and Farallon Islands ASBS (Figure 3.3.7-2). The regulations governing the use of the Game Refuge are coincident with those of the Wildlife Refuge and ASBS. The Farallon Island Game Refuge lies 20 nmi east of Alternative Site 5 (Figure 1.3-1).

Mainland Resource Areas

Other mainland coastal resource areas are located at least 30 nmi from the nearest alternative site. Results from modeling the dispersion of dredged material (see Section 4.4) indicate that sediments discharged at the alternative sites would not reach the mainland shore in detectable quantities.

3.3.8 Potential for Development or Recruitment of Nuisance Species

Some changes in the distribution and abundance of local biological communities are expected following any environmental disturbance, including dredged material disposal. Recolonization and recovery of a disturbed area and the resultant species assemblage will depend on numerous physical and biological interactions, including the size of the impacted area, the availability of larvae and adults, biological interactions among colonizers, and the severity and frequency of disturbance (Connell and Keough 1985; Lissner *et al.* 1991). Typically, recolonization of an altered environment begins with opportunistic species and proceeds through time to more stable communities typical of the surrounding area (EPA 1986a).

Some organisms that may be present in dredged material or that may be favored after a disturbance can be considered nuisance species. EPA defines nuisance species as "organisms of no commercial value, which, because of predation or competition, may be harmful to commercially important organisms; pathogens; or pollution tolerant organisms present in large numbers that are not normally dominant in the area" (EPA 1986a). These species can include viruses, pathogenic bacteria, protozoans, fungi, invertebrates, and fish, or they may include the eggs or spores of parasites that infect local fauna. In addition, in some environments dredged material disposal may alter water quality or local sediments so that pollution-tolerant organisms, normally occurring in low numbers, become the dominant species.

Dredged material disposal is unlikely to promote the development of nuisance species at any of the alternative sites due to: (1) significant differences between dredging and disposal site depths and habitat characteristics and (2) permit restrictions for ocean disposal of dredged material. The environment of the alternative sites consists of deep waters (depths > 1,400 m) and thus is expected to be very different, particularly in terms of dissolved oxygen, temperature, salinity, pressure, food availability, and larval availability, than the relatively shallow dredging sites. Therefore, the placement of shallow-water dredged material at sites of significantly greater depths is not expected to result in colonization or propagation of shallow water nuisance species. All dredged material proposed for disposal at the designated ODMDS must conform to MPRSA's permitting criteria for acceptable quality. The acceptability of the material will be determined by physical, chemical, and bioassay/bioaccumulation testing (EPA/COE 1991).

3.4 Socioeconomic Environment

This section presents information on the socioeconomic environment of the study region, including commercial and recreational fisheries (Section 3.4.1), mariculture (Section 3.4.2), shipping (Section 3.4.3), military usage (Section 3.4.4), mineral or energy development (Section 3.4.5), recreational activities (Section 3.4.6), and cultural and historical areas (Section 3.4.7).

3.4.1 Commercial and Recreational Fisheries

3.4.1.1 Existing Fisheries

The continental shelf and slope off San Francisco support a range of commercial fisheries utilizing a variety of methods including purse seine, dip net, trawl, trap, gill net, troll, and hook and line (Battelle 1989). The principal market species in this region include Dungeness crab, market squid, salmon, tuna, flatfishes (Dover sole, petrale sole, and English sole), a variety of rockfishes (*Sebastes* spp.; including shortbelly, widow, boccacio, chilipepper, splitnose, canary, and yellowtail), thornyheads (*Sebastolobus* spp.), and sablefish (MBC 1989; Tetra Tech 1987; Jow 1992). In addition to primary market species, a number of other species including albacore tuna, mackerels, anchovy, Pacific herring (*Clupea pallasii*), and several species of sharks have commercial value (MMS/CDFG Commercial Fisheries Database 1992). Within the entire San Francisco region (from Point Arena to Point San Pedro, offshore to a distance of 200 nmi) some of the most productive commercial fisheries areas are in the Gulf of the Farallones, including the vicinity of Study Areas 2 and 3 (MBC 1989; Oliphant *et al.* 1990). The estimated value of all major commercial fisheries within the San Francisco region in 1986 totaled over $23,680,000 (Oliphant *et al.* 1990; COE 1988). Figures 3.4-1 through 3.4-3 show the fisheries areas and describe the commercially important megafaunal invertebrates and fishes collected in CDFG catch blocks corresponding to each LTMS study area (including alternative sites).

Battelle (1989) concluded that fisheries resources of the continental shelf are of greater economic value than those in deeper areas. SAIC (1992b) and MMS/CDFG Commercial Fisheries Database (1992) found that some of the most productive areas were located in the deeper parts of Study Area 2 and the shallow part of Study Area 3 (Figure 3.4-1).

Battelle (1989) indicated that three catch block groups had trawl landings in excess of 0.4 million pounds (MP) in 1985. The first group (catch blocks 455 to 458 in depths less than approximately 100 m) had reported landings in 1985 of 0.58 MP, while the second group (catch block 475 in depths between 200 and 600 m) had trawl landings of 0.40 MP (Battelle 1989). The third catch block group (catch blocks 480, 481, and 482 at depths between 200 and 1,000 m) had reported landings in 1985 of 1.5 MP.

Based on analysis of MMS/CDFG Commercial Fisheries Database (1992) information from 1970 through 1986, Study Area 2 lies entirely within an area of moderate to high fisheries resources (0.5–72.5 MP; Figure 3.4-1), while the eastern (i.e., shallow) part of Study Area 3, on the upper

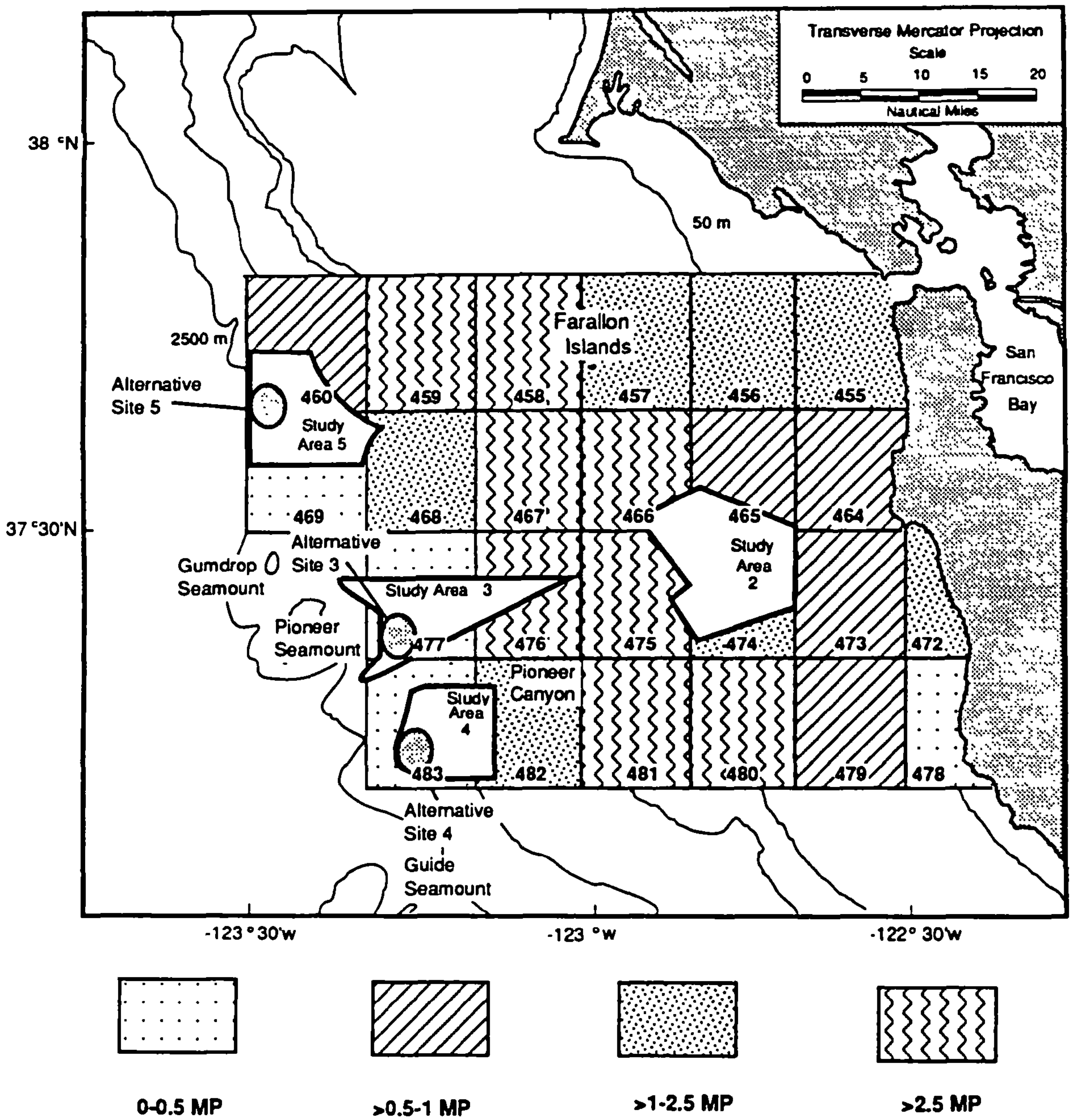

Figure 3.4-1. **CDFG Commercial Fisheries Catch Blocks Showing Locations of Blocks and Total Catches of Fishes and Invertebrates From 1970 to 1986 Within the LTMS Study Areas.**
Total catches are given in millions of pounds (MP).
Source: MMS/CDFG Commercial Fisheries Database 1992.

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continental slope, is represented by high fisheries resources (> 2.5 MP; Figure 3.4-1). Study Area 4 represents an area of low to intermediate fisheries resources, with between 0.5 and 2.5 MP taken from 1970 to 1986. The least productive fisheries resources area within the study region was Study Area 5 (0.5–1 MP).

The landings and catch block data must be interpreted with some caution because they represent reported areas where fish were taken, and the accuracy of these data is difficult to verify. Fish landed in a small portion of a given block may be extrapolated to the entire block or to groups of blocks. Apparently unusual increases in the landings of a given species may actually represent the first time a particular area was fished for that species. Another limitation is that the fishing effort associated with the landings is not known for each catch block. For example, high catches of flatfishes could represent high abundances from a few trawls or moderate catches from many trawls.

The fishery resources for each study area are summarized in the following sections.

Study Area 2

Of the four LTMS study areas, the most significant commercial and recreational fisheries exist on the continental shelf within Study Area 2. The total amount of all megafaunal invertebrates collected commercially in the four primary catch blocks corresponding to Study Area 2 between 1970 and 1986 was over 29,000 pounds (Figure 3.4-2).

Commercially collected megafaunal invertebrates in these catch blocks include red urchins (*Strongylocentrotus franciscanus*); market squid (*Loligo opalescens*); a variety of crabs (*Cancer* spp, presumably including Dungeness crab, *C. magister*, although not specifically identified in MMS/CDFG Commercial Fisheries Database 1992); abalone (*Haliotis* spp.); and various species of bivalves including clams, mussels, and scallops (SAIC 1992b; MMS/CDFG Commercial Fisheries Database 1992; Bence *et al.* 1992). Wild and Tasto (1983) also reported that a significant fishery for Dungeness crab exists at depths centered between 36–64 m. The CDFG Recreational Fisheries Database (1992) lists Dungeness crab as the only megafaunal invertebrate taken in Study Area 2, although few individuals were collected.

Commercially collected fishes within the study area include lingcod (*Ophiodon elongatus*), anchovy, Pacific herring, salmon, albacore tuna, sablefish, various species of rockfishes, and a variety of flatfish species including Pacific sanddabs (*Citharichthys sordidus*), Dover sole (*Microstomus pacificus*), rex sole (*Errex zachirus*), English sole (*Pleuronectes vetulus*), and petrale sole (*Eopsetta jordani*; SAIC 1992b; MMS/CDFG Commercial Fisheries Database 1992; Bence *et al.* 1992; Jow 1992; Battelle 1989). Between 1970 and 1986, the total amount of fish taken commercially in the four catch blocks comprising Study Area 2 exceeded 19 million pounds, as opposed to approximately 10 million, 4 million, and 2 million pounds in Study Areas 3, 4, and 5, respectively (Figure 3.4-3). Of these commercially targeted species, flatfishes, rockfishes, salmon, and albacore tuna represented the most important fisheries. Predominant fishes taken by recreational fishermen in the two of the four catch blocks corresponding to Study

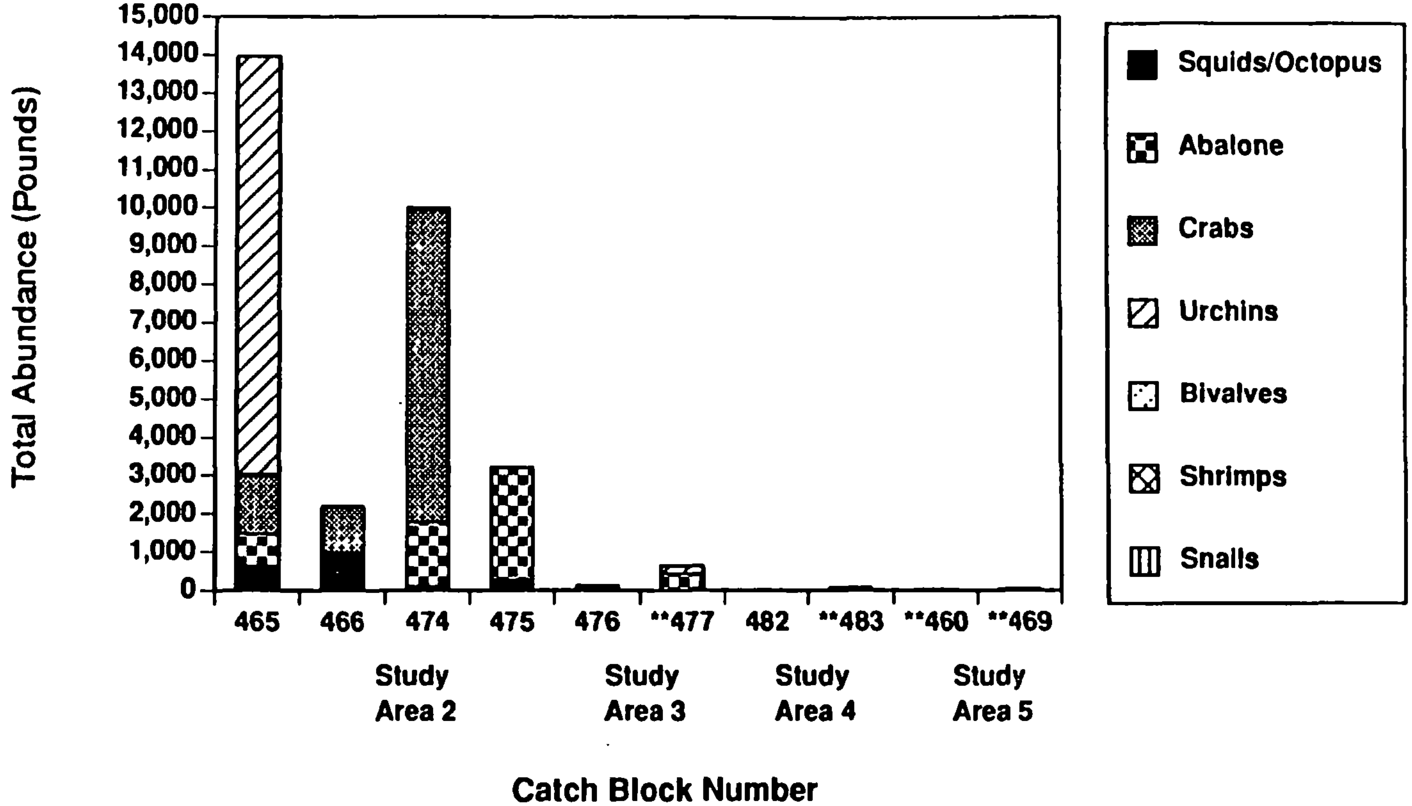

Figure 3.4-2. **Commercially Collected Megafaunal Invertebrates (by catch block in pounds) Within the LTMS Study Areas Between 1970 and 1986.**
**Location of the Alternative Site.
Source: MMS/CDFG Commercial Fisheries Database 1992.

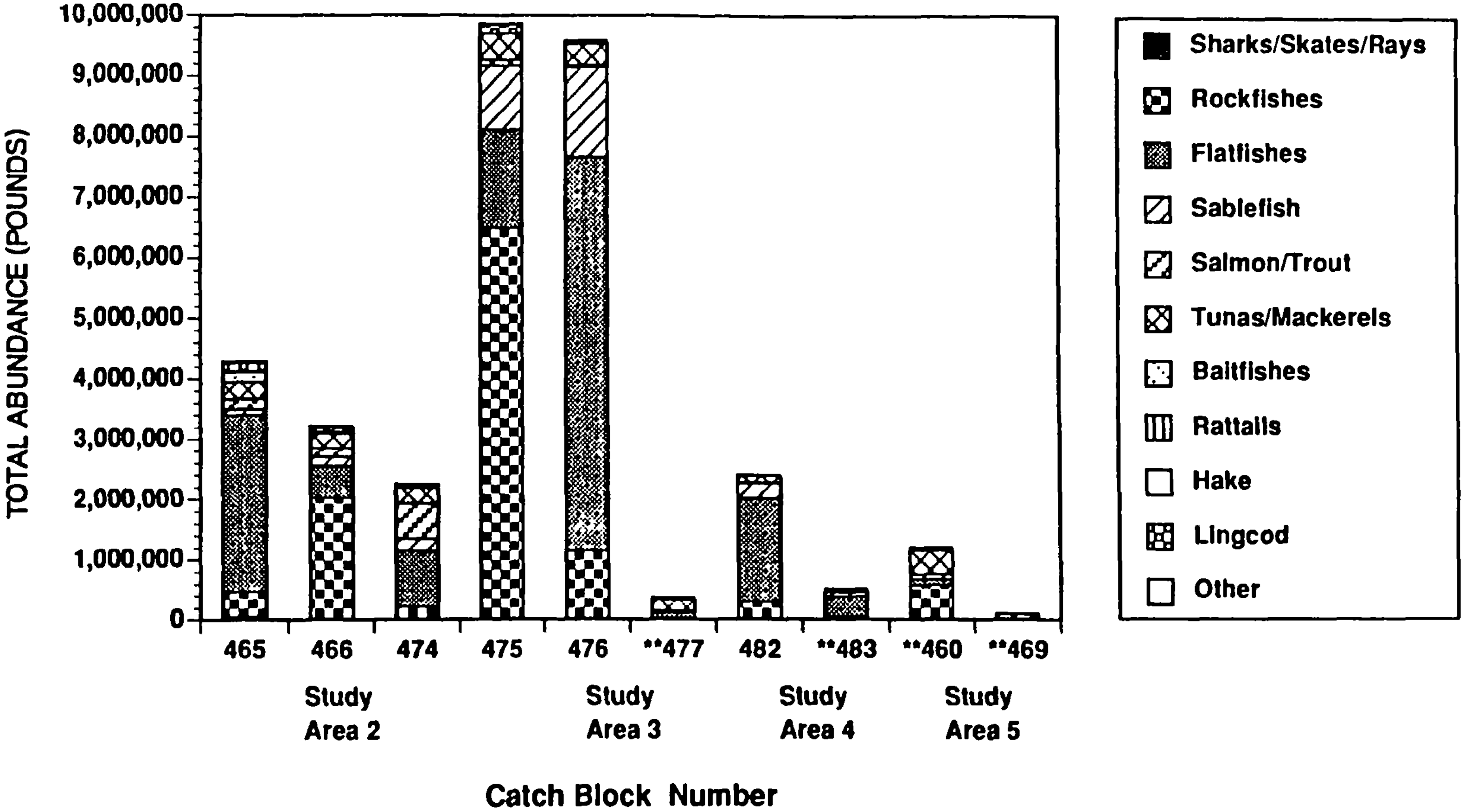

Figure 3.4-3. **Commercially Collected Fishes (by catch block in pounds) Within the LTMS Study Areas Between 1970 and 1986.**
**Location of the Alternative Site.
Source: MMS/CDFG Commercial Fisheries Database 1992.

Area 2 (Catch Blocks 465 and 474) included rockfishes, salmon, albacore tuna, and lingcod (CDFG Recreational Fisheries Database 1992).

Study Area 3

Study Area 3 contains moderate to high commercial fisheries for both megafaunal invertebrates and fishes in the shallow areas (Catch Block 476) but very limited fisheries in the deeper portions (Catch Block 477) including Alternative Site 3 (Figures 3.4-2 and 3.4-3). From 1970 through 1986, commercially collected megafaunal invertebrates were virtually nonexistent within the Study Area 3 (including Alternative Site 3), with a total of less than 1,000 pounds taken from the two catch blocks corresponding to this study area (Figure 3.4-2). Based on the MMS/CDFG Commercial Fisheries Database (1992), a limited abalone fishery exists in the deeper part of the study area, (Catch Block 477; Figure 3.4-2), although this probably reflects reporting or tabulation errors in the database. No megafaunal invertebrates were taken by recreational fishermen in this study area (CDFG Recreational Fisheries Database 1992).

Commercially collected fishes included flatfishes (primarily Dover sole, rex sole, English sole, and petrale sole), sablefish, rockfishes, and albacore. The total amount of fish taken in the shallow parts of this study area exceeded 9 million pounds between 1970 and 1986 (Figure 3.4-3), with flatfishes being the predominant species.

Study Area 4

From 1970 through 1986, very limited commercial fisheries for megafaunal invertebrates existed in Study Area 4 (including Alternative Site 4) (Figure 3.4-2), probably due to difficulties in handling fishing gear at these greater depths. No megafaunal invertebrates were taken by recreational fishermen (CDFG Recreational Fisheries Database 1992). Commercial catches of fishes in the shallow part of Study Area 4 (Catch Block 482, located shoreward of Alternative Site 4) were represented by several species, including flatfishes, sablefish, rockfishes, tunas, and mackerels (Figure 3.4-3). In the deeper part of Study Area 4 (Catch Block 483), including Alternative Site 4, catches were substantially lower, with a total of approximately 600,000 pounds taken from 1970 through 1986. Flatfishes comprised almost 80% of this total. Very few species of fishes such as sharks and tunas were taken by recreational fishermen in this study area (CDFG Recreational Fisheries Database 1992).

Study Area 5

Based on available data, Study Area 5 is characterized by no megafaunal invertebrate fisheries and is a low to moderate commercial fisheries area for fishes (Figures 3.4-2 and 3.4-3). Predominant fishes taken commercially include rockfishes, flatfishes, tunas and mackerels, and sablefish (Figure 3.4-3). However, the region of Alternative Site 5 (Catch Block 469) is characterized by substantially lower fisheries resources. The primary recreational fisheries in this study area are for pelagic species such as some rockfishes, salmon, and tunas (CDFG Recreational Fisheries Database 1992), although catches are low relative to the other study areas.

Detailed information on key existing fisheries species is presented below.

Dungeness Crab

Because of its economic importance to commercial fisheries in central and northern California (as well as Oregon, Washington, British Columbia, and Alaska), the population dynamics of the Dungeness crab have been studied extensively (summarized in MBC 1987). Dungeness crabs typically occur in depths from low tide to approximately 180 m, although they are most abundant in inshore coastal waters (MBC 1987). Dungeness crab catches in the San Francisco region have varied substantially over the years, with a peak catch of 8.9 million pounds in 1956–57 and a sharp decline to a total of 700,000 pounds from 1980 to 1985 (COE 1988). In 1986, over 1.2 million pounds were taken in the San Francisco region, for a total value of over $2.3 million (Oliphant *et al.* 1990). The Dungeness crab fishery continued to show a substantial recovery in 1987–1988 when 3.1 million pounds were taken in the San Francisco region. However, 1988–89 catch results indicated a decline of more than 50% from the previous year (CALCOFI 1990). Pollution stress to juvenile stages has been suggested as a possible cause for these substantial declines (Wainwright *et al.* 1992). Other causes for population fluctuations may include oceanographic factors (temperature and currents), overfishing, parasitism, predation, and environmental degradation (Wild and Tasto 1983). Consequently, water quality monitoring and habitat protection measures have been recommended by CDFG to protect this resource (Wild and Tasto 1983). It is notable that Dungeness crab were uncommon in recent EPA trawl and ROV surveys conducted in Study Area 2 (SAIC 1992b). This may be related partly to the sampling gear used (bottom trawls) since traps are the most common commercial method used to collect Dungeness crabs. The MMS/CDFG Commercial Fisheries Database (1992) indicated market crabs were collected in low numbers in catch blocks corresponding to Study Area 2 (Figure 3.4-2).

Market Squid

Market squid are fished commercially from Baja California to British Columbia, with major fishing grounds located off central California (MBC 1989, 1987). Market squid typically are collected using small purse-seines and dip nets. Historically, market squid have been an important commercial fishery, representing one of the top five in California in terms of weight harvested (MBC 1987). Between 1983 and 1985, an average of 467,000 pounds per year was harvested off California, while 1.8 million pounds were taken in 1986, representing a value of almost $215,000 (Oliphant *et al.* 1990). Although the amount of market squid harvested is large, the overall dollar value is low due to low market prices. Based on analysis of the MMS/CDFG Commercial Fisheries Database (1992), market squid (combined with other squids and octopus) represent a limited fishery in the general study region, occurring only at continental shelf depths including Study Area 2 (Figure 3.4-2). Similarly, Bence *et al.* (1992) suggest that market squid abundances are highest inshore, at depths less than 180 m. Market squid were collected as incidental catch in Study Area 2 by SAIC (1992b); however, none were collected in any of the other study areas or alternative sites.

Pelagic Fishes

The predominant pelagic fishes, defined as those species which spend all or part of their life in the water column (Moyle and Cech 1988), of commercial importance in the study region are anchovies, herring, juvenile rockfishes, and hake. Some species such as salmon and tuna can occur in large numbers seasonally while migrating through the general study region (Oliphant *et al.* 1990).

Northern anchovy (*Engraulis mordax*) are distributed from British Columbia to the tip of Baja California, occurring from the surface to depths greater than 300 m (Love 1991). Northern anchovy are a major component of the commercial and baitfish fisheries in California. For example, anchovy harvests have varied from 508,772 pounds in 1977 to over one million pounds in 1980 (Oliphant *et al.* 1990). Between 1983 and 1985 an average of almost 830,000 pounds were taken, while in 1986 approximately 865,000 pounds, representing a total value of almost $92,000, were collected in the San Francisco region (Oliphant *et al.* 1990). Bence *et al.* (1992) indicated that juvenile northern anchovy were most abundant in the shallow inshore areas such as Study Area 2.

Pacific herring catches within the San Francisco region were consistently high from 1983 through 1985, averaging over 16 million pounds per year (Oliphant *et al.* 1990). The 16.4 million pounds collected in 1986 represented a value of almost $5.3 million. Pacific herring were collected by SAIC (1992b) in low numbers in Study Area 2, representing incidental catch. Similarly, the MMS/CDFG Commercial Fisheries Database (1992) reports that pelagic fishes, including anchovy and Pacific herring, were collected only in low numbers in the catch blocks corresponding to Study Area 2 (Figure 3.4-3).

Pacific hake (*Merluccius productus*) can occur in dense midwater schools and range in distribution from the Bering Sea to Baja California at depths between 10 to 1,000 m (Love 1991). However, this species is not normally targeted by recreational fishermen because of its deep distribution, and is a smaller component of commercial fisheries in the San Francisco region. SAIC (1992b) collected Pacific hake in low numbers using bottom trawls in Study Area 2 and in adjacent mid-depth and Pioneer Canyon locations. Bence *et al.* (1992) concluded that Pacific hake had their highest abundances at intermediate depths corresponding to areas such as the shallow portions of Study Area 3 (i.e., not including Alternative Site 3). Although this species is not currently taken in high numbers, it represents a valuable potential fishery.

Other pelagic species having considerable commercial value are salmon and tuna. Salmon (chinook and coho) in the San Francisco region are a popular partyboat and commercial species, normally trolled for at depths of up to 600 m (MBC 1989). In 1986, over 2.7 million pounds of salmon were taken in the San Francisco region, accounting for a value of approximately $5.6 million. In 1988, the California salmon fishery catch increased to approximately 6.4 million lbs (PFMC 1993). Since 1988, this fishery has steadily declined with catches in 1992 totaling approximately 550,000 lbs (J. Lee, CDFG pers. comm. 1993). Albacore tuna (*Thunnus alalunga*), a valuable gamefish for recreational and sport fishermen (MBC 1987), are most abundant from August through October (Squire and Smith 1977). In 1986, over 500,000 pounds of albacore, representing an estimated value of $326,000 (Oliphant *et al.* 1990), were taken in the San Francisco region.

Roundfishes

Roundfish fisheries in the San Francisco region are comprised primarily of lingcod, sablefish and hake (discussed above). Lingcod (*Ophiodon elongatus*) typically occur in nearshore coastal environments from the Gulf of Alaska to Ensenada, Mexico (Love 1991). Juvenile lingcod are primarily pelagic and distributed nearshore (Bence *et al.* 1992), while larger juveniles live near the bottom over a variety of habitats including sand and gravel and eelgrass beds. Adults typically are found on soft bottoms, moving into rocky areas as they grow older (Love 1991). Lingcod are taken by sport and recreational fishermen as well as commercially. Between 1983 and 1985 an average of almost 860,000 pounds were taken in the San Francisco region. In 1986, over 400,000 pounds representing a total value of almost $140,000 were taken in the San Francisco region (Oliphant *et al.* 1990). During trawl surveys by SAIC (1992b), lingcod were only collected in Study Area 2; however, these represented only low abundances of juveniles.

Sablefish (*Anoplopoma fimbria*) occur from the inner shelf to depths of almost 3,000 m (Miller and Lea 1972). Juvenile sablefish occur on the shelf and upper slope, while spawning adults occur deeper than 1,000 m. The highest reported densities of sablefish are at depths between 324 and 990 m (Allen and Smith 1988). In the study region, sablefish were caught in trawls primarily between 128 and 1,097 m, with the highest catches between 366 and 823 m (Jow 1992). This species also is taken in traps and longlines at deeper depths usually between 384 and 1,262 m. Between 1983 and 1985, an average of almost 1.9 million pounds were taken in the San Francisco region, while approximately 3.4 million pounds (a value of almost $1.4 million) were collected in 1986 (Oliphant *et al.* 1990). Sablefish were collected during trawl surveys by SAIC (1992b) in Study Areas 2, 3, and 4; however, their abundances were highest in adjacent mid-depth and Pioneer Canyon locations at depths between 252 to 1,170 m. No sablefish were collected by Cailliet *et al.* (1992) in Study Area 5, including the Alternative Site 5 region.

Groundfishes

Groundfish fishery resources in the study region are diverse and comprised of a number of rockfishes (primarily including shortbelly, widow, boccacio, canary, chilipepper, yellowtail, and thornyheads), and flatfishes (Dover sole, petrale sole, English sole, rex sole, and sand sole). In 1987, commercial groundfish landings of more than 20,000 metric tons were recorded within the Monterey International North Pacific Fisheries Commission (INPFC) Region, exclusive of foreign fishing and joint ventures (Battelle 1989). Data on commercial groundfish resources for Study Areas 2 through 5 primarily are taken from the MMS/CDFG Commercial Fisheries Database (1992) and CDFG Trawler Database (Jow 1992), while recreational catches are from the CDFG Recreational Fisheries Database (1992).

Landing data for groundfishes have a number of limitations including how certain groups are classified. For example, chilipepper rockfish may be grouped in "rockfish", "chilipepper", or "chilipepper/boccacio" categories. The potential inaccuracy of many of these landing reports must be considered because numerous databases are available for analysis of commercial landings, and conflicting information may be contained within and between each of them.

Rockfishes. The rockfish complex consists of a number of species (*Sebastes* spp. and *Sebastolobus* spp.) collected from the middle continental shelf to areas deeper than 1,400 m; however, most rockfishes are taken commercially at depths between 100 to 400 m (MBC 1987). Most deepwater species of thornyheads (*Sebastolobus* spp.) are taken at depths between 90 to 800 m, although some have been fished at depths as great as 1,400 m (Allen and Smith 1988). The most important rockfish species in terms of annual revenues to commercial fisheries are chilipepper (*Sebastes goodei*), boccacio (*S. paucispinis*), splitnose (*S. diploproa*), yellowtail (*S. flavidus*) and widow rockfish (*S. entomelas*). Widow rockfish catches reached their highest total in 1982, with almost 12 million pounds collected representing a value of approximately $1.6 million (Oliphant *et al.* 1990). Oliphant *et al.* (1990) presents combined data for chilipepper and boccacio. Chilipepper/boccacio catches from 1983 through 1985 averaged over 3.4 million pounds, while in 1986 approximately 1.8 million pounds representing a value of $570,000 were taken (Oliphant *et al.* 1990). SAIC (1992b) collected 12 species of rockfishes throughout the study region. Chilipepper and shortbelly (*S. jordani*) had the highest abundances in Study Area 2, as well as in adjacent mid-depth and Pioneer Canyon locations. Midwater trawls conducted by Bence *et al.* (1992) indicated juvenile rockfish as a group were consistently most abundant inshore, including depths similar to Study Area 2, but also were relatively abundant in some offshore locations including the region of Study Area 5 and Alternative Site 5. In contrast, abundances in Study Areas 3 and 4 were somewhat less, representing moderate to high numbers (Bence *et al.* 1992).

Flatfishes. Dover sole (*Microstomus pacificus*) comprise the largest flatfish fishery in the San Francisco region. They are collected from the Bering Sea and Aleutian Islands southward to central Baja California on the inner continental shelf to depths greater than 900 m, but primarily are taken commercially in trawls at depths between approximately 300 and 900 m (Love 1991; MBC 1987). In 1986, Dover sole landings in the San Francisco region totaled almost 6.3 million pounds representing a value of over $1.6 million (Oliphant *et al.* 1990). Dover sole were collected by SAIC (1992b) within Study Areas 2 and the shallow parts of Study Areas 3 and 4 (not including Alternative Sites 3 or 4). The highest numbers of Dover sole collected by SAIC (1992b) were in the mid-depth and Pioneer Canyon locations at depths ranging from 252 to 500 m.

Petrale sole occur from the Bering Sea southward to northern Baja California, but are most abundant from southern California northward (Love 1991). They are taken at depths ranging from the intertidal to greater than 600 m, but are collected most often between 100 to 300 m. This species is taken by sport and recreational fishermen, as well as by commercial trawlers. From 1983 to 1986, an average of nearly 400,000 pounds per year of petrale sole were taken in the San Francisco region, representing an average value of $300,000 annually (Oliphant *et al.*

1990). Bence *et al.* (1992) and Jow (1992) suggests that the highest abundance of this species is at depths less than 180 m, corresponding to similar depths as Study Area 2. SAIC (1992b) collected this species infrequently and in low numbers in Study Area 2.

English sole are found from the Aleutian Islands to southern Baja California, with their distribution centered from the Gulf of Alaska to southern California, at depths ranging from intertidal to almost 600 m (Love 1991). Historical population centers of English sole in California are located off San Francisco, Eureka, Fort Bragg, Monterey, and Santa Barbara (MBC 1987; Frey 1971). From 1983 to 1985 an average of over 700,000 pounds of English sole were taken in the San Francisco region, while nearly 900,000 pounds representing a value of almost $327,000 were taken in 1986. Within the study region, the major trawl fishery for this species occurs between 37 and 146 m, corresponding to Study Area 2 depths (Jow 1992). SAIC (1992b) collected this species in moderate numbers within Study Area 2. Consistent with their relatively shallow depth distribution, English sole were not observed in Study Areas 3, 4, and 5.

Rex sole have a similar distribution as Dover sole and English sole and are taken at depths ranging from the intertidal to at least 900 m, but are most frequently collected at depths between 100 to 150 m (Love 1991). In the study region, trawl catches were recorded from depths between 18 and 914 m, with most catches occurring between 366 and 549 m depth (Jow 1992). Although this species does not comprise a major part of the commercial flatfish catch in the San Francisco region, an average of over 300,000 pounds was taken between 1983 and 1985, while over 400,000 pounds representing a value of almost $152,000 were taken in 1986. Rex sole were collected by SAIC (1992b) in Study Area 2, as well as at adjacent mid-depth and Pioneer Canyon locations. This species was not collected in any of the other study areas. Bence *et al.* (1992) indicate that juvenile rex sole collected in midwater trawls had the highest abundances in Study Area 5 relative to the other study areas. In contrast, research bottom trawls indicated that adult rex sole were most abundant at depths between 100 to 500 m, corresponding to depths such as Study Area 2 and the shallow part of Study Area 3 (Bence *et al.* 1992).

3.4.1.2 Potential Fisheries

In general, limited fisheries currently exist in depths greater than 900 to 1,440 m (R. Lea, CDFG, pers. comm. 1991). However, data on deep demersal fishes with fisheries potential are available from studies conducted in other areas at similar depths (Pearcy *et al.* 1982; Stein 1985; Wakefield 1990). Currently, the only deep demersal species being targeted are various grenadiers (rattails).

Several fish species represent a potential future fishery resource. Potential or currently underutilized species include shortbelly rockfish, Pacific sanddab, jack mackerel, ocean sunfish, Tanner crab, king crab, rock crabs, krill, giant Pacific octopus, spiny dogfish, sea cucumber, sheep crab, grenadier, hagfish, sharks, and skates (NMFS 1983; S. Kato, NMFS, pers. comm. 1991). Shortbelly rockfish have been identified by NMFS Tiburon as an unexploited fishery with major potential (Chess *et al.* 1988; Lenarz 1980). Bence *et al.* (1992) indicated high abundances of certain species of juvenile rockfishes in Study Area 5 which are an important potential component to the commercial fishery in that area. Other less heavily fished species include hagfish (*Eptatretus* spp.), for which a substantial trap fishery exists for their skins even though these skins are of poor quality, fishing is difficult, and pay for fishermen is low. Wakefield (1990) found black hagfish (*E. deani*) to be predominant along camera sled transects off Point Sur from depths between 400 and 1,200 m, with a strong peak in abundance within the 600 m depth zone. Wakefield (1990) estimated that 82% of the total population of black hagfish resided in this depth zone. Hagfish were collected infrequently by SAIC (1992b) within the entire study region and only in Study Area 3 at approximately 1,000 m depth.

In summary, of the four LTMS study areas, Study Area 2 contains the most substantial commercial fisheries resources and is considered by commercial fishermen to be a very significant area (P. Parravano, Halfmoon Bay Fisherman's Association, pers. comm. 1990). The area is dominated by market fishes such as rockfishes, flatfishes, salmon, and tuna. The shallow parts of Study Areas 3 and 4 (not including Alternative Sites 3 and 4) contain some commercially important species such as flatfishes, rockfishes, salmon, and tuna. The deeper parts of Study Areas 3 and 4 (including Alternative Sites 3 and 4) and Study Area 5 have limited commercial fisheries resources.

3.4.2 Mariculture

Several mariculture operations exist in nearshore embayments of the San Francisco Bay region. These consist primarily of oyster culturing operations in Tomales Bay and Drakes Estero sites leased from CDFG. However, these operations are located over 20 nmi from the nearest study area (Study Area 2) and over 50 nmi from the alternative sites, and therefore are very unlikely to be affected by use of any of the sites.

Mariculture activities in Tomales Bay consist of relatively small lease areas (4–120 hectares). The majority of oysters raised and marketed are giant Pacific oysters (*Crassostrea gigas*) with a commercial value in 1990 of over $800,000 (T. Moore, CDFG, pers. comm. 1992). The remaining mariculture species in Tomales Bay consist of European oysters valued at over $5,000/yr and mussels valued at $18,000/yr in 1990 (T. Moore, CDFG, pers. comm. 1992). Oyster culture in Drakes Estero represented approximately 30% of California's total commercial crop in 1990 (T. Moore, CDFG, pers. comm. 1992). The primary lease in Drakes Estero covers 425 hectares and runs until 2015 (National Park Service 1986). The giant Pacific oyster is the principal species cultured.

3.4.3 Shipping

Ships from six publicly used ports, 11 military installations, and several proprietary installations use the 11 navigable waterways in the San Francisco Bay and Delta. It is estimated that $5.4 billion of economic activity is directly dependent on deep and shallow draft navigation channels in the San Francisco Bay and Delta regions (COE 1990b). Commercial shipping supports up to 35,000 full-time jobs, exclusive of jobs supported by Navy activities.

Movements of all types of vessels within the Bay have exceeded 61,000 per year since 1980. and annual vessel movements in 1991 exceeded 86,000 (Table 3.4-1). A vessel movement is defined as any occasion when a vessel enters San Francisco Bay from the Pacific Ocean, moves within the Bay, or departs the Bay for the Pacific Ocean. The majority (81%) of these movements are by small vessels such as ferries, tugs, and dredge barges and primarily involve transits within the Bay.

The Coast Guard has established a Vessel Traffic Service (VTS) to reduce vessel collisions and groundings and potential environmental or other resource damage that could result from such incidents. As a safety measure, VTS has established a precautionary zone and vessel traffic lanes around major traffic intersections (see Figure 2.1-3). A precautionary zone 22.1 km in diameter is located west of San Francisco Bay and facilitates safe vessel turning movements into and out of the Golden Gate. VTS serves in an advisory capacity, coordinating and monitoring vessel movements using commercial and surveillance radar as well as closed circuit television, and utilizes a radio network to communicate information to inbound, outbound, and within the Bay vessels (Ogden Beeman 1991). Traffic data are maintained by vessel type for movements within the Bay, but are not maintained for movements through the Golden Gate, in the precautionary zone, or in the vessel traffic lanes. Approximately 38% of arriving and departing vessels use the Northern Traffic Lane, 20% the Western, and 42% the Southern. The majority of tanker traffic uses the Western Traffic Lane. The Coast Guard does not specifically track vessel traffic within any of the LTMS study areas (Lt. Cmdr. Gibson, USCG VTS, pers. comm. 1992).

Movements through the Golden Gate account for only a small percentage (6.9%) of all vessel traffic, although they represent a large percentage of the commercial cargo, Coast Guard, Navy, tanker, and other large vessel movements. A summary by vessel type of the percentage of total vessel movements that include transiting through the Golden Gate is presented in Table 3.4-2. These movements represent approximately 99% of all military and commercial traffic, but very few recreational vessel movements. Accurate transit data on recreational and small vessel, including fishing vessel, movements is unavailable since they do not participate in the Coast Guard's VTS (Lt. Cmdr. Gibson, USCG VTS, pers. comm. 1992). However, they are estimated to be about 25 to 50 times the number of large commercial and military vessel movements. This summary is based on the professional judgment of Coast Guard personnel, and reflects traffic conditions during a typical year in the 1980's.

Vessels transporting dredged materials to a disposal site would traverse the traffic lanes shown in Figure 2.1-3 and contribute to the total traffic volume. Based on conservative assumptions of approximately one barge-load every 12 hours (see Section 4.4), this would equate to approximately 730 additional vessel transits. Given the rough or foggy conditions that may be common in the study region (see Section 3.2.1), there is some small risk of collisions by towed barges and hopper dredges within the Bay and the traffic lanes leaving the Bay. However, historically the number of collisions or near collisions among vessels within and near San Francisco Bay has been small. Between 1980 and 1989, collisions occurred an average of three times per year and represent a comparatively small number given the high overall traffic volume. Overall, incidents of all types, including collisions, occurred an average of six times per year.

Table 3.4-1. Total Vessel Transits in the San Francisco Bay Region, 1980-1991.

Vessel Types	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991
Commercial	8102	7191	6516	6633	7225	6653	5982	6298	6090	5761	5877	5876
Hazardous	58	93	87	81	93	85	52	83	79	95	83	97
Navy, Surface vessels	669	847	850	892	840	796	866	1227	1359	2236	1913	1823
Coast Guard	1173	4275	4266	2999	3578	3567	3411	5697	2096	2572	1907	1788
Navy, Submarines	83	139	112	1333	146	87	97	71	67	67	70	69
Foreign Navy	34	28	17	60	30	34	26	25	40	45	59	49
Tugs without Tows	4176	5076	4919	5207	4326	3267	2804	1611	1070	868	525	517
Tugs with Tows	13386	16003	17792	15812	14978	13504	14139	14091	13507	13790	14553	13081
Deep Draft	185	159	103	135	152	158	180	194	219	248	205	700
Ferries	26467	24993	24008	28710	28306	31307	41605	45564	45520	56036	58343	56100
U.S. Government	0	0	0	0	344	771	659	830	906	935	1081	904
Non-Channel 13 (Large Vessels Not Using VTS)	1201	1348	1945	1415	1735	2036	2061	1787	722	532	310	236
Dredges	2669	2309	2638	2804	2780	7544	6943	5270	2813	2819	2390	1914
Tankers	3404	3401	2939	2904	2664	2374	3194	3206	3644	3907	3684	3570
Passenger Ships	0	0	0	0	100	146	213	119	83	65	70	157
TOTAL	61607	65862	66192	67785	67297	72329	82232	83073	78215	89976	91070	86891

SOURCE: Lt. Cdr. Gibson, USCG VTS, pers. comm. 1992.

Table 3.4-2. Percentage by Category of Total Vessel Movements That Include Transiting Through the Golden Gate.

Vessel Category	Percentage
Commercial	95%
Hazardous	80%
Navy, Surface vessels	20%
Coast Guard	5%
Navy, Submarines	100%
Foreign Navy	100%
Tugs without Tows	45%
Tugs with Tows	5%
Deep Draft	95%
Ferries	0%
U.S. Government	25%
Non Channel 13 (Large vessels not using VTS)	5%
Dredges	5%
Tankers	45%
Passenger ships	95%

SOURCE: Lt. Cdr. Gibson, USCG VTS, pers. comm. 1992.

Incidents involving tugs with barges or self propelled barges as recorded by VTS during the same time period are presented in Table 3.4-3.

3.4.4 Military Usage

The San Francisco Bay region and adjacent Gulf of the Farallones represent a major area of military usage, primarily by the U.S. Navy. Within the Bay, the Oakland Naval Supply Center and Alameda Naval Air Station are major facilities (Navy 1993). The Alameda Naval Air Station currently is used for homeporting two aircraft carriers, three cruisers, and one destroyer tender. Although on the current base closure list, Alameda NAS will be active while operations are phased out. The Oakland Naval Supply Center is homeport to two replenishment oilers, one combat replenishment ship, one naval hospital ship, and 28 Military Sealift Command Pacific ships. Maintenance dredging of these facilities is needed to ensure that the berths are accessible to large Naval vessels. The Navy's Third Fleet regularly utilizes the Gulf of the Farallones region for offshore air, surface, and submarine operations. Naval activity within San Francisco Bay averaged approximately 157 vessel movements (including submarines) per month in 1991 (Lt. Cmdr. Gibson, USCG VTS, pers. comm. 1992).

The Navy maintains five submarine operating areas (U1–U5), located 45 to 56 km from the Golden Gate (see Figure 2.1-4). Area U-1 is not used regularly, while the remaining areas receive moderate use (an average of 10 days per month). Use of submarine operating areas typically is associated with trial diving exercises and equipment checkouts. The Navy would consider dredged material disposal in these areas to be incompatible with submarine operations (E. Lukjanowicz, U.S. Navy, pers. comm. 1992). Submarine transit lanes vary in width from 13 to 18.5 km and run parallel to the mainland and west of Bodega Head. The exact locations of active transit lanes are periodically designated by the Navy in advisories to the Coast Guard (E. Lukjanowicz, U.S. Navy, pers. comm. 1992). When lanes are active, other vessels in the vicinity are warned against towing submerged objects within traffic lanes. The Navy also conducts aircraft and surface vessel exercises, often in conjunction with submarine operations, in an area that encompasses North Farallon Island and Noonday Rock along its southern boundary. Activities include anti-submarine warfare training, air-intercepts, surface vessel coordination, and dropping inert ordinance. These exercises typically represent 15 use-days per quarter per year.

In addition to the Navy's activities, the USCG supports infrequent aerial overflight missions throughout the area. The USCG conducts approximately five helicopter sorties per week around the Farallon Islands for serial offshore enforcement purposes, and search and rescue missions are conducted to a variety of destinations along the coast. The USCG also maintains a lighthouse on Southeast Farallon Island, thus requiring regular flights of maintenance personnel from San Francisco to the lighthouse post.

Table 3.4-3. Incidents Involving Tugs, Barges, and Self Propelled Dredges Within and Near San Francisco Bay, 1980-1989.

NATURE OF INCIDENT	NUMBER OF OCCURRENCES	PERCENT
Collision	25	40.9
Grounding	13	21.3
Material Failure	8	13.1
Foundering or Flooding	5	8.2
Barge Breakaway	4	6.6
Steering Failure	3	4.9
Disabled	2	3.3
Weather Damage	1	1.7
	___	___
TOTAL	61	100.0

SOURCE: COE 1992c.

3.4.5 *Mineral Or Energy Development*

Large repositories of oil and gas reserves are located in several areas along and offshore of the California coast (F. White, MMS, pers. comm. 1992). However, there are no oil and gas development activities or structures within the general study region, and all the potential lease areas are over 200 miles from the alternative sites. This is due to current moratorium schedules and technological constraints which have limited oil and gas development to depths less than approximately 300 to 400 m. Therefore, no significant mineral or energy development activities are likely in the vicinity of the study areas and alternative sites. In addition, it is unlikely that any mineral or energy development will take place within any of the marine sanctuaries that cover a large area of the Gulf of the Farallones or in State waters (waters up to three miles from the coast) (K. Walker, California State Lands Commission, pers. comm. 1992). The future of outer continental shelf lease sales has been addressed recently by a Presidential Task Force on oil and gas development (KLI 1991) but the results have not yet been published nor any recommendations implemented.

3.4.6 *Recreational Activities*

Recreational activities that occur within the Gulf of the Farallones include recreational fishing, sailing, whale and bird watching, and commercial sport fishing (California Coastal Commission 1987). Predominant fishes taken by recreational fishermen include rockfishes, king and chinook salmon, tuna, and Dungeness crabs (CDFG Recreational Fisheries Database 1992).

Weather permitting, offshore tours to the GOFNMS are operated by Oceanic Society Expeditions on each weekend day through the summer and fall months (June–September). Nature organizations visit the Farallon Islands infrequently, conduct other commercial ventures, or operate whale watching trips during the winter and spring migrations. On average, over 10,000 people per year have participated in these tours between 1984 and 1992 (M.J. Schramm, Oceanic Society Expeditions, pers. comm. 1992). Large numbers of bird watchers also made boat trips to the GOFNMS and adjacent areas (greater than 2,500 people per year) to observe the rookeries (M.J. Schramm, Oceanic Society Expeditions, pers. comm. 1992). The majority of recreational traffic occurs on weekends. An average of five sailboats per month, mostly originating from San Francisco Bay, have been observed in the vicinity of the Farallon Islands (M.J. Schramm, Oceanic Society Expeditions, pers. comm. 1992). In addition, several motor boat and sailing clubs use the Farallon Islands as a turning point during sponsored races that can occur throughout the year (M.J. Schramm, Oceanic Society Expeditions, pers. comm. 1992).

3.4.7 *Cultural and Historical Areas*

Designation of the GOFNMS, the CBNMS, and the MBNMS is intended to preserve the natural environment and to recognize the increasing "cultural" value placed on areas that are free from the effects of technology. Wildlife tours are popular cultural events around the Farallon Islands. Naturalist and zoological societies, such as the Audubon Society, conduct one or two tours annually, and Oceanic Society Expeditions conducts a tour every Saturday and Sunday from June to mid-November (M.J. Schramm, Oceanic Society Expeditions, pers. comm. 1992). However, use of any of the alternative sites should not significantly affect these activities beyond normal navigational precautions.

No known man-made cultural or historical resources are located in the study areas and alternative sites. This conclusion is based on a file review conducted of the California Archaeological Inventory and listings in the National Register of Historic Places and the California Inventory of Historic Resources. Further, no known shipwrecks of cultural or historical significance are reported within the study areas. According to the "Submerged Cultural Assessment" (which includes the California region), published jointly by NOAA and the National Park Service, only one vessel is located near Study Area 3. This is the aft portion of the PUERTO RICAN, which sank in 1984 one mile inside the boundary of the GOFNMS near the historical 100 Fathom site (located at 37°30.6′ N, 123°00.7′ W). However, this vessel has little historic value (Delgado and Haller 1989).

CHAPTER 4

ENVIRONMENTAL CONSEQUENCES

4.1 Introduction

This chapter assesses the significance of potential impacts of the proposed and alternative actions on the physical, biological, and socioeconomic environments at the preferred and alternative sites. Environmental consequences are evaluated separately for the preferred alternative (Section 4.2), the No-Action Alternative (Section 4.3), and other ocean disposal alternatives (Section 4.4). Site-specific impacts associated with dredged material disposal at the alternative sites are also summarized and compared in Chapter 2 according to the five general and eleven specific criteria.

The significance of potential environmental impacts associated with each of the alternatives is classified according to the following scheme (modeled after EPA 1988):

- Class I: Significant adverse impacts that cannot be mitigated to insignificance. No measures can be taken to avoid or reduce the adverse impacts to insignificant or negligible levels.

- Class II: Significant adverse impacts that can be mitigated to insignificance. These impacts potentially are similar in magnitude to Class I impacts, but the severity can be reduced or avoided by implementation of specific mitigation measures.

- Class III: Adverse but insignificant impacts or no effects anticipated. No mitigation measures are necessary to reduce the magnitude or severity of these impacts.

- Class IV: Beneficial effects. These effects could improve conditions relative to existing or pre-project conditions. These can be classified further as significant or insignificant beneficial effects.

The term "significant" is used to characterize the magnitude of potential impacts; a significant impact is defined as a substantial or potentially substantial change to resources in the vicinity of or adjacent to a proposed ODMDS. In the following sections, the rationale for characterizing potential impacts as significant or insignificant, distinctions between localized and regional spatial scales of impacts, and the duration (short-term versus long-term) of these potential impacts are identified. Associated mitigation measures are discussed where appropriate.

A summary of potential impacts on important resources of the physical, biological, and socioeconomic environments of each alternative site is presented in Table 4.1-1. Further evaluations and comparisons of the alternative sites with respect to EPA's specific site selection criteria are presented in Table 2.2-1. Resources for which comparisons can be made among the alternative sites are addressed separately by site in Sections 4.2 and 4.4. Resources or environmental conditions, such as ocean currents, which are not affected by the proposed action are addressed generically for all sites within each respective section.

4.2 Preferred Alternative

This section describes the potential impacts of the proposed actions on the physical, biological, and socioeconomic environments of the preferred alternative, Alternative Site 5. Potential impacts of these actions on the environments of the other ocean disposal alternatives, Alternative Sites 3 and 4, are addressed in Section 4.4.

Although some dredged material disposal has occurred at the Navy Ocean Disposal Site (NODS), no specific data on the actual effects of disposal operations presently are available. Thus, evaluation of potential effects on sea bottom and water column environments at the preferred and alternative sites relies on modeling the initial deposition of dredged material and dispersion of suspended particles and on information from studies conducted at existing ODMDSs. Where possible, differences between the preferred and alternative sites in the magnitude of expected or model-predicted spatial and temporal impacts are specified in this section and in Section 4.4.

Other sources of information concerning environmental impacts of dredged material disposal are based almost exclusively on research and monitoring of nearshore, shallow-water sites. Effects from dredged material disposal at deep-water sites are not well known. Of the more than 150 dredged material disposal sites in U.S. coastal waters, most are in water depths of less than 20 m (EPA 1980). Some limited information on environmental consequences of dredged material disposal in deep water areas is available. For example, information exists for the Yabucoa Harbor, Puerto Rico, dredged material disposal site at depths between 377 and 914 m (Stoddard *et al.* 1985) as well as sites located off southern California in 100 to 300 m of water (SAIC 1990a,b).

Therefore, the following discussions of potential impacts are based primarily on results of shallow water disposal site studies and the environmental characteristics of the preferred and alternative sites (see Chapter 3). Some of the impacts and processes occurring at these shallow water sites, such as burial and potential mortality of some infaunal and epifaunal species can be extrapolated to deep water environments. However, the lower continental slope environment, within which the preferred and alternative sites are located, represents a unique combination of geological, hydrographic, and biological features that must be considered when evaluating the consequences of ocean disposal of dredged material in these environments. Therefore, as appropriate, limits of present knowledge are identified along with the uncertainties of extrapolating this information to the deep-water environments of the LTMS study region.

Table 4.1-1. Summary of Potential Environmental Impacts at the Preferred Alternative and Alternative Sites 3 and 4.

Description	PREFERRED ALTERNATIVE				OTHER OCEAN ALTERNATIVES							
	Alternative Site 5				Alternative Site 3				Alternative Site 4			
	Impact Class[1]	Spatial Extent[2]	Temporal Extent[3]	Comment	Impact Class	Spatial Extent	Temporal Extent	Comment	Impact Class	Spatial Extent	Temporal Extent	Comment
Physical Environment												
Air Quality	III	R	S		III	R	S		III	R	S	
Water Quality												
- Turbidity	III	R	E		III	R	E		III	R	E	
- Dissolved Oxygen	III	L	E		III	L	E		III	L	E	
- Pollutants	III	L	S	Given that material is suitable quality	III	L	S	Given that material is suitable quality	III	L	S	Given that material is suitable quality
Geology												
- Grain Size	I	L	E		I	L	E		I	L	E	
- Sediment Quality	III	L	E	Given that material is suitable quality	III	L	E	Given that material is suitable quality	III	L	E	Given that material is suitable quality

[1] Impact Class: I = Significant; II = Significant, but can be reduced by mitigation; III = Insignificant or none; IV = Beneficial.
[2] Spatial Extent: S = Confined within site boundaries; L = Localized (up to 1 nmi outside of site boundaries); R = Regional (beyond 1 nmi from site boundaries).
[3] Temporal Extent: S = Short term (less than or equal to 5 hours); E = extended (greater than 5 hours).
[4] Potential interferences mitigated by specifying barge transit areas/Benefit of enhanced access in dredging areas.
[5] NA = No known resources: Spatial and temporal extent of impacts not applicable.
[6] Potential interferences near Farallon Islands mitigated by specifying barge transit areas.

Table 4.1-1. Continued.

Description	PREFERRED ALTERNATIVE				OTHER OCEAN ALTERNATIVES							
	Alternative Site 5				Alternative Site 3				Alternative Site 4			
	Impact Class[1]	Spatial Extent[2]	Temporal Extent[3]	Comment	Impact Class	Spatial Extent	Temporal Extent	Comment	Impact Class	Spatial Extent	Temporal Extent	Comment
Biological Environment												
- Plankton	III	L	S		III	L	S		III	L	S	
- Benthic Infauna	I	L	E		I	L	E		I	L	E	
- Benthic Epifauna	I	L	E		I	L	E		I	L	E	
- Demersal Fish	III	L	E		III	L	E		III	L	E	
- Pelagic Fish	III	L	S		III	L	S		III	L	S	
- Birds	III	L	S		III	L	S		III	L	S	
- Mammals	III	L	S		III	L	S		III	L	S	
- Threatened/ Endangered	III	L	S		III	L	S		III	L	S	

[1] Impact Class: I = Significant; II = Significant, but can be reduced by mitigation; III = Insignificant or none; IV = Beneficial.
[2] Spatial Extent: S = Confined within site boundaries; L = Localized (up to 1 nmi outside of site boundaries); R = Regional (beyond 1 nmi from site boundaries).
[3] Temporal Extent: S = Short term (less than or equal to 5 hours); E = extended (greater than 5 hours).
[4] Potential interferences mitigated by specifying barge transit areas/Benefit of enhanced access in dredging areas.
[5] NA = No known resources: Spatial and temporal extent of impacts not applicable.
[6] Potential interferences near Farallon Islands mitigated by specifying barge transit areas.

Table 4.1-1. Continued.

Description	PREFERRED ALTERNATIVE				OTHER OCEAN ALTERNATIVES							
	Alternative Site 5				Alternative Site 3				Alternative Site 4			
	Impact Class[1]	Spatial Extent[2]	Temporal Extent[3]	Comment	Impact Class	Spatial Extent	Temporal Extent	Comment	Impact Class	Spatial Extent	Temporal Extent	Comment
- Sanctuaries	II or III	L	S	Potential effects from spills mitigated by specifying barge transit areas	II or III	L	S		II or III	L	S	
Socioeconomic Environment												
- Fisheries												
Commercial	III	L	E		III	L	E		III	L	E	
Recreational	III	L	E		III	L	E		III	L	E	
- Shipping	III or IV	R	E	Footnote 4	III or IV	R	E		III or IV	R	E	
- Mineral	III	NA	NA	Footnote 5	III	NA	NA		III	NA	NA	

[1] Impact Class: I = Significant; II = Significant, but can be reduced by mitigation; III = Insignificant or none; IV = Beneficial.
[2] Spatial Extent: S = Confined within site boundaries; L = Localized (up to 1 nmi outside of site boundaries); R = Regional (beyond 1 nmi from site boundaries).
[3] *Temporal Extent*: S = Short term (less than or equal to 5 hours); E = extended (greater than 5 hours).
[4] Potential interferences mitigated by specifying barge transit areas/Benefit of enhanced access in dredging areas.
[5] NA = No known resources: Spatial and temporal extent of impacts not applicable.
[6] Potential interferences near Farallon Islands mitigated by specifying barge transit areas.

Table 4.1-1. Continued.

Description	PREFERRED ALTERNATIVE				OTHER OCEAN ALTERNATIVES							
	Alternative Site 5				Alternative Site 3				Alternative Site 4			
	Impact Class[1]	Spatial Extent[2]	Temporal Extent[3]	Comment	Impact Class	Spatial Extent	Temporal Extent	Comment	Impact Class	Spatial Extent	Temporal Extent	Comment
- Military Usage	III	S	S		III	S	S		III	S	S	
- Recreational Usage	II	R	S	Footnote 6	III	R	S		III	R	S	
- Cultural/Historical	II	R	E	Footnote 6	III	L	E		III	L	E	
- Public Health/Welfare	III	L	E		III	L	E		III	L	E	

[1] Impact Class: I = Significant; II = Significant, but can be reduced by mitigation; III = Insignificant or none; IV = Beneficial.
[2] Spatial Extent: S = Confined within site boundaries; L = Localized (up to 1 nmi outside of site boundaries); R = Regional (beyond 1 nmi from site boundaries).
[3] Temporal Extent: S = Short term (less than or equal to 5 hours); E = extended (greater than 5 hours).
[4] Potential interferences mitigated by specifying barge transit areas/Benefit of enhanced access in dredging areas.
[5] NA = No known resources: Spatial and temporal extent of impacts not applicable.
[6] Potential interferences near Farallon Islands mitigated by specifying barge transit areas.

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4.2.1 Effects on the Physical Environment

These sections address potential effects of dredged material disposal at the preferred alternative site on regional meteorology and air quality, physical oceanography, water quality, geology, and sediment quality.

4.2.1.1 Air Quality

Potential impacts to regional air quality associated with dredged material disposal operations at the preferred alternative site were evaluated using an EPA air quality model. The model assumptions and results are summarized in the following section.

Initial screening modeling was performed for carbon monoxide (CO), volatile organic compounds (VOC), and oxides of nitrogen (NO_x) to determine impacts to air quality. Effects from the emissions of diesel engines on barge tugs were calculated using an EPA model (ISCST2) that was designed to compute air pollutant concentrations from various types of emission sources. EPA guidelines (EPA 1992b) were followed for the modeling analysis.

Air pollutant emissions from barges during transit between the Oakland inner, outer, and middle harbors and the preferred alternative site were modeled as eight, one km^2 volume sources grouped into one line source. The line source stretched from south of Treasure Island to a point 15 km southwest of the Golden Gate Bridge and followed a path along the deep water shipping channel. Initial dispersion coefficients and other related variables were determined following EPA guidance (EPA 1992b).

Emission factors for barge tugs were taken from "AP-42, Compilation of Air Pollutant Emission Factors" (EPA 1985). Other assumptions for barge tugs included a draft of 12 to 18 feet, 900 horsepower diesel engine, speed of 8 km/hr (4.3 knots), fuel consumption of 44 gal/hr, and 2 trips per day. Meteorological data were obtained from EPA's Office of Air Quality, Planning and Standards Technology Transfer Network Bulletin Board System (OAQPS TTN). The surface meteorological data were from San Francisco International Airport data for 1989 and the mixing height data was from Oakland International Airport data for the same year.

The model calculated concentrations for a receptor grid that covers all of San Francisco and parts of Sausalito, Berkeley, Alameda, and western Oakland. Concentrations of pollutants were averaged for one hour, 24 hours, and one year. The model output tabulated the highest concentrations for each receptor and the highest ten concentrations within the grid for each averaging period. These concentrations are compared to State and Federal ambient standards. Table 4.2-1 presents the modeled concentrations and the regulated limits. Based on these model results, no significant effects to air quality were indicated along the presumed route of the barges transporting dredged material to the preferred alternative site. Therefore, effects from barge tug emissions on air quality within the general LTMS study region are considered negligible, and use of an ODMDS for dredged material disposal is estimated to represent a Class III impact.

Table 4.2-1. Model-Predicted Maximum Concentrations of Air Pollutants in Central San Francisco Bay and the Corresponding Air Quality Standards.
The predicted maximum concentration represents the highest concentration within a receptor grid from ambient concentrations plus project-related (dredged material barge transit) operations.

Pollutant	Averaging Period	Predicted Maximum Concentration	Standard California	Standard Federal
CO	1 hour	14.2 $\mu g/m^3$ (0.012 ppm)	20 ppm	35 ppm
	24 hour	0.62 $\mu g/m^3$ (0.0005 ppm)		
	Annual	0.03 $\mu g/m^3$ (0.00003 ppm)		
NO_x	1 hour	115 $\mu g/m^3$ (0.06 ppm)	0.25 ppm[1]	
	24 hour	5.0 $\mu g/m^3$ (0.0027 ppm)		
	Annual	0.27 $\mu g/m^3$ (0.0001 ppm)		0.053 ppm
VOC	kg/day	2.6 kg/day	68 kg/day	

[1]Standard for NO_2; the comparison assumes that all of the NO_x is NO_2.

4.2.1.2 Physical Oceanography

The proposed use of an ODMDS for dredged material disposal is not expected to have any measurable effect on the regional or site-specific physical oceanographic conditions (Class III). Instead, the prevailing oceanographic processes will strongly influence the dispersion and long-term fate of dredged material discharged at the preferred alternative site. In particular, currents will affect the dispersion of particles in the water column and subsequent water quality conditions (discussed in Section 4.2.1.3), as well as settling and initial deposition of dredged material on the sea floor (discussed in Section 4.2.1.4). The oceanographic conditions that are important to assessments of impacts on the physical, biological, and socioeconomic environments are summarized below.

Although the circulation patterns over the continental shelf and slope areas of the study region share some similarities with other regions of the California coast, there are specific current patterns that are unique to this region (Section 3.2). These patterns include: (1) near-surface flow over the slope that is more poleward than expected; (2) tidal effects which can be larger and amplified at different frequencies than those in other areas; (3) the unique spatial pattern of the California Undercurrent; and (4) a non-local source for the upwelled waters occurring on the shelf (Section 3.2). All of these characteristics would affect the resuspension, dispersal, and ultimate fate of dredged material deposited at the preferred and the alternative sites.

On the outer shelf, tidal and low frequency (subtidal) currents combine to generate currents near the sea bottom with speeds greater than 45 cm/sec (Noble *et al.* 1992). These currents are powerful enough to resuspend and transport fine sands. Therefore, any material containing fine sand or smaller grain sizes can be moved by currents within this region in the direction of predominant current flow. In addition, large currents from surface waves are expected to reach the seabed over the outer shelf. When surface wave currents combine with lower frequency flows near the bottom, the erosive potential of the currents over the outer shelf is greatly enhanced (Grant and Madsen 1979). The tendency for currents near the bottom to flow poleward, especially during winter when large surface waves are generated by winter storms, suggest that any fraction of dredged material deposited on the shelf eventually could move along the isobaths into the GOFNMS.

Persistent poleward flow occurs in the upper 1,000 m of the water column over most of the year (Section 3.2.2). This poleward flow is interrupted by equatorward events which can last as long as a month. A strong seasonal pattern in the current regime was not apparent from recent EPA studies (Noble *et al.* 1992). However, there was an abrupt transition to a less energetic regime with more variable current directions from approximately the middle of August until November, after which more energetic but intermittent poleward flow persisted through the winter. There is evidence that the poleward flow is strongest over the inner slope at about 100 m depth near Alternative Sites 3 and 4 but moves offshore to the north in the region of the preferred alternative site. The inner slope currents offshore of the Farallon Islands are particularly weak below the shallow surface layer. Currents below 800 to 1,000 m depth are small magnitude, low frequency flows and are dominated by tides. Flows on the outer shelf appear to be separated and unrelated to flows over the slope (Noble *et al.* 1992). The time and space varying current field has a major influence on dispersion and deposition in deep water.

The local topography of a site is expected to cause enhanced flow and veering in the currents near the bottom. Because enhanced tidal flows generally are stronger than subtidal near-bottom currents, tidal movements represent the largest contributor to the erosive characteristics at the different sites. The near-bottom currents at mooring Stations B and C, located near the southern boundary of Study Area 3, and mooring E, located in deeper water near the eastern boundary of Study Area 5, had maximum current speeds between 37 and 43 cm/sec (Figure 3.2-2). Mooring D, located to the south of Alternative Site 3, and F, located on the upper slope inshore from Study Area 5, had relatively lower near-bottom tidal currents (see Section 3.2.2; Figure 3.2-2). Thus, material deposited near Stations B, C, or E would be eroded more easily than material deposited at Stations D or F. The near-bottom subtidal flow direction suggests that resuspended material at Station B will be dispersed in both directions along the isobaths. Resuspended material at Station C would be carried poleward, and resuspended material at Station E would be carried eastward up the axis of a small, unnamed submarine canyon. However, because Station E is in 2,000 m of water, it is not expected that resuspended material would move onto the shelf, but rather would remain in the deeper portion of the canyon.

Upwelling processes can affect the dispersal of material suspended in the water column; however, recent data from EPA surveys indicate that the local upwelling in the Gulf of the Farallones is weaker than at other sites along the California coast (Ramp *et al.* 1992). The majority of the cold saline water on the shelf during summer is advected horizontally into the region from a strong upwelling center north of Point Reyes. Therefore, it is very unlikely that material, including dredged material, suspended in the waters over the slope would be transported via locally upwelled water onto the shelf. Further, water quality modeling results indicate that significant transport of suspended material to shelf areas from disposal activities at the preferred or alternative sites would be very unlikely (Section 4.2.1.3).

4.2.1.3 Water Quality

This section addresses the predicted behavior of dredged material to be discharged at an ODMDS, and impacts on regional and site-specific water quality. An initial discussion of dredged material settling characteristics is followed by a description of a numerical model developed specifically for simulating the transport and fate of dredged material disposed at the three alternative disposal sites. The model results are used to predict the effects of disposal operations on water quality and chemical constituent concentrations.

Dredged Material Settling Behavior

Dredged material disposal typically has a short term (several hours to days) impact on the water column following discharges of solids and solutes from a barge (e.g., Gordon 1974). The greatest proportion of dredged material consists of negatively buoyant solids that sink as a turbid suspension through the water column to the sea floor. Dissolved constituents of dredged material are entrained in the turbulent water associated with the convective descent. Predictions of the impacts of the descending plume on the ambient water quality depend on the settling velocity of individual particles or particle aggregates, particle concentrations, particle chemistry, water depth, and the presence and strength of water column density stratification (i.e., the pycnocline). The fate of dissolved components depends on their solubility and reactivity with the entrained ambient water and particles, and with the mixing properties of the ambient flow field.

The proposed ODMDS is expected to receive dredged sediment of two general types: "mostly sand" (76% sand, 21% clay, and 3% silt) and "clay-silt" (74% silt, 5% clay, and 21% sand) (Section 3.1). The settling velocities of the medium sand and coarser material have been measured in the laboratories (Table 4.2-2). These measurements can be used to estimate the theoretical transit time in a motionless water column. However, the actual (in situ) settling velocities of individual particles may vary considerably depending on changes in particle concentrations, the density of the water column, and water column turbulence.

Sediment dispersion models (e.g., Koh and Chang 1973) provide reasonably accurate predictions of the transport, fate, and deposition footprint of the coarse fractions of dredged material. This accuracy is achievable due to the availability of empirical settling velocity data for these coarse fractions. Unfortunately, large uncertainties in actual settling velocities of fine particles in oceanic environments greatly limit the accuracy of the numerical models for predicting the transport and fate of fine fractions, which make up a considerable volume of dredged material.

The settling behavior of very fine sand and smaller particles is difficult to estimate because these fractions rarely consist of discrete particles (Bokuniewicz et al. 1978). Very large aggregates (mud "clasts" up to 1 m in diameter) may form the bulk of disposed material, particularly when mechanical clam shell dredges are used to excavate cohesive clay and mud from channels and basins. The rate of convective descent of typical estuarine (e.g., from San Francisco Bay) dredged material consisting of large, cohesive mud clasts has been measured as approximately 1 m/sec (Bokuniewicz et al. 1978); the exception was the 3 to 5% (by weight) of the material that comprises the fine silt fraction, which had a sedimentation rate of about 0.7 cm/sec. Smaller aggregates (up to about 1 mm in size) also dominate the muddy slurry associated with dredged muds and fine sands. The high surface area and surface molecular charges associated with fine particles, particularly clay minerals, result in particle-to-particle aggregation in marine waters. Also, the presence of biologically-produced films, which coat the surfaces of small particles, serve to bind fine particles into low density organic-mineral aggregates. Zooplankton grazing also has been shown to result in repackaging of suspended particles into rapidly settling fecal pellets (Capuzzo 1983).

Individual particle settling velocities (Table 4.2-2) were calculated using theoretical rates. Based on density and weight differences, the settling velocities of aggregates can be much higher than settling rates of their individual component particles. However, no empirical data exist for accurately estimating the settling velocities of such aggregates (Komar et al. 1981) with the exception of the information on some gelatinous zooplankton pellets, which have settling

Table 4.2-2. **Particle Size Classes and Sinking Velocities Used in the Sediment Deposition Model.**

Class	Name	Particle Diameter (μm)	Sinking Velocity (m/sec)	Time to Sink 1,000 m (hours)	Horizontal Distance Traveled at 0.1 m/sec (km)	Percent by Weight*
1	Coarse Sand	1,000	0.086	3.2	1.15	1.1
2	Medium Sand	500	0.041	6.8	2.45	23.9
3	Fine Sand	250	0.016	17.4	6.26	43.4
4	Very Fine Sand	125	0.0052	53.4	19.22	7.6
5	Coarse Silt	62	0.0014	198.4	71.42	3.3
6	Clay-Silt	31	0.0005	556	200.0	10.4**
7	Clay-Silt Clumps	—	0.15	1.85	0.67	10.3**

* Material Composition Oakland NSC Site.
**Assumes 50% clumping of Clay-Silt Material.

Source: SAIC (1992e).

velocities ranging between 1,800 and 2,700 m per day. Therefore, the behavior of these aggregates or clumps cannot be accurately predicted using the sediment dispersion models.

Coarse sand (and larger) size fractions and large, cohesive, silt-clay mud clasts settle rapidly to the bottom and accumulate close to the point of disposal. Slower settling fractions decelerate as the descending plume loses its negative buoyancy as it penetrates deeper in the water column. In shallow (i.e., less than 100 m) regions, the descent plume may reach the sea floor prior to achieving neutral buoyancy, and "dynamic collapse" will occur at the bottom. In deeper regions, the plume may achieve neutral buoyancy at some intermediate depth in the water column. At this level, the momentum of convective descent is lost through dynamic collapse of the plume. Thereafter, particle behavior is largely controlled by passive, horizontal dispersion of the fine fraction.

The depth at which convective decent changes to neutral buoyancy is largely a function of volume of the barge load (Stoddard et al. 1985), but other factors such as dredged material characteristics, water depth, and water column stratification have a significant effect on the depth of dynamic collapse. When dynamic collapse occurs in the water column, the neutrally buoyant plume may achieve the depth of a local pycnocline, and slowly settling particles can accumulate and spread laterally along this density interface with the potential for farfield dispersion by horizonal advection. Therefore, the greatest potential for long-term, water column impacts and farfield dispersion is associated with slowly settling, organic-mineral aggregates within depth regions of neutral particle buoyancy and pycnoclines. Further details of the physical processes affecting the behavior of dredged material in the open ocean are provided below as part of the numerical modeling discussion.

Introduction to the Numerical Model of Dredged Material Transport

Numerical models of dredged material disposal, transport, and fate have been developed and validated for disposal at shallow water sites (e.g., Trawle and Johnson 1986). However, these models were not well suited for predictions of the dispersion and transport of dredged material in deep-water environments such as the alternative sites. To address the specific objectives of the LTMS, SAIC (1992e) developed a numerical model to predict the three-dimensional transport of dredged material discharged at Alternative Sites 3, 4, and 5. This model predicted the following:

- Three-dimensional transport pathways of the dredged material from single discharges;

- The concentration of dredged material within discrete disposal plumes (clouds) at various depths in the water column;

- The probability of dredged material entering one of the National Marine Sanctuaries at concentrations above a conservative estimate of ambient concentrations.

- The pattern and thickness of material that will be deposited on the sea floor following long-term (e.g., 1-year) disposal operations.

For this application, SAIC (1992e) developed a simple particle tracking and settling model. This model predicts the location and concentration of settling clouds following release from the surface. The model consisted of two stages representing the physical processes affecting transport and dispersion of dredged material in a deep-water environment. The first stage entailed statistical analysis of the percentage of disposal events that contact a particular location within the modeled region. The resultant statistic is referred to as the "visitation frequency." Particulate concentrations within the cloud and the duration of water column exposure to excess turbidity from disposal also were calculated for a variety of scenarios and material types.

The second stage of the model calculates the areal coverage and thickness of material deposited on the sea floor throughout the study region (Section 4.2.1.4). The results are based upon tracking individual particle clouds as they settle and become diffused and advected by the current field.

Figure 4.2-1 summarizes the physical processes governing the behavior of dredged material, as represented by the model. The model generates a variety of graphical and quantitative results, the most important of which can be grouped into two categories: (1) particulate concentrations in the water column, and (2) material accumulation on the sea floor. Discussion of these input conditions, physical processes, and model results is provided below.

Model Input Conditions

As illustrated in Figure 4.2-1, a variety of data and information is required as input to the model. Each of these input categories is discussed briefly below.

Model Characteristics:

The model grid extended from 37° to 38° N and from 122° to 124° W, representing an area of roughly 100 km x 160 km. Model elements were 250-m square such that the high-resolution component of the model grid consisted of over 320,000 elements.

The model was run with time-varying input conditions (e.g., currents, disposal operations, etc.) at 1-hour time intervals to provide fine-scale temporal resolution of the various processes affecting settling, transport, and dispersion of the dredged material.

Disposal Operations:

The model assumed that dredged material disposal would occur as discrete events, representing releases from a barge of 6,000 yd^3 every 8 to 12 hours over a period of approximately one year. These are worst case estimates based on projections from the COE. Barges used for the Navy 103 project at NODS have 3,000 yd^3

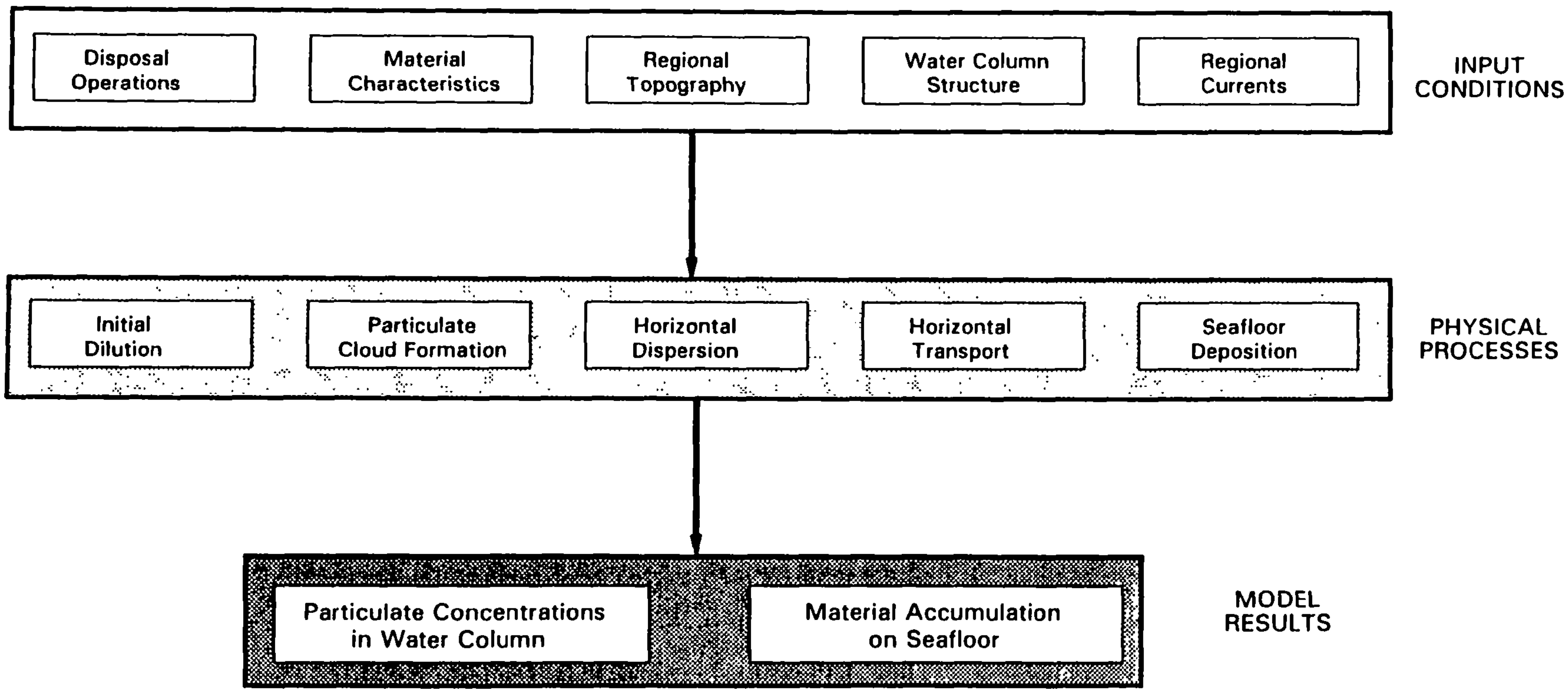

Figure 4.2-1. Model of Dredged Material Transport and Fate.

volumes. This would represent a total annual volume of 6 million yd^3. Simulated releases were made at random locations within a 2-km diameter circle within each of three alternative sites.

Dredged Material Characteristics:

Simulations were made using two material types: "clay-silt" (T1) and "mostly sand" (T3), as described previously under dredged material settling behavior. For each type, the material was assumed to consist of seven particle-size classes, each having a class-specific sinking rate (Table 4.2-2). Particle settling velocities were based on theoretical sinking rates using Stoke's law in a quiescent fluid. Settling velocities of clay-sized particles are known to increase when concentrations are high (> 25 mg/l) due to the effects of clumping on settling rates. Rapidly settling clay-silt clumps (class 7) were included in material T1.

Regional Topography:

Numerical simulations were made for dredged material releases from Alternative Sites 3, 4 and 5. The water depth within each of the model's 250 m-square elements was derived from the high-resolution bathymetric data obtained from NOAA Exclusive Economic Zone (EEZ) surveys. The average water depths at the disposal location within Alternative Sites 3 and 4, and the preferred alternative site were 1,457 m, 1,701 m, and 2,726 m, respectively.

Water Column Structure:

The model assumed homogeneous density throughout the water column. Sensitivity tests have not been conducted to determine the effects of stratification, but these effects are expected to be small compared to uncertainties in other physical processes such as particle settling rates, horizontal dispersion, and advection.

Regional Currents:

Actual current meter data from the EPA measurement program (Section 3.2.2) were used to develop a time-varying, 3-dimensional velocity field throughout the study region. The EPA measurement program consisted of an approximately one year (March to February) deployment of current meters at six locations in the region (see Figure 3.2-2). The water depths at these mooring locations ranged from 92 to 2,000 m. The deepest mooring, within the southeast portion of Study Area 5, provided current velocity data from near-surface to near-bottom. Although this array of current meter moorings provided a characterization of the temporal and spatial variability throughout the study region, none of the measurements were from water depths greater than 2,000 m (such as the majority of Study Area 5). The model used the 2,000-m current data for all greater depth levels. This should not have a major effect on the model predictions as the most intense and persistent dispersal processes reside within the upper 1,500 m of the water column.

Model Components and Implied Physics

Effects on water quality from dredged material disposal at the preferred and alternative sites were evaluated by using the model to determine the dispersion and dilution of suspended particles at varying distances and times following a disposal event. The model calculated the probability, or visitation frequency, of particle clouds moving over specific locations in the vicinity of the sites. The model simulated individual discharge events and predicted the behavior of material that settles according to individual particle size classes.

The duration of turbid plumes near the discharge site will vary with the frequency and location of disposal events. Although the model assumed that disposal would occur every 8 to 12 hours, the actual frequency of disposal events at an ODMDS is likely to be less frequent. As a result, impacts on water quality are expected to be transitory under normal, intermittent site use. Furthermore, disposal will be permitted within a defined area of the disposal site (≈ a 2 km circle), but not necessarily at the same position each time. Consequently, plumes would not originate from the same location. The direction of transport for individual plumes would also vary depending on the prevailing current patterns.

During a disposal event, the first stage of the model involves initial, barge-induced mixing which results in a well-mixed surface-layer plume (cloud) that is 20 to 50-m thick. It is assumed that all particle momentum is lost at the end of this first stage. This initial disposal cloud was modeled as a circular "slab" with a diameter of 100 m and a thickness of 50 m. The "mostly sand" type material, as modeled, contained a maximum concentration of 5,290 mg/l of fine sand class particles. For the "clay-silt" type material, the maximum concentration of fine silt particles is 2,500 mg/l. These initial particle concentrations would be approximately 1,000 times higher than background (ambient) suspended particle concentrations of approximately 1 to 5 mg/l (see Section 3.2.3).

The model assumes that the initial cloud separates into seven clouds comprising the different particle size classes (Table 4.2-2). Because each cloud has different bulk settling rates, they would be transported and dispersed at different rates if the current velocities and horizontal dispersion rates differed with depth in the water column.

Under the assumption of constant dispersion, concentrations of particles in these separate clouds would decrease at a constant rate with time following release from the barge. The model predicted that the average particle concentration within the clouds would decrease to background concentrations (conservatively assumed to be approximately 1 mg/l), or particles would be deposited on the seabed, within about two days for most particle size classes. During this time, if the cloud remained in the water column, the cloud diameter would increase by a factor of 30 or more. Primary exceptions to these time limits for cloud dispersion (known as the cloud age limit) were clouds of fine silt (class 6) which had high initial concentrations that would remain in the upper water column for many days.

It is important to note, however, that these estimates of cloud dilution and particle concentrations are highly dependent on the assumed value of the diffusion coefficient. Values used for the model are smaller (i.e., more conservative) than have been measured directly in the deep ocean (Ledwell and Watson 1991), but are consistent with the behavior of oceanic turbulence on spatial scales associated with the characteristic size of the clouds. Using horizontal diffusion coefficients closer to those measured by Ledwell and Watson (1991) would reduce the cloud age limit by factors of 5 to 10 times (i.e., the time required for particle concentrations to reach background concentrations would be reduced from five days to 12 to 24 hours.) Thus, these estimates are conservative, but more accurate predictions cannot be made unless the coefficient is directly measured in the field.

The final stage of the model involves settling of individual particle clouds, leading to particle deposition on the sea floor or transport out of the model grid prior to deposition. This stage is discussed in Section 4.2.1.4.

Model Predictions of Particle Clouds

The numerical predictions of the behavior of particle clouds created from dredged material disposal at the preferred and alternative sites provide quantitative estimates of the probability of occurrence, areal coverage, particle concentration, and depth of particle clouds throughout the study region. Each run tracked disposed particles for 48 hours using current data for the entire 12-month current measurement program (SAIC 1992e). Combining results from the individual disposal events over all seasons, the model estimated the probability (visitation frequency) over a one-year period that the water column above individual "grid" locations on the sea floor would experience the passage of the particle cloud associated with a discrete discharge event within 48 hours of release. For example, a location having a visitation frequency of 5% for a class 4 (very fine sand) particle corresponds to a probability of 5 out of every 100 disposal plumes containing very fine sand particles passing over that location. The model also calculated the average depth in the water column (cloud depth) of the cloud as it passed over the location and the time required for the cloud to pass over the location (exposure time). Because diffusion in the vertical direction is considered minimal as compared to diffusion in the horizontal direction, the modeled cloud maintains a vertical thickness of 50 m as it passes through the water column (Figure 4.2-2).

Average cloud depths increase in proportion to average cloud age and particle size due to the constant settling rate for each cloud (class of particles). Thus, a cloud of coarse sand (class 1) would descend to the bottom within a few hours and would affect the water column only within a few kilometers of the discharge point. In contrast, coarse silt particles (class 5) would descend only a few hundred meters within a period of two days, and would be dispersed greater distances from the discharge point. In the model, individual particle size clouds separate due to different settling velocities and would not be expected to contact each other after disposal. Characterizing the dredged material as consisting of discrete particle size classes is appropriate for the purposes of a practical model, although it is more likely that actual particle sizes and sinking speeds would represent a continuum.

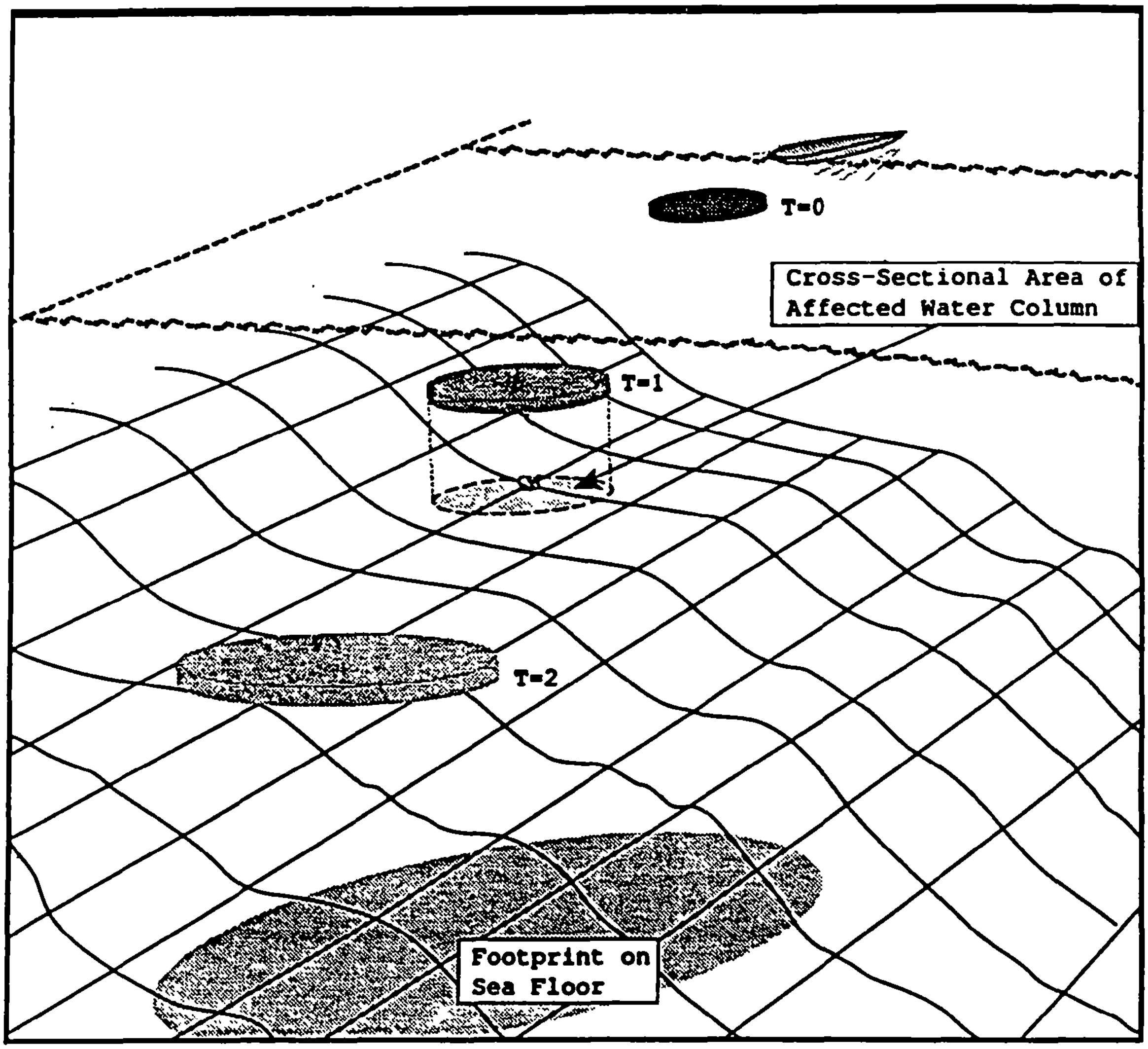

Figure 4.2-2. **Schematic of a Particle Cloud Sinking Through the Water Column.**
T=0, T=1, and T=2 correspond to time at the initial disposal and subsequent time intervals during cloud descent through the water column.
Particle concentrations are indicated by relative shades of grey.
Source: SAIC 1992e.

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The calculated visitation frequencies and average suspended particle concentrations associated with discharges from the preferred and alternative sites are summarized in Table 4.2-3. Selected results from the preferred alternative site are given below:

- Coarse sand (class 1) reached the sea floor roughly 10 h after disposal because of its rapid settling rate. The affected area was only 48 km^2, which was equivalent in area to a circle with radius of 4 km. Note that the model placed all barge releases within a circle having a diameter of 2 km.

- Very fine sand (class 4) attained conservative background particle concentrations (~ 1 mg/l) and cloud depths of roughly 600 to 850 m at 48 h following disposal. The affected area (the region having particle concentrations above 1 mg/l) was roughly 42 times the area of the preferred alternative site.

- Clay-silt material (class 6) spread widely, affecting an area of 3,681 km^2 with particle concentrations greater than 1 mg/l. This affected area was roughly 20% of the model grid and 170 times the size of the preferred alternative site. Cloud depths of this slowly sinking material ranged from roughly 130 to 200 m after 5 days.

- Clay-silt clumps (class 7), whose settling rates exceeded those of the coarse sand, reached the sea floor in roughly 5 hours. The affected area, 23 km^2, was equivalent in area to a circle with a radius less than 3 km.

These results indicate that the affected area can vary greatly (from 23 to 3,681 km^2) and the mean cloud depth will also vary (from 54 m to the sea floor) depending upon the size class of material discharged. Mean visitation frequencies within the preferred alternative site were more consistent, ranging from roughly 2 to 8%. In other words, the likelihood that any individual model cell (i.e., in the water column above a 250-m by 250-m area on the bottom) within the preferred alternative site would be affected by clouds having particle concentrations greater than 1 mg/l ranged from 2 to 8 occurrences in 100 disposal events. This probability is higher for model cells in close proximity to the disposal location, as represented by maximum visitation frequencies that exceeded 70% in Table 4.2-3. Note that only part of the water column above a cell is likely to be affected by particle clouds. Deeper portions of the water column will be affected at relatively greater distances from the disposal site.

The results for Alternative Site 3 (Table 4.2-3) generally were similar to those for the preferred alternative site:

- The affected area for each size class ranged from a minimum of 13 km^2 for the clay-silt clumps to a maximum of 7,855 km^2 for the slowly settling clay-silt material.

Table 4.2-3. Model-Predicted Disposal Plume Visitation Frequencies, Mean Depth, and Exposure Times for Simulated Discharges at the Preferred Alternative (Alternative Site 5) and Alternative Sites 3 and 4.

Area affected corresponds to the area defined by the 1 mg/l suspended particle concentration contour (i.e., the assumed background concentration). Visitation frequency represents the probability or percentage of the total number of disposal events in which a cloud of individual size classes of particles would pass over a particular location on the seafloor. Cloud depth is the average (mean) and standard deviation (SD) of the depths in the water column of the cloud as it passes over a location. Exposure is the length of time that a position in the water column would experience higher concentrations of particles relative to background levels. Cloud age is the time required since disposal for particle concentrations within the cloud to reach background levels or for particles to settle on the bottom. Model-predicted values based on current data for the period March 15, 1991 through February 15, 1992.

Preferred Alternative (Alternative Site 5)							
		Visitation Frequency		Cloud Depth			
Particle Size Class	Area Affected (km^2)	Mean (%)	Maximum (%)	Mean (m)	± SD (m)	Maximum Exposure (hrs)	Maximum Cloud Age (hrs)
1: Coarse Sand	48	6.0	49.2	2393	370	2.6	10
2: Medium Sand	102	8.2	62.7	2237	388	5.5	21
3: Fine Sand	336	8.0	64.0	1902	398	13.2	48
4: Very Fine Sand	932	4.1	54.1	725	113	14.0	48
5: Coarse Silt	603	2.1	28.4	112	17	7.7	24
6: Clay-Silt	3681	3.8	37.2	166	36	43.9	120
6*: Clay-Silt*	1245	5.2	74.4	54	5	6.7	24
7: Clay-Silt Clumps	23	5.2	39.3	2335	360	1.5	5

*Diffusion coefficient increased from 1 m^2/sec to 10 m^2/sec.
Source: SAIC (1992e).

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Table 4.2-3. Continued.

Alternative Site 3							
		Visitation Frequency		Cloud Depth			
Particle Size Class	Area Affected (km^2)	Mean (%)	Maximum (%)	Mean (m)	± SD (m)	Maximum Exposure (hrs)	Maximum Cloud Age (hrs)
1: Coarse Sand	30	3.4	21.3	1237	241	1.4	6
2: Medium Sand	96	3.9	28.6	1326	233	3.3	14
3: Fine Sand	414	4.2	35.1	1315	265	9.8	41
4: Very Fine Sand	1227	3.0	22.8	675	122	16.0	48
5: Coarse Silt	1082	1.4	20.3	115	32	7.0	24
6: Clay-Silt	7855	2.2	19.7	168	28	42.0	120
6*: Clay-Silt*	1717	4.3	62.2	54	5	6.1	24
7: Clay-Silt Clumps	13	2.7	18.7	1073	244	1.0	3

Alternative Site 4							
		Visitation Frequency		Cloud Depth			
Particle Size Class	Area Affected (km^2)	Mean (%)	Maximum (%)	Mean (m)	± SD (m)	Maximum Exposure (hrs)	Maximum Cloud Age (hrs)
1: Coarse Sand	32	3.7	29.6	1404	284	1.6	6
2: Medium Sand	98	4.7	35.3	1505	298	3.4	16
3: Fine Sand	457	4.8	35.6	1511	315	10.9	43
4: Very Fine Sand	1321	3.0	24.9	694	128	15.4	48
5: Coarse Silt	1217	1.3	16.0	115	15	6.9	24
6: Clay-Silt	7708	2.3	19.7	164	29	42.8	120
6*: Clay-Silt*	1913	3.9	55.4	55	5	6.1	24
7: Clay-Silt Clumps	13	4.3	23.9	1378	328	1.0	3

*Diffusion coefficient increased from 1 m^2/sec to 10 m^2/sec.
Source: SAIC (1992e).

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- Cloud age and cloud depth were similar to those of the preferred alternative site, except in cases when the material reached the bottom and consequently, cloud age was reduced and cloud depth was equivalent to the water depth. (Note that the mean depth for Alternative Site 3 was 1,457 m compared to 2,726 m for the preferred alternative site.)

- Visitation frequencies for all particle classes at Alternative Site 3 were less than those for the preferred alternative site, apparently due to increased variability in local currents near Alternative Site 3.

The results for Alternative Site 4 (Table 4.2-3) were very similar to those for Alternative Site 3 as reflected by the modeled data on the affected area, visitation frequencies, exposure times, and cloud age. Maximum cloud depths for Alternative Site 4 were greater than observed for Alternative Site 3, because the average water depth at Alternative Site 4 was approximately 250 m greater.

Figures 4.2-3 through 4.2.-5 illustrate the spatial distribution of visitation frequencies and average particle concentrations for clay-silt material (class 6) discharged at the preferred alternative site and at Alternative Sites 3 and 4, respectively. Spatial results are presented for this particle class because it has the slowest settling rates of the seven classes modeled, the longest water column residency time, the largest horizontal dispersion, and the largest affected area. Consequently, it represents the worst case condition. In Figures 4.2-3 through 4.2-5, the green contour labeled 1.00 mg/l delineates the minimum particle concentration determined by the model. Lower concentrations are not shown because they are below a conservative estimate of the background concentration, and probably cannot be detected with standard sampling methods.

For the preferred alternative site, dredged material concentrations exceeding 1 mg/l will extend over a large area with a preferred orientation toward the northwest due to the predominant flow during the observation year (Figure 4.2-3). Transport along local bathymetric contours toward the southeast also is evident. Concentrations greater than 2 mg/l extend over smaller areas within and adjacent to the preferred alternative site. Concentrations greater than 10 mg/l are not expected outside of the immediate disposal region.

The spatial distribution of visitation frequencies for disposal at the preferred alternative site (Figure 4.2-3) is similar to the modeled distribution of particle concentrations. Visitation frequencies greater than 5% generally extend to the northwest from the disposal site; lower frequencies also extend to the west and southeast.

Spatial results for Alternative Site 3 (Figure 4.2-4) were significantly different than those at the preferred alternative site. At Alternative Site 3, dredged material concentrations exceeding 1 mg/l extended over a broad area to the north, west, and south of the disposal site. Particle dispersion was more multi-directional, with considerably less topographic influence than observed for the preferred alternative site. The inshore boundary for the 1 mg/l concentration corresponded closely with the 200 m isobath. The area affected by concentrations greater than 2 mg/l was

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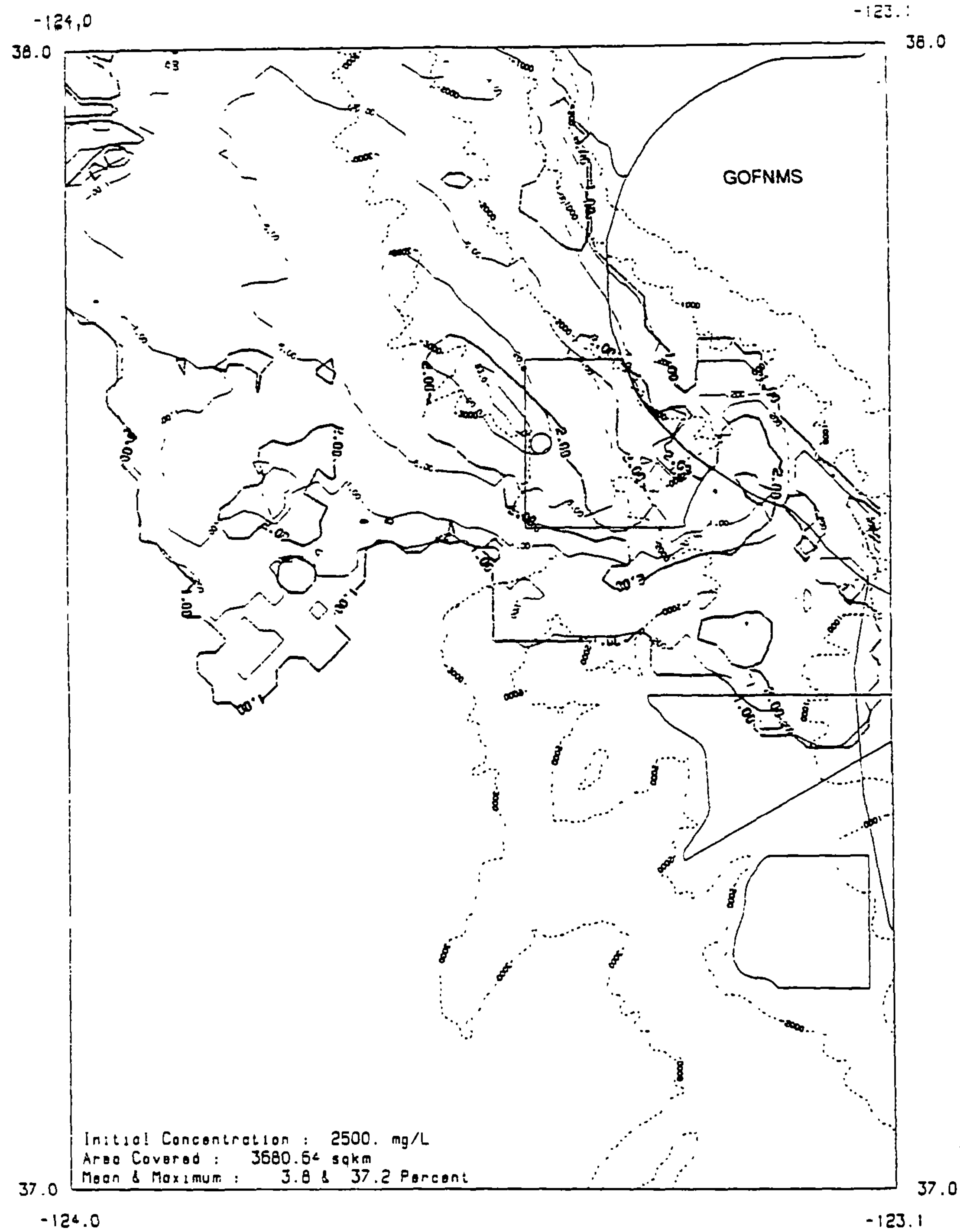

Figure 4.2-3. **Model-Predicted Visitation Frequencies (red) and Average Particle Concentrations (green) for Clay-Silt (Class 6) Sediments Discharged at the Preferred Alternative Site.**

Visitation frequencies (in percent) represent the probability of the total number of disposal events in which a cloud of particles would pass over a location on the seafloor. The circle within the study area represents the location of initial disposal. The concentration contour represents the suspended particle concentration (mg/l) within a cloud as it passes a location. Results were based on current data for the period March 15, 1991 through February 15, 1992, and used a diffusion coefficient of D=1 m^2/sec.

Source: SAIC 1992e.

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Figure 4.2-3. Continued.

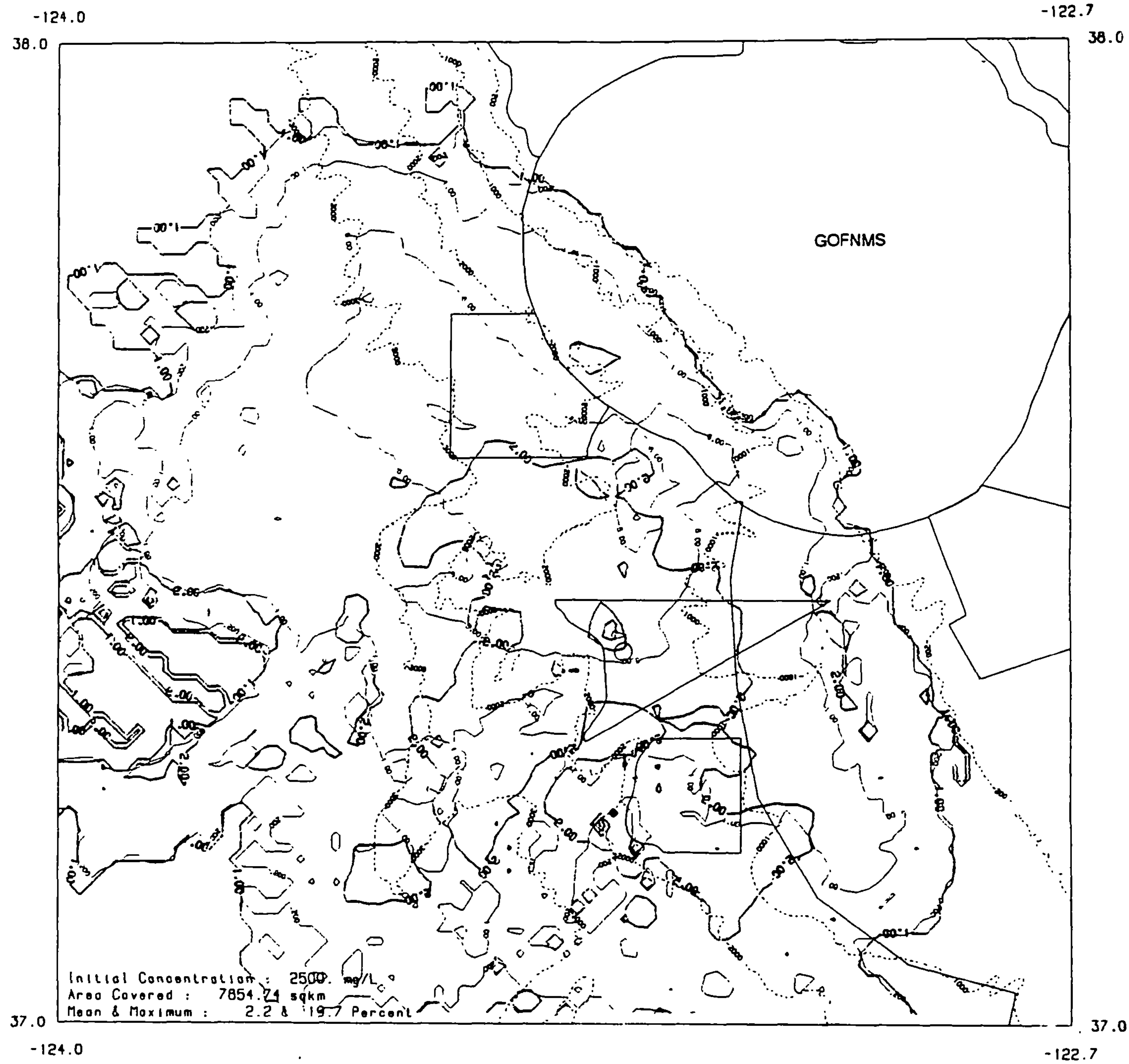

Figure 4.2-4. **Model-Predicted Visitation Frequencies (red) and Average Particle Concentrations (green) for Clay-Silt (Class 6) Sediments Discharged at Alternative Site 3.**

Visitation frequencies (in percent) represent the probability of the total number of disposal events in which a cloud of particles would pass over a location on the seafloor. The circle within the study area represents the location of initial disposal. The concentration contour represents the suspended particle concentration (mg/l) within a cloud as it passes a location. Results were based on current data for the period March 15, 1991 through February 15, 1992, and used a diffusion coefficient of D=1 m^2/sec.

Source: SAIC 1992e.

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Figure 4.2-4. Continued.

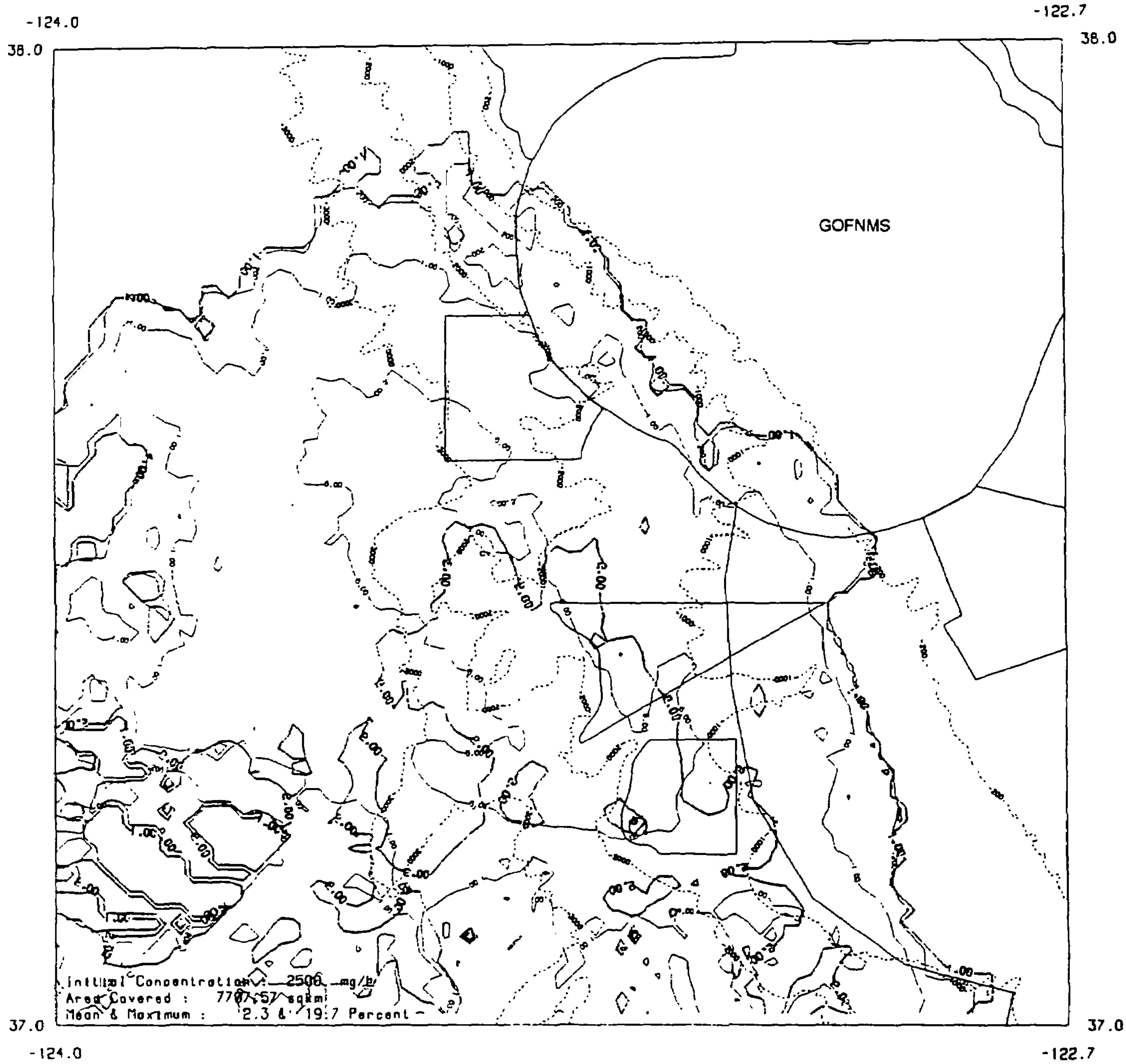

Figure 4.2-5. **Model-Predicted Visitation Frequencies (red) and Average Particle Concentrations (green) for Clay-Silt (Class 6) Sediments Discharged at Alternative Site 4.**

Visitation frequencies (in percent) represent the probability of the total number of disposal events in which a cloud of particles would pass over a location on the seafloor. The circle within the study area represents the location of initial disposal. The concentration contour represents the suspended particle concentration (mg/l) within a cloud as it passes a location. Results were based on current data for the period March 15, 1991 through February 15, 1992, and used a diffusion coefficient of $D=1m^2/sec$.

Source: SAIC 1992e.

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Figure 4.2-5. **Continued.**

greater than observed for the preferred alternative site and distributed equally in all directions. The spatial distribution of visitation frequencies was similar to the distribution of particle concentrations.

Results of visitation frequencies and particle concentrations for Alternative Site 4 (Figure 4.2-5) were similar to the results from Alternative Site 3, with broad spreading of material to the north, west, and south. The 1 mg/l particle concentration boundary corresponded with the inshore topography as was observed for the other sites. Further discussion of model predictions of water quality effects on Alternative Sites 3 and 4 is provided in Section 4.4.

Potential Impacts on Adjacent Marine Sanctuaries

Model results indicated that clouds of coarse to very fine sands and coarse silts (particle classes 1 through 5 and class 7) likely would not be transported across the GOFNMS, CBNMS, or MBNMS boundaries (i.e., probabilities less than 0.2%). Clay-silt particles (class 6) represent the only size class of material with a predicted likelihood of being transported across sanctuary boundaries under the conservative assumptions of high initial concentrations, low dispersion rates ($D = 1\ m^2/sec$), and ambient suspended particle concentrations of 1 mg/l. Based on the model, plumes of fine grained sediments, representing only a fraction of disposed material, were estimated to cross the GOFNMS and/or MBNMS boundaries from only 0.2 to 5% of the disposal events regardless of which site was used for dredged material disposal. The predicted particle concentrations within plumes crossing the sanctuary boundaries would be approximately 1 to 2 mg/l and within the range of presumed background or ambient levels (Figures 4.2-3 through 4.2-5). Thus, dredged material disposal would not be expected to result in measurably elevated concentrations within the sanctuaries. Concentrations at the CBNMS boundary would not be expected to be elevated above background concentrations at any time. The calculated average depths of the plumes at the sanctuary boundaries would range from approximately 60 to 800 m. Using higher dispersion rates (e.g., $D = 10\ m^2/sec$) in the model would result in lower visitation frequencies and particle concentrations in the vicinity of the sanctuary boundaries, as demonstrated in Figure 4.2-6 for disposal from the preferred alternative site.

The differences in results from the three sites were due primarily to differences in the variability of currents at the sites. At each site, the three particle classes having slow settling velocities (classes 4, 5 and 6) remained in the upper water column and had very little overlap in depth ranges. The dispersive effects of the strong and variable currents in the upper water column resulted in very large areas being affected by these size classes, but at low concentrations.

Sensitivity of Model Parameters

The oceanographic regime over the approximately one year (March to February) current meter deployment period varied considerably between the first and second half of the records. The first (spring-summer) deployment was characterized by strong northward flow, whereas the second deployment (fall-winter) exhibited weak, intermittent flow followed by episodic northward flow. Consequently, model runs performed independently with the two portions of the current records

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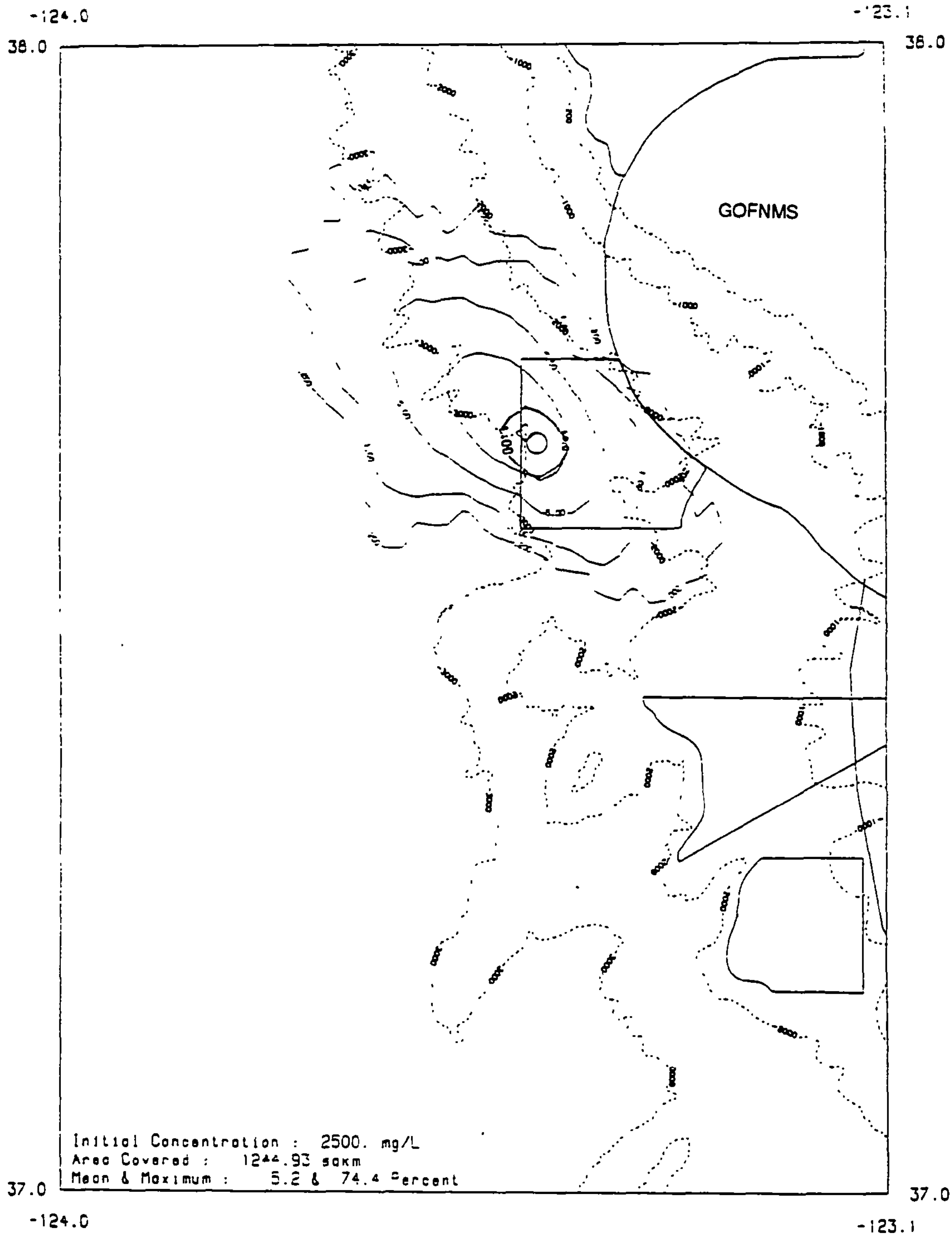

Figure 4.2-6. Model-Predicted Visitation Frequencies (red) and Average Particle Concentrations (green) for Clay-Silt (Class 6) Sediments Discharged at the Preferred Alternative Site Using a Diffusion Coefficient of $D=10m^2/sec$.

Visitation frequencies (in percent) represent the probability of the total number of disposal events in which a cloud of particles would pass over a location on the seafloor. The circle within the study area represents the location of initial disposal. The concentration contour represents the suspended particle concentration (mg/l) within a cloud as it passes a location. Results were based on current data for the period March 15, 1991, through February 15, 1992.
Source: SAIC 1992e.

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Figure 4.2-6. **Continued.**

exhibited considerably more dispersion of material during the spring-summer period. For the spring-summer period, more material was lost through the model boundaries, water column particle distributions were greater, and deposition thicknesses were less than for the fall-winter period. These results demonstrate that temporal variations in currents have a major effect on the water column distribution and deposition of particles released at all three sites.

The model used a dispersion coefficient of 1 m^2/s to represent the horizontal diffusion during model runs. Tests conducted to determine the model's sensitivity to this coefficient revealed that the results were relatively insensitive to variations in this coefficient for values less than 10 m^2/s. However, as shown in Figure 4.2-6, a dispersion coefficient of 10 m^2/sec results in appreciably lower visitation frequencies and particle concentrations outside of the disposal site. Values for the horizontal diffusion coefficient greater than 10 m^2/sec are not realistic for this area, as indicated by results from tracer studies conducted over the slope to the south of the region (Ledwell and Watson 1991). Similarly, if higher background concentrations of suspended particles (i.e., greater than 1 mg/l) are assumed, then the relative visitation frequencies in areas away from the disposal location, particularly near the sanctuary boundaries, would also be appreciably lower. This is because the model assumes that when the dredged material particle concentration reaches the background particle concentration, the particle cloud can no longer be distinguished.

Sensitivity tests also were performed to determine the effect of varying the depth of initial plume release from 20 to 250 m. This test was conducted to determine whether the elimination of the physical stages associated with convective descent and mid-depth dynamic collapse had a major effect on the results of the model. The test illustrated that the results were insensitive to variations in the disposal depths over this range, and hence, the simple physics of the model are representative of the complex physical processes associated with dredged material settling.

Water Quality Effects

Potential impacts on water quality from dredged material disposal are expected to be transient at the preferred alternative site, therefore representing Class III impacts. These changes correspond to localized increases in turbidity, reductions in light transmittance, and increases in dissolved and particulate concentrations of trace chemical constituents contained in the dredged material. The following is a discussion of generic effects; expected effects for the preferred alternative are summarized below.

Chemically reduced inorganic compounds associated with particles sinking through the upper water column (generally above a depth of 400 m) may be oxidized, causing a transient increase in the chemical oxygen demand. Oxidation of labile organic material consequently may reduce dissolved oxygen concentrations in the water. However, because the upper water column in the study region is well oxygenated, this effect may be more pronounced at depths corresponding to the oxygen minimum zone (OMZ) where dissolved oxygen concentrations are naturally low (i.e., less than 2.8 mg/l; Figure 3.2-7).

Similarly, depending on the chemical composition of the dredged material, elevated concentrations of sinking particles may cause changes in the concentrations of trace chemical constituents in the water column. Because the bulk chemical composition of the dredged material is not known, assessments of the contributions of suspended particles to changes in water quality at the preferred and alternative sites, and subsequent comparisons to marine water quality criteria, presently are not possible. However, these chemical concentrations are expected to be low because dredged material must be tested and the results meet established criteria in order to be acceptable for disposal (see Section 4.6). Evaluations of changes in water quality due to a specific disposal event will be made during the permitting process for individual dredging projects.

Dredged material disposed at an ocean site also can introduce dissolved solutes or gases, such as hydrogen sulfide, methane, manganese, iron, ammonia, and phosphorus, that occur naturally in estuarine sediments such as San Francisco Bay. These may be introduced in solution or subsequently released into ambient waters by desorption from particles and/or release of trapped interstitial gas from the break-up of falling cohesive mud clasts. Material deposited on the bottom represents a second source of dissolved compounds (Salomons *et al.* 1987). Once solid particles reach the sea floor, changes in pH and redox potential (Eh), and benthic organism and microbial activity, can redissolve metals and organic compounds. Remobilized, dissolved compounds can accumulate in sediment porewaters or in water overlying deposited material or sediments (Forstner and Wittman 1983; Bryan 1984; Graybeal and Heath 1984; Landner 1986; Salomons *et al.* 1987).

The chemical fate of dissolved contaminants in seawater will be affected by a variety of physical, chemical, and biological processes. These factors include: (1) circulation and mixing processes; (2) the presence of organic matter, clays, iron and manganese oxides and hydroxides; (3) salinity; (4) biological uptake processes; (5) chemical conditions (Eh, pH) in the sedimentary and water environment: and (6) the properties of the compound itself. Water circulation may be the most important factor affecting dispersal of contaminants in the oceans (Bryan 1984). Dissolved constituents also are diluted as the discharged material settles through a deep water column. In the deep ocean, near-bottom currents are capable of dispersing dissolved materials that have diffused out of deposited sediments. Conversely, local topographic depressions, such as submarine valleys or troughs, have the potential to trap finer-grained sediments which often contain relatively higher concentrations of trace chemical constituents.

Organic matter, clays, and iron oxides all have the ability to absorb dissolved organic compounds, metals, and salts due to the ion-adsorptive properties (Lee 1975; Stumm *et al.* 1976; Hem 1977; Kerndorf and Schnitzer 1980; Leckie *et al.* 1980; Davis and Gloor 1981; Tipping 1981; Forstner and Wittman 1983; Hunter 1983; Balistrieri and Murray 1986; Landner 1986). Present evidence suggests that cycling and residence times of dissolved and particulate metals in the oceans are controlled by a combination of biological scavenging and uptake by surface-reactive particles (Fisher *et al.* 1991). Bio-concentration of metals through uptake by zooplankton may result in the production of metal-rich zooplankton fecal pellets. These particles serve as an important vehicle for the rapid removal and sedimentation of contaminants to the sea floor (Capuzzo 1983), and affect the residence times of elements in the ocean (Fowler 1977; Cherry *et al.* 1978; Fisher *et al.* 1991).

Adsorption and scavenging of metals by organic particles or organic coatings on particles is another important process that removes metals from the water column (Brewer and Hao 1979; Balistrieri *et al.* 1981; Forstner and Salomons 1982; Balistrieri and Murray 1983, 1984; Hunter 1983; Bryan 1984; Collier and Edmond 1984; Honeyman *et al.* 1988). Particle concentrations in the water column may be the most important variable affecting metal removal (Capuzzo 1983; Honeyman *et al.* 1988). Organic matter appears to have greater ability to form complexes with metals than with inorganic minerals (Balistrieri *et al.* 1981). Desorption of metals may be driven by interactions with particulate or dissolved ligands (or both) in seawater (Erel and Morgan 1991). Thus, the fate of metal contaminants, even in the dissolved phase, is strongly affected by the number and kinds of particles that are present in the descending or dispersing plume and in the ambient water column.

Once particles have reached the sea floor, reducing conditions may develop again beneath the oxidized surface sediment layer, particularly if concentrations of labile organic carbon are greater than about 1%. Thus, remobilization of metals from particles could occur in both the water column (OMZ) and in the sediment column, resulting in a release of dissolved metals to the overlying water or to porewater.

The mobility of certain metals is strongly affected by pH and the Eh of the environment. Metals which become soluble under reducing conditions include iron, manganese, and mercury (Bothner *et al.* 1980), whereas oxidizing conditions favor the release of cadmium, nickel, lead, and zinc (Bryan 1984). Dissolution of certain metals under anoxic conditions is balanced by their precipitation as metal sulfides. The dissolution of iron or manganese oxides releases other metals, such as zinc, copper, cobalt, nickel, and lead, and organic compounds which were adsorbed to these compounds (Elderfield and Hepworth 1975; Bryan 1984).

Biological activity, including bioturbation and microbial activities, in sediments also can remobilize contaminants in deep-sea surface sediments (Graybeal and Heath 1984). Microbial decomposition of organic matter, including organic compounds, can transform compounds from one form to another, potentially affecting their toxicity, mobility, and release to the water column (Metcalf 1977; Colwell and Saylor 1978; Bryan 1984).

Effects to water quality from dredged material disposal at the preferred alternative site are considered Class III potential impacts because plumes are expected to disperse within 48 hours of discharge, no build-up or accumulation of particles within the water column is expected, and changes to water quality parameters (e.g., turbidity, light transmittance, dissolved oxygen concentrations) are expected to be transient and localized within the discharge plume. Disposal operations should have insignificant effects on concentrations of contaminants in the water column, given that only dredged material of suitable quality will be permitted for disposal.

4.2.1.4 Geology and Sediment Characteristics

Dredged material disposal operations at the preferred or alternative sites are not expected to result in any significant changes in regional bottom topography or sediment transport processes, although minor accumulations of sediments could occur within the sites, as discussed below. In the vicinity of the alternative sites, where depths are greater than 1,400 m and bottom slopes are relatively slight, mounding of bottom sediments or slight changes in sediment stability conditions are not a primary concern (Class III impact). However, accumulation of dredged material, and associated changes in the sediment characteristics may cause impacts to benthic-dwelling organisms (Sections 4.2.2.2 and 4.2.2.3).

The model of dredged material dispersion (see Section 4.2.1.3) was used to predict dredged material deposition under varying disposal scenarios and environmental conditions at the alternative sites. Results from the modeling activities are presented below, followed by a discussion of potential effects within the sites and adjacent marine sanctuaries.

Overview of Particle Deposition (Footprint) Model

As described in Section 4.2.1.3, the first stage of the model (SAIC 1992e) predicts the time-varying, three-dimensional distribution and concentrations of dredged material in the water column following individual releases of 6,000 yd^3 of material. The second stage of this model has the capability for predicting the thickness and areal extent (footprint) of dredged material that will settle on the sea floor in the region encompassing the alternative sites and a broad, adjacent region of the continental slope.

The particle size composition of the dredged material planned for disposal at the ODMDS is not known precisely because of the wide variety of sediment types occurring at potential dredging sites within the Bay. It is likely that the majority of the material to be disposed at an ODMDS would be dredged using a clam shell dredge. As opposed to a suction-type dredge, this type of dredging equipment does not add much water to the dredged material. Therefore, the dredged material clumps likely would retain the physical character of the original Bay muds. The extent to which cohesive materials become fluidized by the dredging operations in transit to the disposal site presently is unknown. Therefore, for the purpose of the model, an assumption was made of 50% clumping of the clay-silt material. Smaller clumping factors would result in smaller maximum deposit thicknesses, but little or no change in the area covered with deposits thicker than 1 mm. This is because fine silt material would be dispersed so widely that effects on the predicted deposit thickness would be negligible. In contrast, sandy material contained in the dredged sediments is not cohesive, and it would sink as individual particles instead of clumps following disposal from a barge.

As noted in the prior discussion of the model (Section 4.2.1.3), two cases were assumed for the average composition of material to be disposed at the alternative sites: clay-silt (74% silt, 5% clay, and 21% sand) and mostly sand (3% silt, 21% clay, and 76% sand). Model results for disposal of both material types at each of the alternative sites are presented in this section.

The model simulations assumed that the momentum from the initial barge release dissipated at a depth of 20 m, and particles acted independently at depths below 20 m. As a sensitivity test, other simulations were performed which varied this depth between 20 and 250 m for a continuous discharge over a one-year period in 1,000 m of water. The results did not change significantly despite this variation in the depth of the initial release.

The model also assumed that discharges of 6,000 yd^3 every 8 to 12 hours did not occur at the same location each day. Instead, the discharge positions were randomized on a daily basis over a region defined by a watch circle having a diameter of 2 km and centered in the southern to central portion of the western boundary for each site.

As described in Section 4.2.1.3, the bathymetric data used in the model simulations were from NOAA's EEZ side scan surveys. These data provided the highest resolution grid available for the study region and resolved bathymetric features to an accuracy of a few meters.

The moored current measurements made by the EPA study (Section 3.2.2.2) provided the first long-term, deep-water current data for this region. Because few current measurements have been made over the continental slope off San Francisco, there was no basis for determining the representativeness of these current measurements relative to long-term climatology or interannual variability (see Section 3.2.2.1). The effects of seasonal and inter-annual variability of the region was predicted by the model using segments of the approximate one-year data set (SAIC 1992e).

The distinct changes in the characteristics of currents between the first and second portions of the study prompted the modeling of dredged material deposition over a one-year period as well as for the two six-month periods. The first time period coincided with the complete period of current measurements (March 15, 1991 through February 15, 1992). The second and third periods corresponded to the first and second six-month segments of the current records, respectively. The first six-month period was characterized by a strong poleward flow, whereas, the second six-month period was characterized by weak, intermittent flows followed by episodic poleward events. These sensitivity tests revealed that the mean and maximum deposition thickness decreased and the areas of deposition increased with increasing current speeds.

Further details on the input conditions and physical assumptions incorporated in the model are presented in Section 4.2.1.3.

Results of Particle Deposition Model

Similar to the results of suspended particulate matter distribution in the water column, the particle deposition results indicate that the slowly settling components cover a larger area of the sea floor due to horizontal diffusion and transport of the slowly settling clouds. Table 4.2-4 presents the model predictions of dredged material deposition, calculated for the period from March 15, 1991 to February 15, 1992, for each of the alternative sites. Results are presented for both the clay-silt (C-S) and mostly sand (M-S) materials, based on an annual disposal volume of 6 million yd^3 of material. The mean deposit thickness is the mean thickness of material within all model

Table 4.2-4. Model-Predicted Deposit Thicknesses, Areal Coverage, and Material Losses Due to Transport Outside of the Model Boundaries
Based on current data for the period March 15, 1991 through February 15, 1992.

Alternative Site	Material Type[1]	Mean Deposit Thickness (mm)[2]	Maximum Deposit Thickness (mm)	Percent Loss	Area Covered (km^2)[3]
3	C-S M-S	7.94 4.46	727.2 62.0	19.3 11.4	362.8 624.4
4	C-S M-S	9.78 5.25	788.3 69.4	21.4 12.7	283.8 500.1
5*	C-S M-S	9.75 5.87	493.2 65.5	27.1 16.2	278.6 449.1

[1]C-S = Clay-Silt Mixture, M-S = Mostly Sand Mixture.
[2]For deposits with thicknesses greater than 1 mm.
[3]Area covered by deposits with thicknesses greater than 1 mm.
*Preferred Alternative Site.

Source: SAIC (1992e).

locations (i.e., 250-m x 250-m areas) that contain at least 1 mm of accumulated dredged material. The maximum deposit thickness corresponds to the thickness within a single, 250-m by 250-m location within the model grid containing the greatest amount of dredged material .

The table also presents the area of sea floor covered by deposits with thicknesses exceeding 1 mm at the end of the model period. The percentage of material that would be transported out of the model boundaries (defined in Section 4.2.1.3) is also presented. The model predicts that roughly 19 to 27% of the clay-silt material would be lost through the lateral boundaries of the model compared to 11 to 16% of the mostly sand material. Material that exits the modeled region prior to deposition eventually would be deposited on the sea floor far from the disposal site, with respective accumulation thicknesses of less than 1 mm for the modeled discharge volumes (6 million yd^3).

As indicated in Table 4.2-4, the type of dredged material (clay-silt versus mostly sand) had a major effect on the predicted thickness and affected area of deposition. For example, mean deposit thicknesses of clay-silt material were nearly twice those of mostly sand material, while the area covered by the mostly sand material was 60 to 75% greater than the area of the clay-silt deposit. Variations in deposit thickness and affected area due to location of the alternative sites were considerably smaller than variations due to the material type. Note, however, that the mean deposit thickness was less than 1 cm for both material types and for all areas (for the model period).

The largest differences between the predicted behavior of the two material types was observed for the maximum deposit thickness. Due to the rapidly settling clumps within the clay-silt material, maximum deposits for the clay-silt material were roughly 7 to 12 times greater than for the mostly sand material. Although the settling rates of sand components are considerably greater than settling rates for fine-grained material, the clumps of fine material reach the sea floor much sooner than the sand components. For example, at depths of 2,000 m, fine sand would reach the sea floor in approximately 34 hours, whereas clumps of fine-grained material would reach the sea floor in approximately 4 hours.

A summary of the model results for dredged material deposition following disposal from each of the alternative sites is given below.

Disposal at the preferred alternative site (Alternative Site 5):

- The mean and maximum deposit thicknesses for the clay-silt material were approximately 10 and 490 mm, respectively, compared to 6 and 66 mm for the mostly sand material.

- Mean deposit thicknesses for a specific material type varied only a small amount between the preferred alternative site and Alternative Sites 3 and 4.

- Maximum deposit thickness for the clay-silt material at the preferred alternative site was roughly 65% less than the maximum deposit at the other two sites, presumably due to the greater water depth at the preferred alternative site.

- Deposit thicknesses greater than 1 mm covered an area of 278 km^2 for the clay-silt material and 449 km^2 for the mostly sand material. (For comparison, the area of the preferred alternative site is 22 km^2.)

- Approximately one-quarter of the clay-silt material disposed at the preferred alternative site was lost through the lateral boundaries of the modeled region; a relatively smaller fraction of the mostly sand material was lost. Material loss from disposal at the preferred alternative site was greater than loss from disposal at the other two sites, presumably because of the northwestward flow and the northerly location of the preferred alternative site relative to the northern boundary of the model grid.

Disposal at Alternative Sites 3 and 4:

Model results for these two sites were very similar, partly because local currents were similar and the mean water depths were in the range from 1,400 to 1,700 m, compared to a mean water depth of over 2,700 m for the preferred alternative site.

- Mean deposit thickness for the clay-silt material was 8 to 10 mm, compared to 4 to 5 mm for the mostly sand material.

- Maximum deposit thickness for the clay-silt material was 727 to 788 mm, compared to 62 to 69 mm for the mostly sand material.

- Deposit thicknesses greater than 1 mm would cover an area of 283 to 362 km^2 for the clay-silt material, and 500 to 624 km^2 for the mostly sand material. (For comparison, the areas of Alternative Sites 3 and 4 are 22 km^2.)

- From 19 to 21% of the clay-silt material disposed at Alternative Sites 3 and 4 was lost through the lateral boundaries of the modeled region; a relatively smaller fraction of the mostly sand material was lost. Material loss from disposal at Alternative Sites 3 and 4 was less than at the preferred alternative site, as discussed above.

Comparisons between results from model runs for the two six-month current measurement periods generally indicated greater deposit thicknesses but over relatively smaller areas during the August to February period, when currents were less intense, than during the spring measurement period.

Spatial Distribution of Dredged Material Deposition

The simulated depositional footprints for disposal of the clay-silt and mostly sand dredged materials at the preferred and alternative sites are shown in Figures 4.2-7 and 4.2-8, respectively. The contour lines correspond to deposit thicknesses of 1 mm, 10 mm, and 100 mm derived from average thicknesses within model cells. Thus, a model cell (250 m x 250 m) covers an area much larger than the dimensions of very small mounds that may result from disposal from individual barge loads containing clumped material.

The 1 mm deposit thickness represents the minimum thickness that might be measured practically using existing technologies under ideal conditions, and does not correspond to any known or predicted adverse impact to the benthic environment. The 10 mm deposit represents an intermediate thickness that was used as the basis for defining the size and shape of the preferred and alternative sites (Section 2.2).

The 1 mm and 10 mm deposit thickness contours for the clay-silt material for all three sites do not extend into any of the National Marine Sanctuaries. The 1 mm deposit thickness of the mostly sand material discharged at the preferred alternative site extends into the GOFNMS, whereas the sandy particle bottom deposits corresponding to Alternative Sites 3 and 4 do not cross sanctuary boundaries.

Modeling the 1 mm and 10 mm deposit thicknesses was intentionally conservative for predicting potential effects, but was considered useful for possible monitoring purposes to determine where measurable amounts of dredged material would be deposited. These deposit thicknesses are much lower than 100 mm (10 cm) that might be expected to cause significant impacts (e.g., smothering) to benthic organisms (Rhoads and Germano 1990; see Section 4.2.2.2). Also, impacts associated with 100 mm thicknesses would result from instantaneous deposition, whereas, the modeled deposits were accumulated over a period of one year. The predicted deposits were discontinuous in some areas because of the effects of topographic irregularities on the deposition patterns.

The particle deposition model assumes that deposition of material is cumulative. It does not account for losses due to sediment transport processes such as bottom current resuspension and transport and/or mass movement, which would reduce the estimated thickness of the deposit but also increase the bottom area affected. The preferred alternative site is located within a depositional zone characterized by low kinetic energy and fine grain size sediments with a relatively high organic content (Section 3.2). It is expected that the depositional characteristics of the site will minimize bottom current-induced dispersion of deposited dredged material. Use of the site over a period of 50 years would increase the predicted deposit thicknesses as well as the areas covered by deposits with thicknesses exceeding 1 mm. However, over time, physical and biological (e.g., bioturbation) processes may transport and mix the dredged material with existing and recently-deposited sediments. The expected result is reduced differences between the physical characteristics of the dredged material and those of existing sediments and reduced potential impacts.

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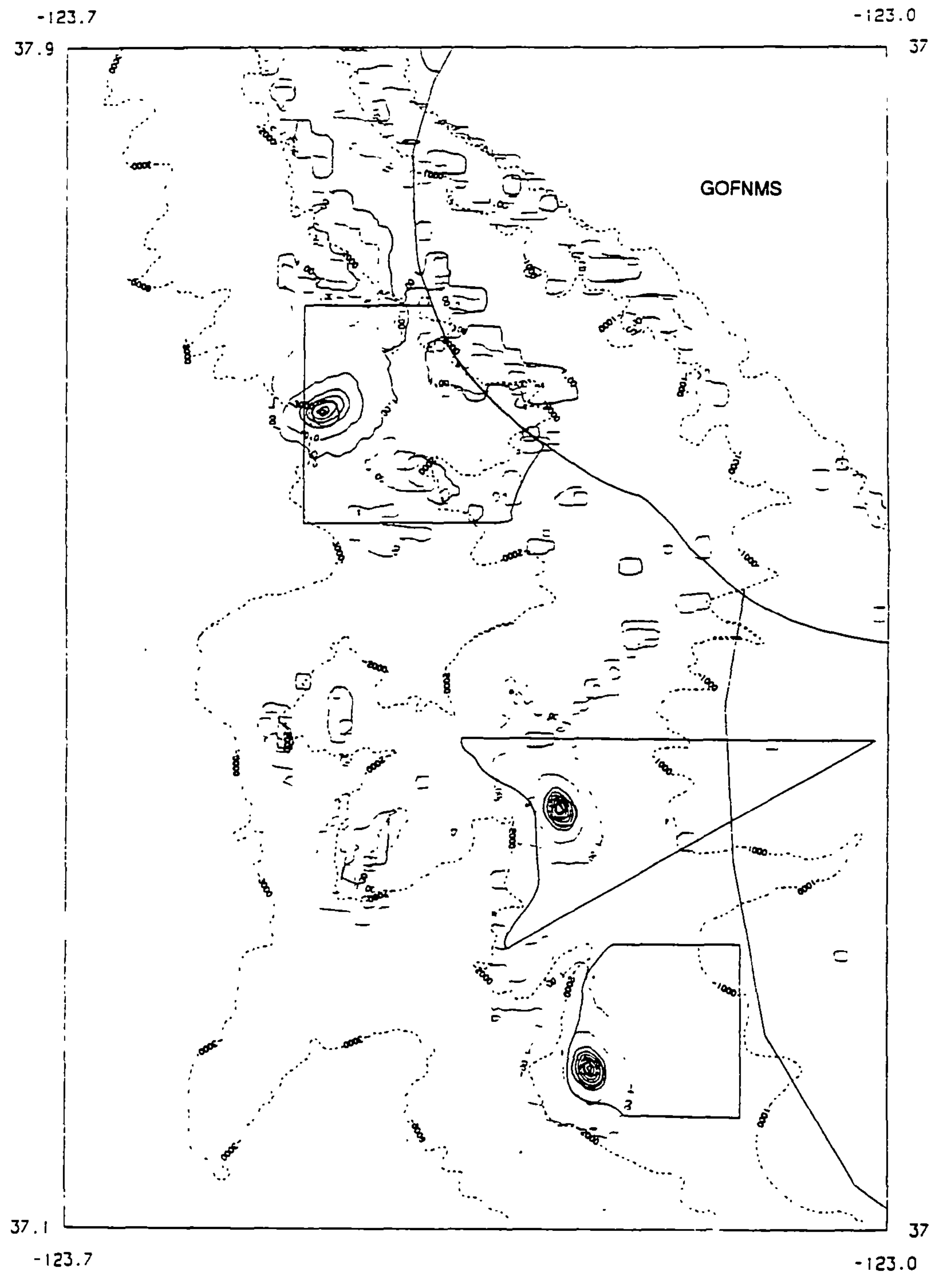

Figure 4.2-7. Model-Predicted Bottom Deposit Thicknesses (in mm) from Discharges of Six Million yd^3 of Clay-Silt Type Material over a One-Year Period at the Preferred Alternative Site (red), Alternative Site 3 (green), and Alternative Site 4 (blue).

The solid black lines near the respective 2 km watch circles (i.e., discharge point) correspond to deposit thicknesses of 100 mm, 200 mm, etc. The circle within the study area represents the location of initial disposal. Results are based on current data for the period March 15, 1991 through February 15, 1992 and used a diffusion coefficient of D=1 m^2/sec.

Source: SAIC 1992e.

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Figure 4.2-7. Continued.

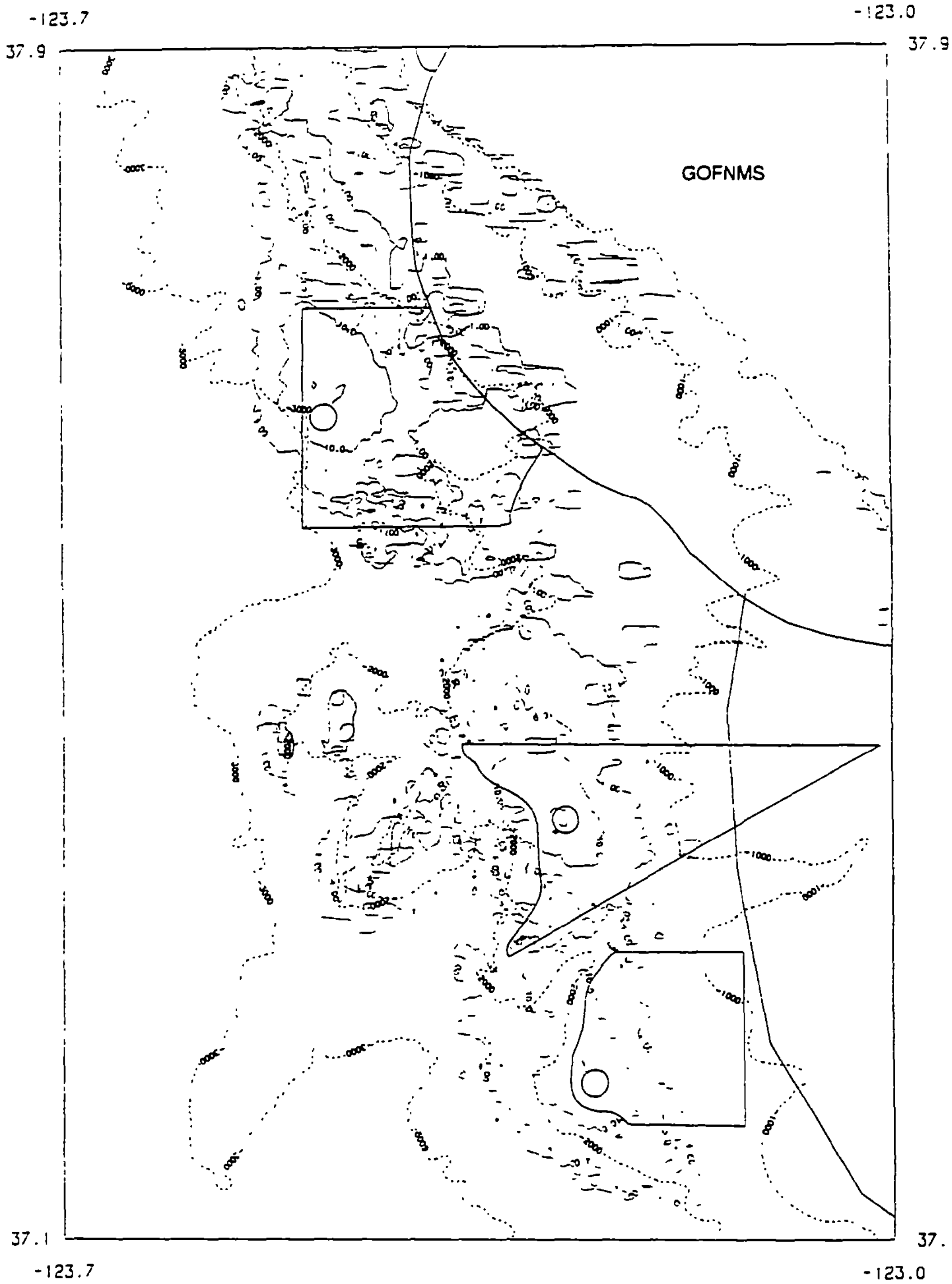

Figure 4.2-8. **Model-Predicted Bottom Deposit Thicknesses (in mm) from Discharges of Six Million yd^3 of Mostly Sand Type Material over a One-Year Period at the Preferred Alternative Site (red), Alternative Site 3 (green), and Alternative Site 4 (blue).**

The circle within the study area represents the location of initial disposal. Results are' based on current data for the period March 15, 1991 through February 15, 1992 and used a diffusion coefficient of D=lm^2/sec.

Source: SAIC 1992e.

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Figure 4.2-8. Continued.

Because the grain size and chemical characteristics of sediments potentially discharged at the ODMDS are not known precisely, the specific effects of dredged material disposal on long-term changes to the properties of the bottom sediments cannot be evaluated or quantified accurately. Sediments must be evaluated using testing procedures for dredged material described in EPA/COE (1991) to ensure that chemical constituents are not present at concentrations that would be toxic or cause adverse impacts due to bioaccumulation by marine organisms. Only material deemed acceptable under these protocols would be approved for disposal at an ODMDS.

Effects from dredged material disposal at the preferred alternative site on sediment grain size are expected to represent a Class I impact. This impact would be localized and would persist for the duration of site use, assuming a continuous disposal schedule. Effects to sediment chemical quality are considered a Class III impact due to the requirements for testing for adverse effects per the Green Book protocols prior to disposal.

4.2.2 Effects on Biological Environment

The following sections discuss the potential consequences of the proposed action on the biological environments associated with the preferred alternative site.

4.2.2.1 Plankton

Any significant water column impacts to the pelagic ecosystem would most likely involve those planktonic organisms that come in contact with slower-settling particles, such as silts, in regions of neutral buoyancy, such as the pycnocline. The impact of suspended particles from dredged material disposal on planktonic organisms is expected to be minimal for the rapidly settling size fractions, including sand and clay-silt aggregates, that reach the bottom within a few minutes to hours (see Section 4.2.1.4).

Some effects of water column turbidity on open ocean planktonic species have been addressed experimentally by a study designed to predict the impact of surface discharges of deep-sea muds simulating a manganese mining operation (Hirota 1981). These results indicated increased mortality and lower recruitment rates in 12 species of epipelagic copepods and one species of mysid exposed in the laboratory. However, mortality of copepods collected in the field from a simulated plume showed only slightly higher mortality relative to reference populations collected from outside the plume (Hirota 1981).

A laboratory study of exposure of the copepod *Calanus helgolandicus* to fine-grained red bauxite muds showed lower survival, growth rates, and body weight at concentrations above 6 mg/l (Paffenhofer 1972). This same type of mud resulted in decreased egg hatching success and lowered survival of larval Atlantic herring (*Clupea harengus*) and adversely affected embryo development and larval feeding at concentrations in the range of 600 to 7,000 mg/l (Rosenthal 1971).

The results from these studies cannot be extrapolated directly to dredged material disposal because most of the adverse biological effects were related to organisms ingesting mineral-rich and nutrient-poor deep-sea ooze or bauxite "red mud". These nutrient-poor suspensions resulted in starvation of the exposed species. Because dredged material plumes will typically consist of relatively organic-rich muds, and will be transient in nature, similar impacts to planktonic organisms are unlikely.

Potential effects of disposal-related turbidity on planktonic organisms are difficult to assess due to the transient nature of the dredged material plume and the free-floating or mobile characteristics of the organisms. Turbid plumes associated with dredged material disposal can temporarily attenuate light penetration into the water column, thereby reducing primary production by phytoplankton. Measurements of primary production in a disposal plume showed 50% reduction in productivity compared to that of ambient phytoplankton populations (Chan and Anderson 1981). However, this effect lasted only a few hours until the plume dissipated. Additional factors which complicate these assessments are seasonal and annual variations in plankton productivity, standing stock, and species composition (Section 3.3.1).

Since the duration of potential plume exposure is short and of limited spatial extent, the overall effect of disposal on plankton communities at the preferred alternative site is expected to be insignificant (Class III; Table 4.1-1). This conclusion also is based on substantial natural variation in plankton communities throughout the general study region. The highest plankton abundances are inshore of the preferred and alternative sites and there are no distinguishable differences between the sites.

4.2.2.2 Infauna

Impacts of Burial

As dredged material accumulates on the sea floor, benthic organisms in the area of initial deposition may be impacted. However, information on the response of deep-water organisms to burial or smothering is limited. The ability of buried infauna (or epifauna) to reestablish normal depths and orientations within bottom sediments is an adaptation for surviving burial from natural events such as storm-related changes in sedimentation or slumping. In deep water, particularly on the continental slope, turbidity currents, submarine slumps, and debris flows can be major natural causes of burial (Hollister *et al.* 1984). The frequency of disturbance and depth of burial are also critical for determining the response of infauna to burial. Frequencies of disturbance that are less than one year tend to keep the colonizing benthos in an early successional stage while burial frequencies much greater than one year allow colonization of higher order successional species with longer mean life-spans and more conservative reproductive strategies (e.g., Rhoads *et al.* 1978).

Impacts to bottom-dwelling organisms from burial by either natural processes or dredged material disposal can vary from negligible to localized mortality, depending on the rate of accumulation, burial depth, textural and mass properties of the deposited sediment, burial time, water temperature, and the species experiencing burial. This type of impact has been quantified for several species in estuarine environments. For example, Kranz (1974) determined the depth of burial that caused mortality of several bivalve species. The critical burial depth for epifaunal suspension feeders was less than 5 cm, while infaunal deposit-feeders could survive and burrow through as much as 50 cm of overburden. *In situ* burial experiments by Nichols *et al.* (1978) indicated that overburden thicknesses of 5 to 10 cm did not cause significant mortality to "mud-dwelling" invertebrates as most of these motile infauna could initiate "escape" responses by burrowing upward, while organisms covered with overburdens of 30 cm could not initiate escape responses. Similar results for estuarine organisms were documented in a laboratory study by Maurer *et al.* (1978), who also noted critical overburden thicknesses of 5 to 10 cm. The critical burial depth for estuarine infauna therefore appears to range from 5 to 30 cm. The response of a species to a specific overburden thickness can be estimated from how frequently a species population experiences natural sediment burial. For example, species living on rippled bottoms or sediments subjected to resuspension are better able to withstand burial by relatively thick sediment layers than species living in low kinetic energy, low sedimentation rate areas.

Generalizations about critical burial depths based on shallow water data noted above are directly applicable to Study Area 2 and perhaps the shallower part of Study Area 3. However, care must be exercised in extrapolating these observations to deep water as comparable data on critical burial depths for deep-sea benthos have not been fully investigated. The present information comes from observations of the burial of benthos by "accidental" sedimentation events. Jumars (1977) reported an accidental burial of benthos in the San Diego Trough (1,200 m depth) by a small avalanche of sediment (2 to 10 cm thick) produced by a submersible. The next day, the site was revisited and the submersible took cores through the new sediment layer. Organisms were beginning to migrate upward through layers 1 cm thick, while deeper burial resulted in increased mortality. The polychaete *Prionospio spp.* was noted to be an important casualty in this experiment, suggesting that surface deposit feeders might be affected most by burial (Jumars 1977). *Prionospio delta* is present in water depths of ≥ 2,000 m in the Farallones region. These observations suggest that deposition of shallow layers of sediment at these depths might allow deep water species to recover from burial, but that disposal layers substantially deeper than 10 cm might cause high local mortality. Support for this inference is presented from Study Area 5, sampled in 1990 and 1991 (SAIC 1991; SAIC 1992c). In 1990, high densities of infauna were recorded at Station F-17, while in 1991 densities near Station F-17(B-5) were lower by a factor of seven (see Section 3.3.2.1). Bottom photography showed a "hummocky" surface typical of sedimentation deposits. One explanation for the change in density between 1990 and 1991 is partial mortality related to an intervening depositional (burial) event.

Rapid burial of a benthic community by 30 to 100 cm thick, natural turbidity flows in the Cascadia Channel (2,900 to 3,000 m depth) off the Oregon and Washington coast resulted in a "no escape" response of the buried species. An inference of total mortality was based on the absence of escape burrows across the contact zone between the buried and basal layers of the overlying sediments (Griggs *et al.* 1969). There are no direct studies on the ability of slope-dwelling infauna to escape from thinner deposits of sediments. However, based on the considerable abilities of many species to burrow through and modify natural sediments (Hecker

1982), it is likely that many slope infaunal species would have the ability to survive periodic burial by submarine slumping or moderate amounts of dredged material.

In summary, available information on shallow-water infaunal invertebrates indicates that the rapid accumulation of sediments (either natural sediments or dredged material) in thicknesses exceeding approximately 5 to 30 cm can result in significant mortality of the buried species. Sessile or otherwise immobile species are the most sensitive to burial while mobile deposit-feeding infauna have the greatest ability to escape upward through newly deposited sediments.

Colonization after Deposition

Colonization by infaunal organisms of deposited dredged material has been well documented in shallow water environments, but equivalent studies at deeper depths are lacking. In most cases, the colonization process in shallow water begins within a few days following cessation of discharges (Germano and Rhoads 1984; Scott *et al.* 1987). The mode of colonization is sensitive to the thickness of the deposit. For thin overburden layers (less than or equal to 10 cm), buried adults have an upward escape response, with selective survival based on the ability of different species to reestablish their natural vertical depth positions within the new sediments. When dredged material accumulates in a thick mound, only the thin, distal edges of the deposit may be colonized by this means. The thicker part of the deposit primarily is colonized through larval recruitment or immigration of organisms from adjacent, undisturbed areas.

In shallow water (less than 50 m depth), colonization by adults (reburrowing) and larval recruitment normally is very rapid, taking only a few days to weeks to establish a low diversity but numerically abundant pioneering community. Rapid colonization is attributed to the presence of competition-free space and the availability of detrital organic food that commonly is in greater concentration in dredged material than on the ambient sea floor. In addition, the diffusion of sedimentary sulfides from dredged material into the water column may serve as a larval settlement cue and as a nutritional factor for opportunistic species such as *Capitella* (Cuomo 1985; Tsutsumi 1992).

In shallow water disposal site studies, three phases of macrofaunal recolonization have been described (Rhoads and Germano 1982, 1986, 1990; Scott *et al.* 1987). This successional paradigm is based on "...the predictable appearance of macrobenthic invertebrates belonging to specific functional types following a benthic disturbance" (Rhoads and Boyer 1982). The first infaunal organisms (Stage I) to colonize a disposal site by larval recruitment are usually small opportunistic polychaetes, such as Spionidae and Capitellidae. Species within these families are commonly associated with frequently disturbed and/or organically enriched areas (Pearson and Rosenberg 1978). The worms form dense tube mats and feed at, or near, the sediment surface. Within one or two years, these dense polychaete assemblages may be replaced by dense aggregations of tubiculous amphipods and tellinid bivalves (Stage II). Densities of pioneering species on dredged material often are significantly higher than densities on the ambient bottom. Disposal sites can exceed the secondary productivity measured on the natural sea floor by a factor of six fold or more (Rhoads *et al.* 1978). The degree of enhancement of secondary productivity is proportional to the amount of labile organic matter in the dredged material because organic detritus serves as food for many resident benthos. This high secondary productivity may account for intensive foraging by mobile predators observed at many disposal sites (SAIC 1989a).

Larval recruitment and establishment of Stage III species on a disposal site requires several years because these organisms tend to have more conservative reproductive strategies, slower population and developmental growth rates, and longer mean life spans (Pearson and Rosenberg 1978; Rhoads *et al.* 1978; Hecker 1982). Stage III species are "head-down" deposit feeders and are commonly encountered as part of the equilibrium community on ambient mud bottoms adjacent to disposal sites. Stage III species typically consist of deep burrowing polychaetes (e.g. Maldanidae, Pectinariidae), caudate holothurians, infaunal ophiuroids, or burrowing urchins. Deep burrowing is accompanied by vertical bioturbation of both particles and pore-water fluids to depths of 10 to 20 cm or more. Bioturbation modifies sediment chemistry through oxidation of the sediment column and advective exchange of sulphate, ammonia, or nitrate across the sediment water interface (Aller 1982; Rice and Rhoads 1989). Similarly, bioturbation can change the chemical properties of dredged material and its associated constituents (Rhoads *et al.* 1977).

A series of biological, physical, and chemical changes occur over a period of several months to years after disposal operations cease. The changes include gravitational compaction and biological modifications as well as the reshaping of the deposit in relation to current-mound interactions. Small-scale boundary roughness of cohesive materials is reduced over time as surficial bioturbation and surface current scour reduce elevations and fill in depressions. Diversion of flow over a mound can result in a local change in mound texture as fine-grained sediments are eroded, leaving a coarser surface layer. Long-term bioturbation by Stage III species can result in a progressive increase in fluidization and oxidation of the surface of a dredged material deposit. Furthermore, bioturbation can cause pelletization and repackaging of organic-mineral aggregates which decreases the overall cohesiveness of fine-grained sediments (Rhoads 1991) and often results in the surface becoming physically destabilized (Rhoads and Boyer 1982). Such biogenic processes can contribute to destabilization of the bottom over the long term, especially on slope environments (Hecker 1982).

The successional changes described above for shallow water disposal sites apply only to sites that experience "normal" succession. Normal succession involves rapid initial colonization progressing to Stage III within one to two years. Such a progression can be retarded or stopped if disposal operations are continuous or frequent, if the disposed material experiences erosion and dispersal, or if the disposal area is seasonally or permanently affected by low dissolved oxygen. The relationship between near bottom dissolved oxygen and the successional model indicates that mobile epifauna or demersal species avoid regions with dissolved oxygen concentrations below approximately 3 mg/l. Dissolved oxygen concentrations below about 1.4 mg/l appear to prevent successful colonization of Stage III taxa (Tyson and Pearson 1991). The ecological and physiological effects of low oxygen conditions can be compounded by hydrogen sulfide and/or methane gas associated with organically enriched hypoxic habitats. These compounds may further stress benthic species. Additionally, if pollutants are present, the ability of an oxygen-stressed organism to survive exposure may be significantly reduced. These synergistic effects are poorly known. The shallow portions of Study Areas 3 and 4 are within or near the OMZ (Section 3.2), but the preferred and alternative disposal sites are located in waters deeper than the OMZ. Disposal at any of the sites is unlikely to result in reduced colonization due to low oxygen tensions.

The successional patterns described above for shallow-water disposal sites have been compared to results from studies at deeper water dredged material disposal sites off Los Angeles (LA-2) in 110 to 320 m of water (SAIC 1990a) and off San Diego, CA (LA-5) in 100 to 220 m of water (SAIC 1990b). The dredged material disposed at these sites was from their respective metropolitan harbors and comprised a wide range of textures including sandy material and cohesive mud clasts overlying ambient silt-clays and very fine sands. Presumably due to the relatively deep water at these two sites, the dredged material footprints were in the form of thin deposits. All parts of the dredged material mounds were colonized by benthic organisms, and relatively fresh dredged material could be distinguished from older dredged material by the degree of bioturbation, depth of oxidation of the sediment column, and successional status. Stage I and III species were present both on and off the dredged material. Therefore, similar colonization by benthic infauna is expected at the deep-water alternative sites off San Francisco.

Studies of colonization of experimental sediment trays deployed in the deep-sea, and research on the effects of natural disturbances such as submarine slumping on the rate of colonization, diversity, abundance, and biomass of benthic communities provide some information on rates of recolonization as compared to shallow water systems. Some studies of deep-sea colonization indicate that early colonies may occur in lower densities than the natural communities, even after two years (Grassle and Morse-Porteous 1987), suggesting that deep-sea recruitment rates and succession may operate very differently than those in shallow water. Also, observations of repopulation at depths greater than 2,000 m in the Bay of Biscay have shown rapid colonization within six months by opportunistic species resulting in abundances in experimental trays that were five times higher than on the ambient bottom (Desbruyeres *et al.* 1980). These observations suggest that some deep-water colonization shares attributes with shallow-water succession. However, when organic-rich, shallow-water sediments were introduced into an oligotrophic deep-water environment, some studies indicated inhibition of colonization (Desbruyeres *et al.* 1980) while others showed a stimulatory or enhancement effect (Griggs *et al.* 1969; Jumars and Hessler 1976).

Predicting the responses of infaunal communities to disposal within the preferred and alternative sites is difficult because of the wide range of results from the few relevant studies on recolonization in deep-water environments. However, the dispersion modeling results indicate that the impact of disposing 6 million yd^3 of sand, silt, and clay over a period of one year at all sites will result in most of the dredged material footprint being less than 10 cm thick. The only part of the footprint that might be thick enough to cause extensive burial and mortality is the relatively small central mound formed by rapidly settling cohesive material (see Figure 4.2-6). Therefore the impact class for the central mound is estimated to be Class I for the preferred and alternative sites (Table 4.1-1) and is expected to persist throughout the duration of site use.

Infaunal communities at the preferred alternative site are expected to be significantly impacted (Class I) in a localized area by dredged material disposal. Spionid polychaetes, which are relatively common at this site, likely would be sensitive to sedimentation caused by burial, as discussed above. However, because overall species richness and density is slightly lower at this site (Section 3.3.2.1), the overall composite impact should be less than at Alternative Sites 3 and 4. Also, recovery or recolonization of the benthic populations at the preferred alternative site following dredged material disposal might be slower than in Alternative Sites 3 and 4 because the flux of organic material needed to provide food and stimulate reproductive processes in benthic invertebrates is generally lower with increasing depth. The preferred alternative site is approximately 1,200 m deeper than Alternative Sites 3 and 4.

4.2.2.3 Epifauna

Predicting the effects of dredged material disposal on pelagic and deep-water demersal megafauna is difficult because most studies on the impacts of dredged material have focused on infaunal species assemblages and community characteristics in estuarine environments (Wainwright *et al.* 1992). Few studies have been conducted on megafaunal invertebrates, especially deep-sea species such as those occurring at the preferred and alternative sites.

Following dredged material disposal, it is likely that relatively motile pelagic megafauna, such as euphausiids, siphonophores, and various gelatinous species (cnidarians), would be most affected by suspended sediments causing displacement through avoidance of, or escape behavior from, the disposal plume. Although limited information is available concerning pelagic megafauna within the general study region, some information can be extrapolated from midwater trawls conducted by Bence *et al.* (1992) and from incidental catches in bottom trawls by SAIC (1992b). In general, some pelagic species of cephalopods (not including market squid) were found by Bence *et al.* (1992) at depths greater than 1,200 m, corresponding to depths similar to those of the preferred and alternative sites. Other pelagic species, including euphausiids, are patchy in their distributions within the sites (Bence *et al.* 1992). However, as noted above, potential impacts to these pelagic species probably would be insignificant due to their distribution over broad depth and geographic ranges and at least localized ability to avoid disposal plumes.

Similar to the potential impacts noted for infauna (Section 4.2.2.2), slow-moving epifaunal invertebrates such as seastars and sea pens may become buried and smothered as dredged material is deposited on the bottom within the alternative sites, while more motile benthic taxa such as some crustaceans may be displaced as a result of escape responses. Also similar to the infauna, recovery and recolonization of an impacted area will depend on the frequency and severity of the disturbance and the species involved. Thus, recolonization is expected by individuals able to escape burial, larval recruitment, and immigration from adjacent, undisturbed areas (e.g., SAIC 1989b). Based on uncertainties and variability in the timing of these events, some recovery may occur within hours to days, but full recovery could require a few years. However, accumulation of dredged material should be localized, and there are no known epifaunal species of limited geographic distribution within the preferred or alternative sites.

Therefore, based on an assumption of significant but localized impacts, particularly to some slow-moving epifauna, potential impacts (worst case) are projected to be Class I (Table 4.1-1).

There are few differences between the preferred alternative site and Alternative Sites 3 and 4 in the taxonomic composition, density, and biomass of epifauna (Section 3.3.2.2). The predominant species within the site (e.g., sea cucumbers, seastars, and brittlestars) are slow-moving and have the greatest potential for burial and possible mortality. Therefore, potential, localized impacts from dredged material disposal at the preferred alternative site are expected to be significant and designated as Class I, persisting throughout the duration of site use.

4.2.2.4 Fishes

Information on direct impacts of dredged material disposal on fish communities is extremely limited. Most studies on the effects of dredging and dredged material disposal on fish communities have focused on larvae and eggs in estuarine environments (Auld and Schubel 1978; Johnston and Wildish 1981). However, results from these studies suggest that if disposal of dredged material does not significantly affect these sensitive life stages, then plankton, fishes, or commercial fisheries also should be unaffected by disposal events.

Pelagic Species

During a disposal event, the greatest impact to pelagic fish species may be from increased turbidity within the disposal plume, which may limit the feeding efficiency of visually-oriented predators. However, most of the near-surface pelagic species characteristic of the preferred and alternative sites are highly mobile species, such as juvenile rockfishes, salmon, tunas, and mackerels (Section 3.3.3), which may actively avoid the disposal plume. Deep-water mesopelagic and bathypelagic species such as deep-sea smelts and lanternfishes characteristic of the region also should be able to avoid the disposal plume, although there are no specific studies on avoidance behavior in these fishes. Therefore, it is estimated that potential impacts of dredged material disposal on pelagic fishes will be insignificant and are designated as Class III.

Demersal Species

The number of demersal fish species, density, and biomass at the preferred and alternative sites is relatively low (Section 3.3.3). Impacts from dredged material disposal are expected to be insignificant, particularly due to the relatively high mobility of most species. Some relatively sedentary demersal species such as eelpouts (Zoarcidae) may be less able to avoid burial from rapidly accumulating sediments than more mobile species such as rattails (Macrouridae), which may escape disposal areas entirely. These species also may be displaced from primary deposition areas, but following recolonization by prey species, eventually may return to areas affected by disposal. Therefore, because the preferred and alternative sites are located in relatively deep water and have similar species composition with low fish densities and biomass, potential impacts are estimated to be localized and insignificant (Class III) (Table 4.1-1).

The preferred alternative site has similar numbers and types of fishes as Alternative Sites 3 and 4 (Section 3.3.3). These include pelagic, offshore species such as salmon, tunas, and mackerels. Pelagic species are expected to be least impacted by dredged material disposal due to their high mobility. Alternatively, demersal species within the site such as codling and eelpouts, have lower mobility, and thus are expected to be more impacted by disposal than pelagic species. However, the relatively low numbers of demersal fish species and abundances found within the preferred alternative site (Section 3.3.3) suggest that impacts will be minimal. Some feeding habitat may be lost temporarily following disposal activities. However, demersal species should return to the affected areas following recolonization by prey species. Overall, potential impacts of dredged material disposal on fishes at the preferred alternative site are expected to be insignificant and designated as Class III.

4.2.2.5 Marine Birds

Information concerning impacts of dredged material disposal to resident and migrating bird populations is limited. Potential impacts may include ship-following behavior, temporary reductions in prey items, and visual impairment of marine birds foraging in the vicinity of the disposal plume.

It is common for many species of birds to follow ships. The regular occurrence of dredged material barges and tugs transiting to and from the preferred alternative site may potentially distract some marine birds from their normal feeding activities and/or passage routes. However, the increase in vessel traffic created by dredged material barges is considered insignificant when compared to existing ship traffic (Commander S. Tiernan, U.S. Coast Guard, pers. comm. 1992).

It is anticipated that many pelagic prey organisms will exhibit various escape behaviors in response to dredged material disposal. Thus, following a disposal event the immediate area may contain temporarily reduced populations of some organisms, including juvenile rockfish, anchovies, euphausiids, and squid, that are important prey items for marine birds that breed and nest on the Farallon Islands (Ainley and Boekelheide 1990; Ainley and Allen 1992). Therefore, foraging success of marine birds may be reduced temporarily following disposal activities. However, because these prey species characteristically are patchy in their distribution (see Sections 3.3.1 and 3.3.3), localized reductions in prey densities may not significantly affect feeding behavior of marine birds in the region.

It has been suggested that reductions in water clarity following disposal operations may temporarily inhibit feeding activities of marine birds that typically forage in surface waters (Navy 1993). Computer model results indicated that the finer silt-clay components of dredged material may require up to approximately 48 hours to reach presumed background concentrations of 1 mg/l, and particle clouds could affect an area over 3,600 km^2 (Section 4.2.1.4), thereby potentially limiting the foraging efficiency of deeper water bird predators. In addition, attraction of marine birds to positively buoyant particles remaining at the surface following disposal suggests that some marine birds may expend substantial energy with limited prey acquisition. However, dispersion modeling results indicated that mean plume depths increase with distance from the disposal site. Thus, significantly reduced clarity in surface waters likely is restricted to the immediate release site. Further, permit conditions will ensure that dredged material contains negligible quantities of buoyant (floatable) debris. Therefore, these potential impacts should be localized and of relatively short duration; consequently, they are not expected to affect significantly the breeding, feeding, or passage of marine birds that occur broadly throughout the study region.

Based on the above information, dredged material disposal impacts on marine birds are designated as Class III. The types of impacts are expected to be similar at the preferred and alternative sites; therefore differences in disposal consequences to marine birds should be related primarily to differences in the relative abundance of marine bird species within each site (see Section 3.3.4).

The preferred alternative site is located approximately 25 nmi from the breeding and nesting grounds of the Farallon Islands. As compared to Alternative Sites 3 and 4, survey results suggest that the preferred alternative site receives the highest use by marine birds (Section 3.3.4). Thus, potential impacts (Class III) to marine birds are expected to be greatest, but still insignificant, at the preferred alternative site as compared to Alternative Sites 3 and 4.

4.2.2.6 Marine Mammals

The potential impacts of dredged material disposal to marine mammals are expected to be similar to those of marine birds. These impacts include temporary impairment of foraging activities attributable to disturbances caused by disposal and subsequent reductions in water clarity (see Section 4.2.2.5).

An additional potential impact may be alteration of marine mammal passage routes to avoid noise from ship traffic or from increased water turbidity during or following disposal activities. Further, noise may influence non-auditory physiology (Fletcher 1971), increasing the stress response and lowering resistance to disease. Because ship noise levels correlate generally with vessel size, speed, and load, larger, faster ships underway with full loads (or towing/pushing loads) may emit more sound than smaller, slower, and lighter ships (Richardson 1991). In addition, ships with older auxiliary equipment such as generators and compressors radiate more noise than modern, well-maintained vessels (Richardson 1991). Some studies have suggested that the noise associated with increased vessel traffic may affect marine mammal migration routes. Specifically, it has been suggested that increased ship traffic in Japanese waters disturbed migration routes of minke and Baird's beaked whales (Nishiwaki and Sasao 1977). Baleen whales such as grays, humpbacks, and blues sometimes move quickly away from approaching vessels, although there is little evidence that they are affected after the vessel has passed. However, based on limited data, Richardson (1991) suggests that ship noise has little impact on pinnipeds. Although vessel traffic may potentially impact marine mammals, the increase in ship traffic attributable to dredged material barges is considered insignificant in relation to existing traffic (Commander S. Tiernan, U.S. Coast Guard, pers. comm. 1992).

Dohl *et al.* (1983) indicated that gray whales may change their course to avoid turbid plumes caused by run-off from rivers and bays. Similarly, experiments with dolphins (*Tursiops truncatas*) suggested that they were able to detect and avoid oil patches using echolocation, especially if air bubbles were present in the patch (Geraci and St. Aubin 1987). Thus, it is possible that marine mammals capable of detecting differences in water turbidity may alter their route to avoid a disposal area.

However, vessel noise and plume impacts to marine mammals are temporary and localized to the immediate vicinity of the disposal site, and are not expected to affect breeding, nursery, or feeding areas for adults or juveniles. Thus, potential impacts to marine mammals are characterized as Class III (Table 4.1-1). These potential impacts are similar for the preferred and alternative sites. As described for marine birds, differences in potential disposal effects on marine mammals are based on comparisons of their relative abundances within each of the sites (see Section 3.3.5).

Survey results suggest that the preferred alternative site receives the highest use by marine mammals (Section 3.3.5) as compared to Alternative Sites 3 and 4. Thus, impacts to marine mammals are expected to be greatest but still insignificant at the preferred alternative site as compared to Alternative Sites 3 and 4.

4.2.2.7 Threatened, Endangered, and Special Status Species

As described in Section 3.3.6, eight known threatened or endangered species occur somewhat regularly in the general study region. These include four whale species (humpback, blue, finback, and sperm), one pinniped species (northern sea lion), two bird species (peregrine falcon and California brown pelican), and one fish species (winter-run chinook salmon).

Potential impacts of dredged material disposal on whale and pinniped species may include temporary impairment of feeding activities and avoidance of barge vessels and the disposal plume, as described in Section 4.2.2.6. Impacts to peregrine falcon include the potential for ship following behavior which may affect normal feeding or passage activities. California brown pelican and winter-run chinook salmon populations occur primarily over the continental shelf (see Section 3.3.6), and thus are not expected to be significantly impacted by disposal activities within any of the sites.

Due to the temporary nature and localized spatial distribution of disposal activities, potential impacts to area endangered species are estimated to be insignificant (Class III). The types of potential impacts are expected to be similar at the preferred and alternative sites. However, differences in disposal consequences between sites can be identified based on the relative abundances of threatened or endangered species at the alternative sites (See Section 3.3.6) as described below.

Compared to Alternative Sites 3 and 4, the preferred alternative site is a relatively high use area for threatened or endangered marine bird and mammal species (Section 3.3.6). Therefore, potential impacts to threatened or endangered species are expected to be higher but still insignificant at the preferred alternative site than at Alternative Sites 3 and 4.

4.2.2.8 Marine Sanctuaries

Six designated national marine sanctuaries, refuges, or special biological resource areas occur within the study region. One or more of these areas lies within 5 nmi of the preferred and alternative sites (Section 3.3.7). These areas contain a wide variety of sensitive habitats and biological resources including threatened and endangered species.

Disposal of dredged material from San Francisco Bay will not occur within the boundaries of any of the national marine sanctuaries, refuges, or areas of special biological significance. However, because the dredged material barges must transit through one or more of the marine sanctuaries to reach any of the sites, accidents or overflow from the barges could result in inadvertent releases of dredged material within sanctuary boundaries.

The volumes of dredged material released by single or isolated incidences likely would be small (e.g., 3,000 yd^3 for a single barge load) and environmental consequences would depend on location of the discharge, rate and direction of plume dispersion, and specific resources in the path of dispersing material. Dredged material released within or immediately adjacent to a sensitive habitat, and repeated discharges over a longer time period, could result in more significant environmental impacts. However, the probability of these circumstances will be reduced or mitigated by specifying that barges use specific transit routes that avoid sensitive habitats (Class II impact).

The Farallon Islands lie in the direct route of barges transiting from San Francisco Bay to the preferred alternative site. Accidental discharge or overflow of dredged material near the Farallon Islands should be avoided as specified in permit conditions. Mitigative measures as discussed above indicate that potential disposal impacts at the preferred alternative site are Class II.

4.2.3 Effects on Socioeconomic Environment

The following sections discuss the potential consequences of the proposed action on the socioeconomic environment associated with the preferred and alternative site. Resources addressed include commercial fishing, commercial and recreational shipping, mineral and oil and gas development, military usage, recreational activities, cultural resources, and public health and welfare.

4.2.3.1 Commercial and Recreational Fishing

Analysis of the MMS/CDFG Commercial Fisheries Database (1992) and CDFG Recreational Fisheries Database (1992) indicated that the majority of commercial and recreational fisheries are located predominantly in the continental shelf region. Extremely limited fishing activity occurs over the slope areas corresponding to the preferred and alternative sites (Section 3.4.1). The commercial fishery data suggest that some minor catches of tunas, mackerels, and some flatfishes were taken from the region of Alternative Sites 3 and 4, while tunas and mackerels were taken in low numbers in the region of the preferred alternative site (MMS/CDFG Commercial Fisheries Database 1992).

Most species targeted by commercial or recreational fishermen in offshore areas such as the alternative sites are fast-moving pelagic fishes such as salmon, tunas, and mackerels. According to Bence *et al.* (1992), juvenile rockfishes are abundant offshore in the preferred and alternative sites but are somewhat more abundant in the region of the preferred alternative site. However, because all the sites are located far offshore (e.g., 45 to 55 nmi), where most commercial and recreational fishing is limited, and because these species are mobile and should be able to avoid the disposal plumes, there should not be any significant impacts to these fisheries at any of the sites. Therefore, impacts are considered to be Class III.

Historical catches within the region of the preferred alternative site are somewhat lower than those for the regions of Alternative Sites 3 and 4. Thus, potential fishery impacts at Alternative Site 5 may be relatively lower as compared to Alternative Sites 3 and 4.

4.2.3.2 Commercial Shipping

The preferred and alternative sites are located outside of designated commercial vessel traffic lanes and away from any restricted passage areas, precautionary zones, or anchorages for commercial shipping. Dredged material barges using an ODMDS would represent additional vessel traffic within the study region. However, the magnitude of this additional ship traffic is expected to be negligible (Section 3.4.3), representing a Class III impact that is not expected to vary significantly between sites. Furthermore, because the ultimate purpose of dredging operations is to provide adequate water depths and access to vessel traffic for channels and berths within the Bay, the proposed action could be considered a Class IV (beneficial effect) impact.

4.2.3.3 Mineral or Energy Development

As discussed in Section 3.4.5, no oil and gas development activities occur within the general region of the preferred or alternative sites, and the closest potential lease blocks are more than 200 miles from the sites. This is based on current moratoriums on development, and present technological limitations which restrict these activities to depths shallower than approximately 300 to 400 m (Section 3.4.5). The average depth at the preferred alternative site is over 2,000 m. Further, because of the deep bottom depths at the sites, no other mineral development activities are likely to occur. Therefore, use of any of the sites for dredged material disposal will not interfere with or impact existing mineral resources or energy development operations in the foreseeable future (Class III impact).

4.2.3.4 Military Usage

Military usage of the LTMS study region, including areas in the vicinity of the preferred and alternative sites, is considered to be significant (Section 3.4.4). In particular, submarine operating areas are delineated near but outside of Alternative Sites 3, 4, and 5 (Figure 2.1-5). With exception of operating area U1 which is used infrequently, submarine operating areas U2 through U5 are used by the Navy an average of 10 days per month for trial diving exercises and post-overhaul checkouts. However, because the preferred and alternative sites are located outside of the operating areas, dredged material disposal at any of the sites is expected to have negligible impacts (Class III) on military operations in the region. Use of an ODMDS is not expected to interfere with any other military vessel traffic or training exercises. Although the preferred alternative lies near submarine operating area U4, use of the site for dredged material disposal is not expected to adversely impact military activities (Class III impact).

4.2.3.5 Recreational Activities

Recreational activities in the general vicinity of the preferred and alternative sites are centered around the Farallon Islands. Although specific data are unavailable, recreational activities such as sailing, fishing, or whale watching, within the boundaries of the alternative sites are generally infrequent (Section 3.4.6). Therefore, potential impacts from use of the alternative sites for dredged material disposal are considered insignificant. Potential effects of dredged material barge traffic on recreational boating or fishing within the vicinity of the Farallon Islands could be mitigated by requiring barges to stay within defined traffic lanes and avoid the areas immediately around the Farallon Islands.

Of the three alternative sites, the preferred alternative lies closest to the Farallon Islands. Thus, relative to Alternative Sites 3 and 4, potential impacts to recreational activities may be greatest at the preferred alternative site. However, as noted, restricting dredged material barges to specified traffic lanes will mitigate potential impacts (Class II).

4.2.3.6 Cultural and Historical Resources

As discussed in Section 3.4.7, no known shipwrecks of cultural or historical importance, or other man-made cultural or historical resources, are located within the immediate vicinity of the preferred or alternative sites. Therefore, designation of an ODMDS is not expected to have any significant effect on historical resources. Oceanic tours or expeditions by wildlife and naturalists groups are concentrated around the Farallon Islands and Cordell Banks. Potential interferences from dredged material disposal operations would be limited to minor navigational conflicts with dredged material barges in the vicinity of the Farallon Islands. However, these potential interferences could be mitigated by specifying barge transit lanes that avoid the vicinity of the Islands. Therefore, these potential impacts are considered Class II.

4.2.3.7 Public Health and Welfare

There are no obvious impacts to public health and welfare associated with the designation of an ODMDS (Class III). Collisions between a dredged material barge and a commercial or recreational vessel, or operation of a dredged material barge in the Gulf of the Farallones during extreme weather conditions, could endanger human lives. However, these events are expected to be rare (Section 3.4.3). Conversely, maintenance dredging of navigational channels within San Francisco Bay supports the continued operation of several ports and, consequently, promotes local and regional commerce.

Potential impacts to public health and welfare associated with disposal at the preferred alternative site are insignificant (Class III) due to the projected rare occurrence of vessel collisions near the site.

4.3 No-Action Alternative

As stated in the Purpose of and Need for Action (Section 1.2), it is the intent of this EIS to identify and designate an ODMDS that is suitable for approved Federal and permitted dredging projects. Selection of the No-Action alternative would not fulfill the LTMS goal of providing a long-term, multi-user ODMDS for disposal of dredged material from San Francisco Bay. In the absence of a designated ODMDS, or Section 103 interim ODMDS, other disposal options, such as within the Bay or at nonaquatic sites, would be required for dredged material. Alternatively, planned dredging would have to be delayed until a suitable disposal option is identified. Cessation of dredging would result in shoaling within the main shipping channels, thus impairing and potentially endangering shipping operations within the Bay, with associated impacts on the economy of the region and the logistical needs of the Navy (COE 1990b).

Selection of the No-Action Alternative per se would result in no impacts or changes to the existing environmental conditions at the preferred or alternative sites due to dredged material disposal operations. However, the consequences of the No-Action Alternative may cause varying environmental impacts. For example, non-ocean disposal options, such as the use of sites within the Bay or nonaquatic sites also would result in location-specific environmental impacts. At this time, the ability of non-ocean sites to receive the volume of dredged material planned for the next 50 years is not known. However, the nature and extent of potential impacts at nonaquatic sites and sites within the Bay presently are being evaluated by the In-Bay and Nonaquatic/Reuse LTMS Work Groups. Disposal of dredged material at a Section 103 ocean disposal site would result in some impacts on conditions at the Section 103 Site, although the magnitude of these impacts would depend on the volume and characteristics of the dredged material and the physical and biological conditions at the particular site.

Selection of the No-Action Alternative would preclude the use of ocean disposal as a long-term management option and would result in a failure to meet LTMS objectives, with unknown consequences (COE 1992a). Therefore, EPA proposes to designate an ODMDS based on the preferred alternative described in this DEIS.

4.4 Other Ocean Disposal Alternatives

This section describes the potential environmental consequences of dredged material disposal at Alternative Sites 3 and 4.

4.4.1 Effects on the Physical Environment

These sections address potential effects of dredged material disposal at the other ocean disposal alternatives on regional meteorology and air quality, physical oceanography, water quality, and sediment quality.

4.4.1.1 Air Quality

Potential impacts to regional air quality associated with dredged material disposal at Alternative Sites 3 and 4 were evaluated using the same EPA air quality model and assumptions as summarized in Section 4.2.1.1 for the preferred alternative site. As noted for the preferred alternative site, no significant effects on air quality were indicated along the anticipated route of the barges transporting dredged material to Alternative Sites 3 and 4 (Table 4.2-1), therefore representing a Class III impact.

4.4.1.2 Physical Oceanography

Similar to the preferred alternative site, the use of Alternative Sites 3 and 4 would not have any measurable effect on the regional or site-specific physical oceanographic conditions, and therefore is predicted to represent a Class III impact. The prevailing oceanographic processes will strongly influence the dispersion and long-term fate of dredged material discharged at the alternative sites. The overall circulation patterns that would affect disposal activities are summarized in Section 4.2.1.2.

In general, poleward current flows are typical of the upper 1,000 m of the water column over most of the year, with the strongest flows over the inner slope region, including the general area of Alternative Sites 3 and 4 (Section 3.2.2). Near-bottom currents in the vicinity of Alternative Site 3 (Mooring D) were characterized by relatively low speeds and thus were less likely to erode sediments than currents measured at Station E near the eastern boundary of Study Area 5 (Section 3.2.2). No specific information from the current meter program is available for Alternative Site 4. Based on the data presented in Section 3.2.2, it is very unlikely that upwelling would be a significant mechanism at either of the alternatives to transport dredged material from slope to shelf environments.

4.4.1.3 Water Quality

Potential impacts on water quality from dredged material disposal at Alternative Sites 3 and 4 were addressed by disposal plume modeling (SAIC 1992e), as discussed in Section 4.2.1.3 for the preferred alternative. Similar to the preferred alternative, changes in water quality such as localized increases in turbidity, reductions in light transmittance, and increases in dissolved and particulate concentrations of trace contaminants that could result from dredged material disposal are expected to be transient, and therefore represent Class III impacts.

Alternative Site 3

Results from the water quality model (SAIC 1992e) indicated that dredged material plumes comprising class 1 through class 6 particles would disperse over areas of 13 to 7,855 km^2 in the vicinity of the site, (assuming a conservative background suspended particle concentration of 1 mg/l, conservative dispersion rates, and conservative initial and background concentrations; Table 4.2-3). The mean plume visitation frequencies over these affected areas would range from approximately 1 to 4%, and the predicted maximum exposure times would range from 1.0 to 42 hours for individual particle size classes. The mean cloud depth over the affected area for individual particle size classes would range from 54 m for clay-silt particles to approximately 1,300 m for fine and medium sand particles (Table 4.2-3). The areas affected and the water column residence times would be expected to vary as a function of the particle size. Larger particles with higher sinking rates would have shorter residence times and deeper cloud depths. In contrast, smaller particles with lower sinking rates would have longer residence times and shallower cloud depths because stronger and more variable near-surface currents would disperse the plumes over relatively larger areas. Dredged material disposal at Alternative Site 3 would be expected to result in concentrations from approximately 1 to 2 mg/l of fine-grained (class 6) suspended particles at the MBNMS boundary for 0.2 to 5% of the discharge events, and concentrations from approximately 1 to 2 mg/l of fine-grained particles at the GOFNMS boundary for 1 to 5% of the discharge events. Particle concentrations at the CBNMS boundary were not expected to be elevated above background concentrations (Figure 4.2-4). Clouds of larger dredged material particles would not be expected to cross any of the sanctuary boundaries.

Based on the above information, effects on water quality from dredged material disposal at Alternative Site 3 are considered Class III because the plumes are expected to disperse within 48 hours of discharge, no build-up or accumulation of particles within the water column is expected, and changes to water quality parameters (e.g., turbidity, light transmittance, dissolved oxygen concentrations) are expected to be transient and localized within the discharge plume. Disposal operations should have insignificant effects on concentrations of contaminants in the water column, given that only dredged material meeting Green Book criteria (EPA/COE 1991) will be permitted for disposal at the ODMDS.

Alternative Site 4

The water quality model results (SAIC 1992e) indicated that disposal plumes comprising class 1 through class 6 particles would affect areas up to 7,708 km^2, although the mean visitation frequency over this area would range from approximately 1 to 5% (Table 4.2-3). The mean cloud depth would vary from 55 to 1,511 m, and the maximum exposure time would range from approximately 1.0 to 43 hours. Use of Alternative Site 4 would result in concentrations from approximately 1 to 2 mg/l of fine-grained particles at the GOFNMS and MBNMS boundaries for approximately 0.2 to 1.0% of the discharge events (Figure 4.2-5). Clouds of coarser particles would not be expected to reach the sanctuary boundaries. Effects on water quality from dredged material disposal at Alternative Site 4 are considered Class III, similar to those discussed for Alternative Site 3.

4.4.1.4 Geology and Sediment Characteristics

Potential impacts on sediment characteristics from dredged material disposal at Alternative Sites 3 and 4 were evaluated by deposition modeling (SAIC 1992e) as discussed in Section 4.2.1.4 for the preferred alternative site. Specific effects of dredged material disposal on long-term changes to the grain size and chemical characteristics of the bottom sediments cannot be determined quantitatively. Although localized and extended impacts to grain size may be expected, significant effects on sediment quality would not be anticipated, given that only dredged material of suitable quality will be approved for disposal at an ODMDS.

Alternative Site 3

The deposition model (SAIC 1992e) calculated that disposal of 6 million yd^3 over a one-year period at Alternative Site 3 would result in bottom deposits of clay-silt and mostly sand material with thicknesses greater than 1 mm covering areas of approximately 360 and 620 km^2, respectively. The maximum deposit thicknesses for these material types would be approximately 730 and 62 mm, respectively, and the mean deposit thicknesses over these areas would be 7.9 and 4.5 mm, respectively. The model-predicted bottom deposit with thicknesses greater than or equal to 100 mm would cover an area of 5.91 km^2 based on a discharge of 6 million yd^3 of clay-silt materials over a one-year period.

Clay-silt material would produce the greatest thickness (approximately 70 cm) near the disposal site center due to deposition of rapidly-settling clumps. The maximum thickness of mostly sand material is an order of magnitude lower (approximately 60 mm). Because the alternative site boundaries were defined to encompass the 10 mm deposit thickness contour for clay-silt material (Section 2.2), deposits of both clay-silt and mostly sandy material with thicknesses greater than 10 mm would, by definition, be contained within site boundaries.

Deposition of dredged material could result in a significant localized alteration of the bottom sediment grain size properties (Class I impact; Table 4.1-1). The extent of this alteration would depend on the grain size distribution of the dredged material. Although it is desirable to minimize these differences, it is likely that some of the material disposed at the ODMDS would contain sand-sized sediments that do not occur naturally at the site. This impact would be expected to persist at least for the duration of the site use, assuming continuous disposal schedules. Subsequent return to pre-disposal conditions could result from extended interruption of disposal operations and natural particle deposition, dispersion, and mixing processes (Section 4.2.2.2). Contours for the model-predicted 1 mm and 10 mm deposit thicknesses extended towards the northwest (Figure 4.2-7), but there was no indication that these deposits would affect Pioneer Seamount (to the west of Alternative Site 3) or other hard-bottom features that might occur in the vicinity of the site.

Effects from dredged material disposal on the chemical characteristics of the site sediments cannot be determined accurately because the organic content and trace contaminant concentrations in the dredged material are not known. Conclusions that disposal operations at Alternative Site 3 would represent a Class III impact on sediment quality assume that the dredged material has satisfied Green Book testing criteria designed to establish that the material is of suitable quality for ocean disposal (EPA/COE 1991).

Alternative Site 4

The deposition model (SAIC 1992e) predicted that disposal of 6 million yd^3 per year of clay-silt and mostly sand type material at Alternative Site 4 would result in bottom deposits with thicknesses greater than 1 mm covering areas of 280 and 500 km^2, respectively. The maximum deposit thicknesses for these material types would be approximately 790 and 69 mm, respectively, and the mean deposit thickness over these areas would be 9.8 and 5.2 mm, respectively. The model-predicted bottom deposit with thicknesses greater than or equal to 100 mm would cover an area of 5.88 km^2 based on a discharge of 6 million yd^3 of clay-silt materials over a one-year period.

Effects from dredged material disposal at Alternative Site 4 on sediment grain size also are expected to represent a Class I impact. This impact also would be relatively localized (i.e., corresponding approximately to the 10 mm footprint contour), but would persist for the duration of site use assuming a continuous disposal schedule. Deposits with thicknesses between 1 and 10 mm would extend in a northwest direction beyond the site boundaries (Figure 4.2.7). The extent of hard-bottom features in the adjacent portion of Pioneer Canyon presently is not known. Regardless, it is unlikely that deposition of dredged material at a rate of 1 to 10 mm per year on a hard substrate would have a significant impact on an attached epifaunal community which might occur within the area (e.g., Lissner *et al.* 1991). Effects on sediment quality are considered a Class III impact, as noted above for Alternative Site 3, and similar to the magnitude of effects at Alternative Sites 3 and 5.

4.4.2 Effects on Biological Environment

The following sections discuss the potential consequences of the proposed action on the biological environments of Alternative Sites 3 and 4.

4.4.2.1 Plankton

As noted for the preferred alternative (Section 4.2.2.1), impacts on plankton from rapidly settling dredged material particles such as sand and clay-silt aggregates are expected to be minimal because of relatively limited exposure times (minutes to hours). Longer exposure times and potentially greater impacts would be expected from slower-settling, fine-grained particles which may concentrate more in regions of neutral buoyancy, such as the pycnocline. However, based on the transient nature of the dredged material plume and the characteristically high seasonal and annual variability in plankton communities, overall impacts are expected to be insignificant and classified as Class III.

Alternative Site 3

Significant seasonal and annual variations in productivity, standing crop, and species composition of plankton communities are evident from existing data of the general study region (Section 3.3.1). Phytoplankton and zooplankton (including ichthyoplankton) abundances vary seasonally, but are highest inshore of Alternative Site 3 and the lower slope environment. Therefore, no significant effects (Class III) on plankton from the proposed action are expected at this site (Table 4.1-1).

Alternative Site 4

Based on existing data on plankton communities of the general study region, no differences can be distinguished in the productivity, standing crop, or species composition between Alternative Sites 3 and 4. Therefore, potential impacts to plankton at this site also are classified as insignificant (Class III).

4.4.2.2 Infauna

As described in Section 4.2.2.2, potential impacts to infauna following dredged material disposal include burial and smothering, and will be influenced by the frequency and severity of disturbance and the capacity for species recolonization after the disposal event. Extensive burial would be expected within a relatively small, central mound at each of the sites regardless of which alternative was selected. Thus, relative differences in potential impacts are based on differences in infaunal compositions and densities within each of the sites.

Alternative Site 3

Burial and mortality of infauna at Alternative Site 3 are expected to be significant (Class I) within the boundary of the 10 cm depositional area (e.g., up to 5.91 km^2 for a discharge of 6 million yd^3 per year) as noted in Table 4.1-1 and Figure 4.2-7. No species that are known to be unique to the area or geographically limited in distribution are found at this site or at Alternative Sites 4 or 5. However, the high abundances of filter-feeding amphipods found in Alternative Site 3, among other deep-water parts of Study Area 3, were not found at any other sampled locations within the study region. Overall infaunal densities are similar to Alternative Site 4, but slightly higher than Alternative Site 5 (Section 3.3.2.1). Therefore, the impacts of dredged material disposal at Alternative Site 3 are expected to be similar to those at Alternative Site 4 but somewhat greater than those at Alternative Site 5 due to the relative differences in infaunal densities.

Alternative Site 4

Similar to Alternative Site 3, impacts of dredged material disposal at Alternative Site 4 are expected to be significant (e.g., over an area up to 5.88 km^2 for a discharge of 6 million yd^3 per year) (Class I) but localized. Based on infaunal densities (Section 3.3.2.1) the impacts at Alternative Sites 3 and 4 are expected to be similar but somewhat higher than at Alternative Site 5. However, Alternative Site 4 does not contain high abundances of filter-feeding amphipods as found at Alternative Site 3.

4.4.2.3 Epifauna

Disposal impacts to slow-moving epifaunal species such as seastars and sea pens are expected to be more significant as compared to impacts on more mobile species (e.g., many crustaceans) which may respond to disposal events with various escape behaviors (see Section 4.2.2.3). Although the taxonomic compositions of epifaunal species are similar at the preferred alternative site and Alternative Sites 3 and 4, overall density and biomass of epifauna species at the preferred alternative site can be characterized as low. Localized burial of epifauna would occur at each of the sites within the 10 cm depositional contour. Thus, potential impacts are projected to be Class I at each alternative site.

Alternative Site 3

Alternative Site 3 contains relatively high numbers of species, abundances, and biomass of epifaunal organisms (Section 3.3.2.2). Predominant species, including sea cucumbers, seastars, and brittlestars, are all slow-moving and would have the greatest potential for burial and possible mortality. Based on this assumption and the conservative nature of the modeling, impacts are estimated to be significant (Class I) and localized within the 10 cm depositional boundary at this site, and are expected to persist throughout the duration of site use.

Alternative Site 4

Similar to Alternative Sites 3 and 5, impacts of dredged material disposal at Alternative Site 4 are expected to be significant (Class I) but localized. This is based on similar epifaunal species and densities at these sites (Section 3.3.2.2).

4.4.2.4 Fishes

Potential impacts to pelagic fishes following disposal activities could include a decrease in feeding efficiency and an increase in avoidance behavior (Section 4.2.2.4). Potential disposal impacts to demersal species could include burial (for relatively sedentary species), displacement, and temporary habitat loss. However, because fish densities and biomass within the alternative sites are relatively low and populations are widely dispersed throughout the region, potential impacts are estimated to be insignificant (Class III).

Alternative Site 3

Pelagic fishes such as salmon, tunas, and mackerels that occur in offshore areas such as Alternative Site 3 should not be impacted due to their high mobility (Class III). Moreover, this site contains relatively low numbers of demersal fish species and abundances (Section 3.3.3). Although some feeding habitat may be temporarily lost following a disposal event, demersal fishes are expected to return to these affected areas after a disposal event. Most species at this site should be able to avoid impacted areas and would not be affected significantly by dredged material disposal. Therefore, potential impacts are designated as Class III.

Alternative Site 4

The number of species, densities, and biomass of fishes in Alternative Site 4 is similar to Alternative Site 3 (Section 3.3.3); therefore, potential impacts of dredged material disposal at Alternative Site 4 also are expected to be insignificant and classified as Class III.

4.4.2.5 Marine Birds

Potential impacts on marine birds from dredged material disposal are discussed in Section 4.2.2.5. These impacts are expected to be similar and insignificant at the preferred and alternative sites. Therefore, the discussion of differences in disposal consequences to marine birds focuses on abundances of marine bird species within each site (see Section 3.3.4).

Alternative Site 3

Alternative Site 3 is located approximately 25 nmi from the Farallon Islands, an important breeding, nesting, and feeding area for marine birds (Section 3.3.4). The combined results from recent survey efforts (Ainley and Boekelheide 1990; Ainley and Allen 1992; Jones and Szczepaniak 1992) indicate that Alternative Site 3 receives relatively higher use by marine birds as compared to Alternative Site 4 but lower use than the preferred alternative site (Section 3.3.4). Thus, the extent of potential impacts to marine birds occurring at Alternative Site 3 may be relatively greater than at Alternative Site 4 and relatively less than at the preferred alternative site. However, based on the transient nature of potential impacts, overall effects are estimated to be insignificant and designated as Class III.

Alternative Site 4

Of the three alternative sites, Alternative Site 4 is located the greatest distance (approximately 30 nmi) from the Farallon Islands breeding and nesting grounds. In contrast to Alternative Site 3 and the preferred alternative site, survey results for Alternative Site 4 indicate that it is a relatively low use area for marine birds (Section 3.3.4). Therefore, it is expected that fewer potential impacts (Class III) to marine birds would occur at Alternative Site 4 than at the preferred alternative or Alternative Site 3.

4.4.2.6 Marine Mammals

Potential impacts on marine mammals from dredged material disposal are discussed in Section 4.2.2.6. These impacts are expected to be similar and insignificant at the preferred and alternative sites. Thus, as for marine birds, differences in potential disposal effects on marine mammals are based on relative abundances of marine mammal species within each site (see Section 3.3.5).

Alternative Site 3

Alternative Site 3 does not appear to be within an important marine mammal passage area, although it may be important as a feeding ground for some marine pinnipeds (Section 3.3.5). The combined results from historic (Bonnell *et al.* 1983; Dohl *et al.* 1983) and recent marine mammal surveys (Ainley and Allen 1992; Jones and Szczepaniak 1992) indicate that Alternative Site 3 receives intermediate use by marine mammals as compared to lower use of Alternative Sites 4 and higher use of the preferred alternative (Section 3.3.5). Therefore, although impacts at the alternative sites can be defined as Class III, based on the transient nature of potential effects, disposal impacts on marine mammals are expected to be greater at Alternative Site 3 than at Alternative Site 4, but less than at the preferred alternative site.

Alternative Site 4

Alternative Site 4 is not located in close proximity to marine mammal breeding or feeding grounds or important passage areas (Section 3.3.5). In contrast to Alternative Site 3 and the preferred alternative, survey results indicate that Alternative Site 4 is a low use area for marine mammals (Section 3.3.5). Thus, potential impacts on marine mammals are expected to be lower (Class III) within Alternative Site 4 as compared to Alternative Site 3 and the preferred alternative site.

4.4.2.7 Threatened, Endangered, and Special Status Species

As discussed in Section 4.2.2.7, the types of potential impacts to threatened and endangered species are expected to be similar and insignificant at each of the alternative sites. Thus, differences in disposal consequences to these species are based on their relative abundances within each site.

Alternative Site 3

Compared to Alternative Site 4 and the preferred alternative, Alternative Site 3 is an intermediate use area for endangered cetacean and threatened pinniped species, but it is a relatively low use area for endangered marine bird and fish species (Section 3.3.6). Therefore, the magnitude of potential impacts at Alternative Site 3 is expected to be greater than at Alternative Site 4 but less than at the preferred alternative site. However, as noted for marine birds and mammals, the transient nature of potential effects represents insignificant impacts (Class III).

Alternative Site 4

Alternative Site 4 is a relatively low use area for threatened or endangered marine mammals, birds, and fish (Section 3.3.6). Therefore, the magnitude of potential impacts to threatened or endangered species is expected to be lowest at Alternative Site 4 (Class III) as compared to Alternative Site 3 and the preferred alternative site.

4.4.2.8 Marine Sanctuaries

As discussed in Section 4.2.2.8, there are six national marine sanctuaries, refuges, or special biological resource areas within the study region. These areas contain sensitive habitats in addition to some biological species that are threatened or endangered (Section 3.3.7). Although disposal of dredged material will not occur within any of these sensitive areas, there is some concern that accidental overflow or discharge of dredged material in the vicinity of sensitive areas may occur as dredged material barges transit to the disposal site. EPA and COE will address these concerns through the site management and monitoring plan and special conditions on permits for individual dredging projects. Therefore, potential impacts at the alternative sites are expected to be Class II (significant adverse impacts that can be mitigated to insignificance).

Alternative Site 3

Alternative Site 3 is located south of the GOFNMS and west of MBNMS. Dredged material barges must pass through one or both of these sanctuaries en route to and from this site. To reduce or mitigate potential impacts caused by accidental overflow of dredged material from the barges, specific transit routes will be identified that avoid sensitive areas within the sanctuaries (e.g., Farallon Islands). Therefore, impacts at Alternative Site 3 are considered Class II.

Alternative Site 4

Alternative Site 4 is located in a similar position as Alternative Site 3 (i.e., south of the GOFNMS and west of MBNMS). Therefore, potential impacts to sensitive habitats within sanctuaries from use of Alternative Site 4 also are designated Class II because specific transit routes will be identified that avoid sensitive areas.

4.4.3 Effects on Socioeconomic Environment

4.4.3.1 Commercial and Recreational Fishing

As discussed in Section 4.2.3.1, the potential impacts of dredged material disposal on pelagic and demersal fisheries are limited due to the high mobility of pelagic fishes that may avoid disposal plumes, location of many demersal fish species inshore of the alternative sites, and overall historical record of limited catches within any of the sites.

Alternative Site 3

In the vicinity of Alternative Site 3, most of the commercially and recreationally important pelagic fishes, such as tunas and mackerels, are expected to be able to avoid dredged material discharges. Therefore, the impacts on fisheries for pelagic species would be negligible (Class III). Similarly, fisheries for demersal fishes, including some flatfishes, are located primarily inshore of Alternative Site 3 (Section 3.4.1), indicating that potential impacts to these species also would be insignificant (Class III).

Alternative Site 4

Commercial and recreational fishery resources in the region of Alternative Site 4 are very similar to those of Alternative Site 3. Therefore, potential impacts are expected to be Class III, because targeted pelagic species should be able to avoid disposal plumes, and the majority of demersal fishery resources are located inshore of the alternative sites.

4.4.3.2 Commercial Shipping

All of the alternative sites lie outside of designated commercial vessel traffic lanes (see Section 4.2.3.2). The additional vessel traffic represented by dredged material barges transiting to and from an ODMDS is expected to be negligible (Commander S. Tiernan, U.S. Coast Guard, pers. comm. 1992) (Class III) and is expected to vary only slightly among sites.

Alternative Site 3

Alternative Site 3 is located outside of commercial vessel traffic lanes. Therefore, impacts to commercial shipping activities created by use of an ODMDS are considered to be Class III.

Alternative Site 4

Alternative Site 4 also is located outside of commercial traffic lanes. Therefore, similar to Alternative Site 3, potential impacts on commercial shipping activities are considered to be Class III.

4.4.3.3 Mineral or Energy Development

Mineral or energy development activities are currently restricted to depths less than approximately 400 m, whereas bottom depths at the alternative sites are greater than approximately 1,500 m (Section 3.4.5). In addition, the closest potential oil and gas lease block is located over 200 miles from the alternative sites. Therefore, use of either of the alternative sites for dredged material disposal is not expected to interfere with existing mineral resources or energy development activities (Class III impact).

Alternative Site 3

Due to its deep depths (approximately 1,500 m) and its distant location (over 200 miles) from the closest potential lease block, impacts to mineral or energy development attributable to dredged material disposal at Alternative Site 3 are considered to be Class III.

Alternative Site 4

Alternative Site 4 also is located in deep water (greater than 1,500 m) and is over 200 miles from the nearest potential lease block. Therefore, impacts to potential mineral or energy development activities also are considered to be Class III.

4.4.3.4 Military Usage

As discussed in Section 4.2.3.4, military activities within the study region are primarily focused on exercises conducted within five submarine operating areas. All of these areas lie outside of the alternative site boundaries. Thus, use of an ODMDS site is not expected to interfere with military activities (Class III).

Alternative Site 3

Alternative Site 3 is located over 10 nmi from the nearest submarine operating area (U2). Therefore, impacts on military activities related to dredged material disposal at Alternative Site 3 are considered to be negligible (Class III).

Alternative Site 4

Alternative Site 4 also is located over 10 nmi from the nearest submarine operating area (U5). Similar to Alternative Site 3, impacts of disposal operations on military activities are considered to be Class III.

4.4.3.5 Recreational Activities

Most of the recreational activities (sailing, whale watching, and fishing) within the study region occur around the Farallon Islands (see Section 4.2.3.5). Such activities are infrequent within any of the alternative sites. In addition, the restriction of dredged material barges to specified traffic lanes will ensure that interferences between barges and recreational users of the Farallon Islands will be minimized. Thus, potential disposal impacts on recreational activities are considered negligible (Class III).

Alternative Site 3

Alternative Site 3 is located over 20 nmi from the Farallon Islands. Therefore, as noted above, potential disposal impacts on recreational activities are considered to be Class III.

Alternative Site 4

Alternative Site 4 is located over 30 nmi from the Farallon Islands. Thus, similar to Alternative Site 3, potential impacts are classified as Class III.

4.4.3.6 Cultural and Historical Resources

No known cultural or historical resources exist within the alternative sites. Wildlife and naturalist tours are concentrated around the Farallon Islands and Cordell Bank (at least 20 nmi from the alternative sites). Therefore, potential impacts should be limited to possible navigational conflicts between dredged material barges and naturalist vessels. However, these conflicts will be mitigated by specification of barge traffic lanes that avoid the Farallon Islands region, thus representing a negligible impact (Class III).

Alternative Site 3

Alternative Site 3 is located over 20 nmi from the Farallon Islands. Therefore, potential disposal impacts on cultural and historical resources are considered insignificant (Class III).

Alternative Site 4

Alternative Site 4 is located over 30 nmi from the Farallon Islands. Thus, similar to Alternative Site 3, potential disposal impacts are considered insignificant (Class III).

4.4.3.7 Public Health and Welfare

As discussed in Section 4.2.3.7, disposal impacts on public health and welfare primarily are associated with the potential for interferences between dredged material barges and commercial and recreational vessels. The potential for such events is considered to be insignificant because navigational interferences will be minimized by specifying that barge transit lanes and the overall increase in vessel traffic is considered negligible (Section 4.2.3.7) (Class III).

Alternative Site 3

The potential for vessel interferences at Alternative Site 3 is expected to be negligible, as discussed above. Therefore, potential impacts from disposal are considered to be Class III.

Alternative Site 4

Similar to Alternative Site 3, the potential for vessel interferences at Alternative Site 4 also is expected to be insignificant. Therefore, potential impacts from disposal also are considered to be Class III.

4.5 Other Alternatives

The environmental consequences associated with other general dredged material disposal options, such as disposal at sites within the Bay, disposal at nonaquatic sites, or treatment/reuse, are being evaluated by the LTMS In-Bay, Nonaquatic Reuse, and Implementation Work Groups. Therefore, detailed evaluations and comparisons of the potential impacts associated with these options are not addressed by this EIS. The specific environmental consequences of each of the alternative disposal options will be evaluated, relative to the potential impacts from use of the ODMDS, during the assessment of permit applications for individual dredging projects.

4.6 Management of the Disposal Site

The primary goal of site management is to assure that the continued use of the disposal site will not cause significant adverse impacts on the marine environment. Management of an ocean disposal site consists of the following:

- Regulating the quantities and types of material, and the time, rates, and methods of disposal;
- Maintaining an effective site monitoring program;
- Recommending changes for site use, disposal amounts, or designation for a limited time based on periodic evaluation of site monitoring results; and
- Enforcing permit conditions.

Site management is accomplished through regulation of ocean dumping permit applications, development and implementation of a Site Management and Monitoring Plan (SMMP), and evaluation of permit compliance and monitoring results. Ocean dumping permits and site management and monitoring are discussed in the following sections. The SMMP is detailed in a separate document from this FEIS.

4.6.1 Ocean Dumping Permits

Permits are required for dredging projects which propose to use an ODMDS (except for COE projects that do not require permits but require EPA approval). In general, the permit application must demonstrate the need, other than for short-term economic reasons, to use the ODMDS. Ocean disposal is permitable only if there are no practical alternatives. Some of the factors evaluated in this process are the environmental risks, impacts, and costs of ocean disposal compared to those of other feasible alternatives. Therefore, information required for permit applications must be consistent with COE's Regulatory Program requirements (33 CFR 320-330), NEPA regulations (33 CFR 230 and 325), and EPA's Ocean Dumping Regulations (40 CFR Parts 220, 225, 227, and 228), and may include the following:

- Written documentation of the need to dispose dredged material in the ocean;
- A description of historical dredging and activities at or adjacent to the proposed dredging site that may represent sources of contamination to the site;
- The type and quantity of the dredged material proposed for disposal at the ODMDS;

- The existing condition of the proposed dredging area, including the proposed dredging depths, overdredge depths, and depths adjacent to the boundary of the proposed dredging area;

- Composition and characteristics of the proposed dredged material, including the results from physical, chemical, and biological testing. These data will be used to determine whether the proposed dredged material is suitable for disposal at the ODMDS.

- An estimate of the planned start and completion dates for the dredging operation; this information is needed to avoid potential resource conflicts and may be used to schedule inspections at the dredging site and/or the disposal site;

- A debris management plan that addresses the disposal of materials other than the dredged sediment (e.g., pilings or metal debris) to ensure that these other materials are not discharged at the ODMDS.

The need for ocean disposal is demonstrated when other, feasible alternatives have been evaluated, and no practicable alternative locations, methods of disposal, or treatment technologies exist to reduce adverse impacts from disposal.

The suitability of dredged material proposed for disposal at the ODMDS must be demonstrated through appropriate physical, chemical, and biological testing according to the requirements and procedures defined in EPA's Ocean Dumping Regulations (40 CFR Parts 220, 225, 227, and 228). Section 227.6 of the Ocean Dumping Regulations prohibits the disposal of certain contaminants as other than trace chemical constituents of dredged material. Regulatory decisions rely on assessments of the potential for unacceptable adverse impacts based on persistence, toxicity, and bioaccumulation of the constituents, instead of specific numerical limits (EPA/COE 1991).

The present technical guidance for determining the suitability of dredged material involves a tiered-testing procedure (EPA/COE 1991). This procedure includes four levels of testing: Tiers I and II apply existing or easily obtained information and limited chemical testing to predict effects. If these predictions indicate that the dredged material has any potential for significant adverse effects, higher tiers are activated. Tiers III and IV utilize water column and benthic bioassay and bioaccumulation tests to determine effects on representative marine organisms.

Dredged material proposed for ocean disposal will be tested for bioaccumulation potential according to Green Book protocols (EPA/COE 1991). These protocols state that if testing results indicate that the bioaccumulation of contaminants statistically exceeds that of reference-material tests, the following eight factors will be assessed to evaluate LPC [Limited Permissible Concentrations] compliance:

- Number of species in which bioaccumulation from the dredged material is statistically greater than bioaccumulation from the reference material;

- Number of contaminants for which bioaccumulation from the dredged material is statistically greater than bioaccumulation from the reference material;

- Magnitude by which bioaccumulation from the dredged material exceeds bioaccumulation from the reference material;

- Toxicological importance of the contaminants whose bioaccumulation from the dredged material statistically exceeds that from the reference material;

- Phylogenetic diversity of the species in which bioaccumulation from the dredged material statistically exceeds bioaccumulation from the reference material;

- Tendency for contaminants with statistically significant bioaccumulation to biomagnify within aquatic food webs (Biddinger and Gloss 1984; Kay 1984);

- Magnitude of toxicity and number and phylogenetic diversity of species exhibiting greater mortality in the dredged material than in the reference material; and

- Magnitude by which contaminants whose bioaccumulation from the dredged material exceeds that from the reference material also exceed the concentrations found in comparable species living in the vicinity of the proposed disposal site.

Management decisions concerning the use of the ODMDS in lieu of disposal sites within the Bay, at nonaquatic sites, or other, approved treatment/reuse options, will be made according to guidance presently being developed by the LTMS. Decisions regarding the suitability of dredged material for ocean disposal will be guided by criteria contained in MPRSA and EPA's Ocean Dumping Criteria (40 CFR Parts 220, 225, 227, and 228). MPRSA authorizes the COE to administer the permit program for dredged material. The COE, San Francisco District will prepare the Public Notice concerning the proposed disposal operation, and EPA Region IX as well as other Federal and State agencies, will participate in the review of the application. In accordance with 40 CFR 220.4(c), EPA Region IX will approve, disapprove, and propose conditions on the MPRSA Section 103 permit. EPA Region IX will not approve the ocean disposal of material which has the potential for significant adverse biological impacts.

Dumping permits subsequently issued for individual dredging projects may impose additional conditions on the disposal operations to preclude or minimize potential interferences with other activities and/or uses of the ocean. Management options for the permitting process may include: full or partial approval of dredged material proposed for ocean disposal; limits on disposal volumes; seasonal restrictions (see Section 3.1.2); disposal within a spatially-limited portion of the disposal site; or requirements, for example, for dredged material barge operators to stay within specified transit paths, utilize navigation equipment with specified accuracy, and maintain appropriate ship logs.

Measures to ensure that disposal occurs reliably within the boundaries of the designated ODMDS are being developed jointly by EPA Region IX and the COE for incorporation into disposal permits. EPA Region IX will work with the COE, San Francisco District and the U.S. Coast Guard to inspect, monitor, and conduct surveillance of disposal operations in the San Francisco area. If violations of the permit(s) are detected, EPA Region IX may take appropriate enforcement actions as authorized under MPRSA Section 105(a).

4.6.2 Site Management and Monitoring

In accordance with 40 CFR 228.3, site management is the responsibility of EPA. However, 40 CFR Section 228.9(c) states that EPA will require full participation of permittees and will encourage participation by other Federal, State, and local agencies in the development and implementation of disposal site monitoring programs. Since COE is a major dredger and Federal regulatory agency in the Bay, EPA will involve the COE in site management and monitoring.

Management decisions related to the proposed dredged material and the disposal operations will be based on:

1. Compliance with applicable criteria defined in the EPA's Ocean Dumping Regulations at 40 CFR Part 227.

2. Requirements imposed on the permittee under the COE's Permitting Regulations at 33 CFR Parts 320-330 and 335-338.

3. Guidance on evaluation of disposal options developed by the LTMS Implementation Work Group.

4. The potential for significant adverse environmental impacts at the ODMDS from disposal of dredged material.

Existing regulatory information, such as the Federal Water Quality Criteria and the State of California Water Quality Objectives, may also be used in some cases as management decision points.

Management decisions will be implemented to reduce or mitigate any significant adverse environmental impacts. Potential environmental impacts from dredged material disposal are considered significant, therefore constituting a basis for a management decision at the permitting stage, when such impacts result in statistically significant changes (i.e., differences at the 95% confidence level compared to the reference site) and/or pose an unacceptable risk to the marine environment or human health. Determinations will be based on appropriate statistical methods to evaluate differences between the proposed dredged material and reference site conditions for chemicals of concern, acute toxicity of the proposed dredged material, the magnitude of bioaccumulation, and potential ecological impacts. The main concerns are: (1) disposal of sediments that may cause significant mortality or bioaccumulation of contaminants within the disposal site or adjacent to the site boundaries, and (2) adverse ecological changes to the ODMDS and the surrounding sea floor. Changes in the benthic community inside the ODMDS are expected because different grain size characteristics in the dredged material may promote colonization of the site by different benthic species (Section 4.2.2). If dredged material is detected outside of the disposal site, benthic community changes adjacent to the site may be evaluated to determine whether these changes are acceptable.

Management options for the permitting process may include: (1) full or partial approval of dredged material proposed for ocean disposal; (2) prohibition of sediments proposed for ocean disposal; or (3) special management restrictions for ocean disposal of the proposed material, including limits on disposal quantities, disposal frequencies, or disposal at specific areas within the ODMDS. In addition to project-specific, site-use conditions, possible management restrictions on use of the ODMDS will include the following considerations:

1. Material volumes:

   - Disposal of unrestricted volumes is dependent on results from future monitoring surveys.

2. Material suitability:

   - The suitability of the material for ocean disposal must be demonstrated to EPA and the COE in accordance with specifications and requirements of the Green Book (EPA/COE 1991) and EPA Region IX's (1989) regional guidance for sediment testing.

3. Time of disposal:

   - Unrestricted seasonal use is dependent on results from future monitoring surveys. Seasonal restrictions may be placed on the timing and/or frequency of dredged material disposal as necessary to protect breeding, migrating, and listed species.

   - Barge transit from the Bay may be restricted when wave heights along the route are predicted to exceed 18 feet. When wave heights exceed 10 feet and wave periods reach 9 seconds or less, extra precautions may be required to prevent spillage or other loss of material during transit to the ODMDS. These precautions may include a reduction of barge loading, in addition to any other measure(s) deemed necessary by the tug captain, including canceling the trip until sea conditions have subsided or returning to the dredging site without disposing the load.

4. Disposal technique:

- Barge load capacities may be limited for the initial trip(s).

- No water or dredged material will be permitted to leak or spill from barges during transit to the ODMDS.

- Tugs with barges will remain outside of the territorial sea boundary surrounding the Farallon Islands by following the inner portion of the outbound western shipping lane for transit into and out of the Bay.

- When the disposal barge is west of the VSS, the tug shall proceed directly to the ODMDS. The barges must be towed at least 3 nmi from the Farallon Islands.

- The tug will be required to use navigation systems with specified minimum accuracy and precision capabilities.

5. Placement of materials:

- All material will be discharged within a circle of specified diameter centered at 37°39'N,123°29'W.

- When dredged material is discharged, no portion of the barge shall be farther than a specified distance from the center of the ODMDS.

6. Disposal monitoring and documentation:

- The permittee will maintain daily records of dredging operations, transportation schedules, barge load volumes disposed, and exact location and time of disposal.

- An inspector will be required to observe all dredging operations and submit reports containing a description of operations.

- The permittee will be required to report any violations to EPA within 24 hours. In the event of a violation, the permittee must make all necessary changes to bring disposal operations into compliance before making another trip to the ODMDS.

- Development and implementation of more sophisticated surveillance systems, which can be demonstrated to EPA to be effective and capable of being audited, may be substituted pending approval from EPA for one or more of the above conditions.

Evaluations and possible revisions of these generic site-use conditions will occur at a minimum frequency of once every five years. Additional conditions on use of the ODMDS may be determined during the permit review process.

Once dredging and disposal operations have begun, management responsibilities, including surveillance and inspection of dredging and disposal, will be initiated to ensure compliance with permit conditions. Surveillance of the disposal operations will be carried out by the USGS's Eleventh District with assistance from EPA Region IX and the COE's San Francisco District. EPA Region IX has the authority, as defined in Section 105 of MPRSA, to enforce against illegal disposal activities, including non-compliance with permit conditions. Management options by the COE's San Francisco District could involve temporary or permanent withdrawal of a permit.

Surveillance and inspection may consist of one or more of the following:

1. On-board inspection by EPA Region IX or the COE's San Francisco District staff to ensure that transportation and disposal of the sediments occur within the designated discharge zone and that the permittee complies with all permit terms and special conditions.

2. On-board inspection by a certified inspector hired by the permittee or a regulatory agency to ensure that transportation and disposal of the sediment occurs within the designated discharge zone and that the permittee complies with all permit terms and special conditions.

3. Plots of barge navigation course while inside the disposal site boundaries. Disposal contractors will be required to navigate using an electronic positioning system or other approved navigation system with specified accuracy and precision. Permittees may be required to provide a record of the barge navigation course, annotated with the coordinates at the beginning and end of the disposal operation.

As an integral part of the SMMP, a tiered monitoring program was designed for the ODMDS to provide data for site management. Tiered approaches to monitoring result in a highly structured framework for hypotheses and observations, give management action thresholds or "triggers" and provide guidance for evaluating appropriate management actions. The monitoring program comprises three interdependent modules: a Physical Monitoring Module, a Biological Monitoring Module, and a Chemical Monitoring Module. The Physical Monitoring Module will provide information about the plume behavior in the water column and dredged material footprint on the bottom. The Biological Monitoring Module provides information about the effects of the water column plume on sea birds, marine mammals, and mid-water fishes. In the event that the dredged material footprint extends outside of the designated site, impacts on the benthos will be investigated. The Chemical Monitoring Module provides data on sediment quality and will evaluate bioaccumulation of contaminants in benthic organisms if trigger concentrations of contaminants in sediments are exceeded. Tier 1 monitoring studies are performed as part of each module. However, initiation of subsequent studies under Tiers 2 and 3 will be based on exceedences of trigger levels specified in the SMMP.

The program design facilitates monitoring of both short-term (e.g., transient water column impacts) and long-term (e.g., benthic) impacts, enabling EPA Region IX and the COE San Francisco District to make management decisions in a timely manner should potential or actual unacceptable adverse impacts be detected. The physical, biological, and chemical monitoring also will help these agencies to verify whether disposal operations are carried out in compliance with permitting requirements and environmental regulations.

Specific questions to be addressed by the monitoring program will be based on outstanding issues and concerns in the site designation process. These questions may include the following:

- Is the area affected by disposal of dredged material restricted to the disposal site? (Impacts may be measured by changes in water quality, sediment grain size, sediment chemistry, and biological communities, including benthic invertebrates and fish).

- Does the model used to simulate the dispersal of dredged material accurately predict movement of material through the water column and to the bottom?

- Do concentrations of chemicals of concern in sediments within and outside the ODMDS exceed specific trigger levels?

- Is there significant bioaccumulation of chemical contaminants in local organisms at the site?

- Do disposal operations have a significant impact on biological resources?

- Do disposal operations have a significant impact on the distribution or feeding habits of seabirds or mammals?

Monitoring of physical processes is focused on the potential transport of dredged material following disposal. Field measurements will be necessary to answer specific management questions concerning the transport of material out of the disposal site and, potentially, into the GOFNMS.

If the field measurements and numerical model results show that dredged material does not leave the site, then no management actions (relating to physical processes monitoring) will be necessary. On the other hand, if material is exiting the site, then additional field measurements will be implemented to evaluate the horizontal transport of material suspended within the water column and the potential accumulation of dredged material on the sea floor outside of the site and/or within the GOFNMS.

Chemical monitoring is focused on the effects of dredged material deposition on the chemical characteristics of bottom sediments within and adjacent to the ODMDS and potential effects of biological uptake of contaminants associated with the bottom sediments. In particular, routine monitoring of selected chemical constituents is performed to evaluate potentials for accumulations in sediments and exposures of benthic and demersal organisms to toxic and/or biologically available contaminants.

The biological monitoring module of the SMMP addresses the effects of dredged material disposal on two marine ecosystem components: the pelagic (marine birds, mammals, and fish) and the demersal (benthic invertebrate communities). Potential impacts to marine birds, mammals, and fish are expected to be transient and occur within a limited time period during and immediately after disposal operations, while impacts to the benthic community are expected to last somewhat longer and be readily detected within the footprint area of dredged material accumulation.

Management actions will be initiated if monitoring data indicate nonconformance with permit conditions or if disposal activities have caused any of the following conditions:

- Significant accumulation of waste constituents at or within any shoreline, marine sanctuary, or critical area;
- Biota, sediments, or the water column are adversely affected to the extent that there are significant decreases in populations of valuable commercial or recreational species, or in other species essential to the propagation of such species;
- Significant adverse effects to populations of seabirds or marine mammals, including threatened and endangered species of limited distribution;
- Material has accumulated to the extent that major uses of the site are impaired;
- Adverse effects to the taste or odor of valuable commercial or recreational species; or
- Dredged material is identified consistently in toxic concentrations outside the disposal site more than 4 hours after disposal [40 CFR 228.10 (c)(1)(i)-(v)].

Management actions to mitigate significant adverse impacts may include the following:

- Revise the size or location of the disposal zone, or move the disposal zone;
- Enforce revised permit conditions on navigation and placement of barges in the disposal zone;
- Limit the amount of dredged material disposed at the site each year;
- Limit the season of disposal;
- Evaluate the effect of the sediment plume on the exposed species;
- Reconfigure the boundaries of the disposal site;
- Initiate environmental studies for a new disposal site;
- Designate a new disposal site; or
- Implement other feasible and responsive management options that are developed as the monitoring program progresses.

4.7 Cumulative Impacts as a Result of the Project

Ongoing and historical discharges in the LTMS study region are described in Sections 1.7 and 3.1.1. These discharges include disposal of dredged material at the Channel Bar ODMDS (5.6 km from shore) and discharges of treated wastewaters from several coastal outfalls, including the San Francisco Southwest Ocean Outfall (10.2 km from shore), City of Pacifica Outfall (0.8 km from shore), and Northern San Mateo County Outfall (0.8 km from shore). Disposal of 1.2 million yd^3 of dredged material is permitted within Alternative Site 5 [coincident with the Naval Ocean Disposal Site (NODS)] through December 1, 1994 as part of the Navy's MPRSA Section 103 Permit. Discontinued historical waste discharges in the LTMS study region include dredged material disposal, acid waste, cannery waste, low-level radioactive waste, munitions, refinery waste, and vessel and dry dock disposal (Figure 3.1-1).

Due to the large distances (greater than 45 nmi) from shore to the alternative sites, discharges of treated wastewaters from nearshore outfalls are unlikely to cause any cumulative effects with regard to designation or use of an offshore ODMDS. Ocean disposal of acid waste, cannery waste, and refinery waste was discontinued approximately 20 years ago (in 1971–1972), and the presence of residual wastes which could interact with discharged dredged material to produce cumulative, adverse, environmental effects has not been detected (Section 3.2.5). Similarly, the majority of the dredged material disposal activities were discontinued 14 to 25 years ago (BART in 1967, COE Test Site in 1974, and the 100-Fathom Site in 1978). Present dredged material disposal activities at the Channel Bar ODMDS are too far (approximately 45 to 55 nmi) from the alternative sites to produce cumulative effects. Also, sandy material from the entrance channel discharged at the site is not expected to contain chemical contaminants which could contribute to cumulative effects. In contrast, other discharge activities discussed below may have some effect on the proposed actions due to the proximity of these historical discharge operations to one or more of the alternative sites and the likelihood of residual contamination.

4.7.1 Radioactive Waste Disposal Sites

One of three radioactive waste sites (Site B in 1,800 m of water) is located in the vicinity of Study Area 5 (Figure 3.1-1). The other two sites (Site A at 90 m depth and C at 900 m depth) are within the GOFNMS and located approximately 20 nmi or more from the alternative sites. However, the precise locations of the majority of the waste containers are unknown, and the wastes may be spread over a large area within the general region. All known disposal of containerized, low-level radioactive wastes at Sites A, B, and C was suspended by 1965. Due to the expected residual radioactivity associated with this waste, some potential exists for contamination of bottom sediments and organisms. The magnitude of the contamination, and potential risks to environmental resources and human health, presently are being evaluated by NOAA and EPA.

It is unlikely that dredged material disposal would cause cumulative effects in conjunction with these low-level radioactive waste containers. In fact, deposition of dredged material could have the effect of burying and further isolating some containers. Although the present condition of the containers is unknown, it is unlikely that deposition of dredged material would result in any substantial releases or dispersion of contaminated materials present at the site. It would not be practical at this time to use dredged material specifically for burying waste containers because, according to best available information, most of the containers are close to the Farallon Islands and within the GOFNMS. The primary concern related to ODMDS designation is the potential for accidental recovery of radioactive waste material during monitoring surveys of the ODMDS. Inadvertent collection of some radioactive material has occurred in the southeastern portion of Study Area 5, but outside of Alternative Site 5 (Lissner, SAIC, pers. obs. 1992). Therefore, while cumulative effects are not a significant concern, it is important to address the feasibility of monitoring an ODMDS situated in the vicinity of the radioactive waste disposal sites.

4.7.2 Munitions Waste Sites

The Chemical Munitions Dumping Area (CMDA) is located within Study Area 5 (Figure 3.1-1). Two other disused munitions disposal areas are adjacent to Study Area 4. As with the radioactive waste sites, disposal operations at the munitions waste disposal sites were terminated over 20 years ago (by 1969). The potential exists for regional environmental contamination and/or human health concerns from historically disposed chemical agents and explosives. However, cumulative impacts from dredged material disposal are unlikely, and deposition of dredged material could bury some munitions. The primary concern associated with designation of an ODMDS would be accidental recovery of munitions wastes during monitoring surveys of the ODMDS. Inadvertent collection of munitions near Alternative Site 5 has occurred (Lissner, SAIC, pers. obs. 1992). Thus, while cumulative impacts are not considered significant, it is important to evaluate the feasibility of monitoring an ODMDS which lies in vicinity of the historical munitions disposal sites.

4.7.3 Navy Section 103 Dredged Material Disposal

The Navy currently is discharging 1.2 million yd^3 of dredged material at NODS under an MPRSA Section 103 permit (No. 19260E48) issued by the COE San Francisco District. Dredged material disposed at the NODS could contribute to cumulative effects associated with any subsequent use of Alternative Site 5 for other dredged material disposal operations. As required under MPRSA, any dredged material, whether disposed of at a Section 102 or a Section 103 site, must meet all applicable criteria to be eligible for ocean disposal. Assessment of any cumulative effects will be part of the site monitoring plan. Data collected by the Navy, required as part of their monitoring program as specified in the Section 103 permit, will be used to assess cumulative effects from subsequent disposal operations at Alternative Site 5.

4.7.4 B1B Dredged Material Disposal Site

The B1B site is located within the boundary of LTMS Study Area 2 (Figure 3.1-1). The site was used briefly in 1988 for disposal of approximately 18,000 yd^3 of dredged material from the Port of Oakland. In general, this volume of material is very small, and residual effects at the site, including cumulative effects related to the proposed action, are unknown. Results from recent EPA surveys (SAIC 1992b,c) indicate that the shelf area is a high-energy zone and fine-grained material appears readily dispersed (Noble *et al.* 1992; SAIC 1992c). Therefore, detectable quantities of dredged material from the Port of Oakland may no longer exist in the vicinity of the BIB site.

4.8 Relationship Between Short-Term Use and Long-Term Resource Uses

The proposed designation of any of the alternative sites as an ODMDS is not expected to produce significant, long-term, adverse impacts to resources, including the physical, biological, and socioeconomic environments, within the LTMS study region. Impacts to benthic invertebrates within the site are expected to persist as long as the site is used for disposal. However, cessation of disposal should result in gradual recovery over time. Deep-water sites generally are expected to require longer recovery times than shallow-water sites due to the slow rates of change that typically are associated with more stable conditions (Sanders and Hessler 1969).

Use of the proposed ODMDS is not expected to interfere with uses of resources outside of the boundaries of the alternative sites. These resources include commercial and sport fishing, marine bird and mammal observation, and use of the region by commercial, military, and recreational vessels (Sections 3.4 and 4.4). No significant mineral or oil and gas resources occur within any of the alternative sites (Sections 3.4 and 4.4). Therefore, use of ODMDS does not represent a potential conflict with the long-term use of resources.

Any impacts or restricted uses of resources within the site boundaries would represent a very small percentage of these resources within the LTMS study region. This marginal loss of some resources is balanced by the significant benefit that would be derived from the proposed action. In contrast, lack of a designated ocean disposal site capable of receiving large quantities of dredged material could have a significant adverse effect on the economic productivity and national defense activities associated with San Francisco Bay (COE 1990a,b, 1991).

4.9 Irreversible or Irretrievable Commitment of Resources

Irreversible or irretrievable resources that would be committed if an ocean disposal site is designated will include:

- Energy resources used as fuel for dredges, pumps, and disposal vessels, and for research vessels involved in monitoring studies;
- Economic resources associated with ocean disposal including monitoring and surveillance;
- Unavailability of sediments disposed at the ODMDS for potential marsh restoration or other beneficial use projects; and
- Some loss or degradation of the benthic habitat and associated benthic communities at the site for at least the duration of site use.

The commitment of energy and economic resources will increase with increased distance of a site from dredging areas. However, the three alternative sites are similar distances from the Golden Gate Bridge, and no significant differences in the resources contained within the alternative sites are evident. Therefore, the magnitude of any long-term commitment of irreversible or irretrievable resources that can be determined from the existing information is essentially the same for each of the three alternative sites.

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CHAPTER 5
COORDINATION

This chapter contains information on public involvement and interagency activities related to the Draft Environmental Impact Statement (DEIS) and Final Environmental Impact Statement (FEIS) for designation of the Deep Water Ocean Dredged Material Disposal Site off San Francisco, California (Sections 5.1 and 5.2, respectively); evidence of formal consultation (Section 5.3); and requested reviewers and public distribution of the DEIS and FEIS (Sections 5.4 and 5.5, respectively).

5.1 Notice of Intent and Public Scoping Meeting

The Notice of Intent (NOI) to prepare an environmental impact statement related to designation of an ocean dredged material disposal site (ODMDS) was published in the *Federal Register* on March 31, 1989 (Exhibit 1).

A public scoping meeting was held in Sausalito, California on April 11, 1989 to identify affected public and agency concerns and to define the issues and alternatives to be examined in detail in the EIS. At this scoping meeting, EPA explained the need for and process of site designation and identified several geographic areas for further evaluation. These areas included the continental shelf, shelf break, slope, deep slope, and Pioneer Canyon.

Comments made during the scoping meeting covered the following general topics:

- Proximity of the ocean disposal site to the Gulf of the Farallones National Marine Sanctuary, Cordell Bank National Marine Sanctuary, hard-bottom areas, and Pioneer Canyon;

- Potential interferences with existing and/or future fishery resources, and feeding, breeding, and migratory activities of marine birds and mammals;

- Potential impacts to other water column organisms if dredged material particles remained suspended;

- Potential problems predicting the area affected by disposal operations; and

- Potential problems monitoring short- and long-term effects from disposal operations at a deep-water site.

5.2 San Francisco Bay Long-Term Management Strategy for Dredged Material

The Long-Term Management Strategy (LTMS) program began in January 1990 as a Federal/State partnership between the four agencies which have regulatory authority for dredged material in the San Francisco Bay area. As the lead agencies for the LTMS, the U.S. Army Corps of Engineers (COE), the Environmental Protection Agency Region IX (EPA), the San Francisco Bay Regional Water Quality Control Board (SFBRWQCB), and the San Francisco Bay Conservation and Development Commission (BCDC), share responsibility for managing the various components of the LTMS. The LTMS is designed to provide a regional plan for the disposal of up to 400 million yd^3 of dredged materials from the San Francisco Bay over the next 50 years.

Within the LTMS structure are several committees (Figure 5.2-1). The Executive Committee is composed of the COE South Pacific Division Commander, the EPA Regional Administrator, the SFBRWQCB Chairperson, the BCDC Chairperson, and a state coordinator. This committee provides management and policy guidance and retains principal decision-making authority for LTMS program issues. However, overall LTMS coordination and technical direction is delegated to the Management Committee. This committee, consisting of the COE South Pacific Division LTMS Program Manager, the EPA Water Management Division Director, the SFBRWQCB Executive Officer, and the BCDC Executive Director, oversees four LTMS work groups and the Technical Review Panel.

LTMS work groups include the Ocean Studies Work Group (OSWG), the In-Bay Work Group, the Nonaquatic/Reuse Work Group, and the Implementation Work Group. Each of these work groups has its own structure, public involvement strategy, and specific objectives. The Ocean, In-Bay, and Nonaquatic/Reuse Work Groups are responsible for conducting the tasks described in the LTMS Study Plan (COE 1991). The Implementation Work Group is the newest of the work groups. The Steering Committee of this work group has recently proposed a series of subcommittees to deal with the issues of a siting framework, sediment quality, financing and ownership, containment sites, a programmatic management document, and project coordination.

The Technical Review Panel is composed of five scientific experts who provide critical reviews of technical issues that lie outside of the LTMS program's broad conceptual approach. The members of the Technical Review Panel are shown in Table 5.2-1.

The LTMS structure also includes an advisory group, the Policy Review Committee, which is comprised of a broad range of Federal and State agencies, ports, development, environmental, and fishing interests (Table 5.2-2). This committee meets quarterly and provides an important forum for public involvement in, and review of, LTMS development and implementation. Another mechanism for public involvement in the LTMS is the San Francisco Estuary Project, which serves to disseminate information to the general public through its outreach programs.

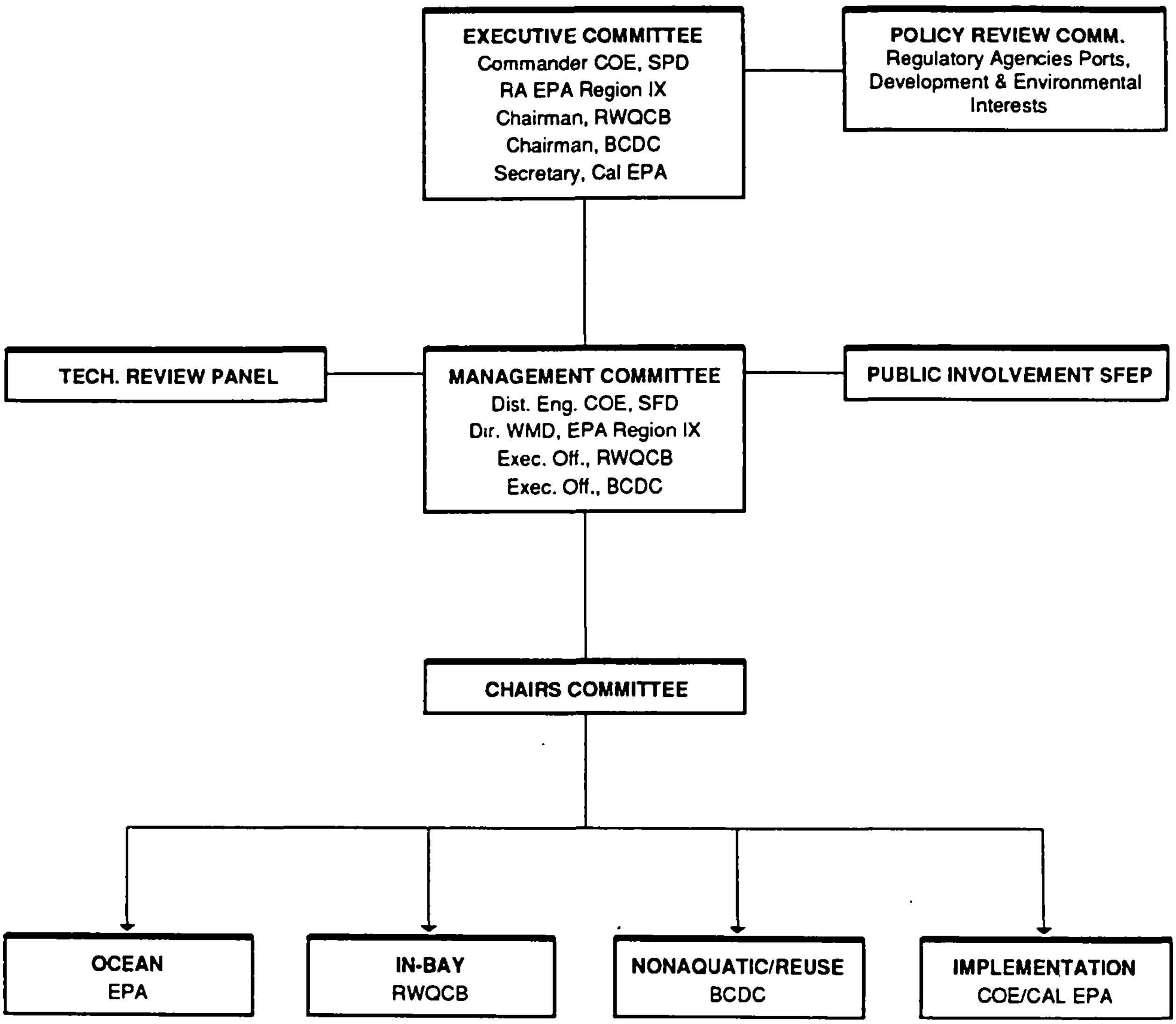

Figure 5.2-1. Long-Term Management Strategy (LTMS) Management and Implementation Structure.

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Table 5.2-1. Members of the LTMS Technical Review Panel.

Name	Specialty	Organization
Don F. Boesch	Benthic Community Analysis	University of Maryland
R. Risebrough	Chemistry	University of California—Santa Cruz
Hsieh W. Shen	Physical Processes	University of California—Berkeley
Tom Ginn	Sediment Toxicology	PTI, Inc.
David R. Stoddart	Wetland Geomorphology	University of California—Berkeley

Table 5.2-2. Members of the LTMS Policy Review Committee.

Category	Member Organization
Federal Agencies	Gulf of the Farallones National Marine Sanctuary National Marine Fisheries Service National Oceanic and Atmospheric Administration U.S. Army Corps of Engineers U.S. Coast Guard U.S. Environmental Protection Agency U.S. Fish and Wildlife Service U.S. Geological Survey U.S. Navy
California State and Regional Agencies	Coastal Commission Department of Boating and Waterways Department of Fish and Game Department of Water Resources Integrated Waste Management Board San Francisco Bay Conservation and Development Commission Secretary for Environmental Protection Secretary of Business, Transportation, and Housing State Lands Commission State Water Resources Control Board The Resources Agency
Special Interest Groups	Bay Planning Coalition California Marine Affairs and Navigation Conference Citizens for a Better Environment Golden Gate Ports Association Half Moon Bay Fisherman's Marketing Association Marin Audubon Society Ocean Alliance Pacific Coast Federation of Fisherman's Associations Pacific Inter-Club Yacht Association Port of Oakland Port of Redwood City Port of Richmond Port of San Francisco Save San Francisco Bay Association Sierra Club United Anglers of California

5.3 LTMS Ocean Studies Work Group

The LTMS OSWG, led by EPA, meets periodically to allow EPA and others to present preliminary or final study findings and to solicit comments from group members. The members of the OSWG, commentors on OSWG products, and attendees of the OSWG meetings are shown in Tables 5.3-1, 5.3-2, and 5.3-3, respectively. Under the LTMS program, EPA first convened representatives of interested agencies and groups on February 20, 1990, to present an outline of the LTMS Ocean Studies Plan (OSP). The purpose of the OSP was to define objectives and identify studies necessary to address the site selection general and specific criteria (see Table 1.1-1). At a meeting of the LTMS Policy Review Committee on February 27, 1990, interested reviewers were asked to submit comments on the OSP outline.

Using comments received at the February 1990 meeting and written comments from members of the Policy Review Committee, EPA prepared a response to comments and developed the OSP outline into a detailed plan. This draft OSP was presented and distributed to the Ocean Studies Work Group at its first official meeting on November 8, 1990. At this meeting, attendees were asked to submit comments on the draft OSP by early December. EPA prepared responses to comments and presented those responses at another OSWG meeting held December 17, 1990.

Since one of the major issues for the site designation process was the methodology used in assessing fish communities, EPA convened a special work group meeting at National Marine Fisheries Service (NMFS, Tiburon, California) on January 8, 1991 to discuss these issues. Afterward, another OSWG meeting was held on February 20, 1991. At this meeting, the COE presented a draft Zone of Siting Feasibility determination which included all of the study areas identified by EPA in the draft OSP. Other topics discussed at this meeting included preliminary footprint modeling and proposed changes to the OSP based on comments received at the previous two meetings.

EPA released a draft final OSP on March 8, 1991. This document contained a detailed description of each of the site selection criteria and defined specific objectives for four study elements: Physical Oceanography, Benthic Infauna and Sediments, Epifauna and Fisheries, and Marine Birds and Mammals. In addition, the document provided an assessment of existing information for the study areas, a description of specific studies to be conducted, and a cost estimate. EPA received written comments on the draft final OSP and revised it into a final OSP which was released at a Policy Review Committee meeting on June 7, 1991.

Since some commentors felt that the final OSP had not resolved all of the outstanding issues, EPA prepared responses to comment letters from the Gulf of the Farallones National Marine Sanctuary and the California Environmental Protection Agency and held an OSWG meeting on July 29, 1991 to address these issues. Other presentations at this meeting included additional preliminary footprint modeling and the scope of services for the OSP biological studies.

At the next OSWG meeting held on December 12, 1991, EPA presented preliminary results of the benthic infauna and sediments, trawl, and remotely-operated vehicle studies. Preliminary

Table 5.3-1. LTMS Ocean Studies Work Group (OSWG) Members.
Members listed alphabetically by affiliation.

Name	Organization
Bill Boland	individual
Tom Jow	individual
Ellen Johnck	Bay Planning Coalition
Mark Delaplaine	California Coastal Commission
Jim Raives	California Coastal Commission
George Armstrong	California Department of Boating and Waterways
Pete Phillips	California Department of Fish and Game
Robert Tasto	California Department of Fish and Game
Tracy Wood	California Integrated Waste Management Board
Mary Bergen	California State Lands Commission
Barbara Miller	Center for Marine Conservation
Alan Ramo	Citizens for a Better Environment
Kathleen van Velsor	Coastal Advocates
Chris Peterson	Dutra Construction, Inc.
Marie White	Entrix
Lindsay Rehm	Environmental Forum of Marin
Jeffrey Cox	Evans-Hamilton, Inc.
Stanley Ekren	Great Lakes Dredge & Dock Company
Jan Roletto	Gulf of the Farallones National Marine Sanctuary
Ed Ueber	Gulf of the Farallones National Marine Sanctuary
Pietro Parravano	Half Moon Bay Fisherman's Association
Stuart Siegal	Levine-Fricke
Barbara Salzman	Marin Audubon Society
Krista Hanni	Marine Mammal Center
Robert Battalio	Moffatt and Nichol
Dilip Trivedi	Moffatt and Nichol
Greg Cailliet	Moss Landing Marine Laboratories
James Nybakken	Moss Landing Marine Laboratories
Jim Bybee	National Marine Fisheries Service

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Table 5.3-1. Continued.

Name	Organization
Alec MacCall	National Marine Fisheries Service
Chris Mobley	National Marine Fisheries Service
Don Pearson	National Marine Fisheries Service
Herb Curl	National Oceanic and Atmospheric Administration
Cynthia Koehler	Natural Heritage Institute
H. Lee Halterman	Office of Congressman Ron Dellums
Lynelle Johnson	Office of Congressman George Miller
Gail Blaise	Office of Congresswoman Barbara Boxer
Zeke Grader	Pacific Coast Federation of Fish Association
David Ainley	Point Reyes Bird Observatory
Sarah Allen	Point Reyes Bird Observatory
Veronica Sanchez	Port of San Francisco
Jim McGrath	Port of Oakland
Charles Schwarz	Port of Oakland
Jody Zaitlin	Port of Oakland
Catherine Courtney	PRC Environmental Management Inc.
David Cobb	PTI Environmental Services
Wade Eakle	Regulatory Branch, SF District ACOE
Steve Goldbeck	San Francisco BCDC
Scott Rouillard	San Francisco Bay Keeper
Michael Carlin	San Francisco Regional Water Quality Control Board
Paul Jones	San Francisco Regional Water Quality Control Board and U.S. Environmental Protection Agency
Andrew Lissner	Science Applications International Corporation
John Lunz	Science Applications International Corporation
David Nesmith	Sierra Club
James Royce	Sierra Club
Kim Brown	Tetra Tech
John Beuttler	United Anglers of America
Commander Scot Tiernan	U.S. Coast Guard Marine Safety Office

Table 5.3-1. Continued.

Name	Organization
Rod Chisholm	U.S. Army Corps of Engineers
Bill McCoy	U.S. Army Corps of Engineers
Lynn O'Leary	U.S. Army Corps of Engineers
Richard Stradford	U.S. Army Corps of Engineers
Tom Wakeman	U.S. Army Corps of Engineers
William Allen	U.S. Department of the Interior
Darrin Fong	U.S. Fish and Wildlife Service
Jean Takakawa	U.S. Fish and Wildlife Service
Herman Karl	U.S. Geological Survey
Marlene Noble	U.S. Geological Survey
Curt Collins	U.S. Naval Postgraduate School
Steven Ramp	U.S. Naval Postgraduate School
Sherman Seelinger	U.S. Navy Western Division

Table 5.3-2. Agencies and Organizations that Provided Written Comments on LTMS Ocean Studies Plan, February 1990 to June 1991.

California Coastal Commission
California Department of Fish and Game
California Environmental Protection Agency
Golden Gate Ports Association
Gulf of the Farallones National Marine Sanctuary
Half Moon Bay Fisherman's Marketing Association
National Marine Fisheries Service, Santa Rosa
National Marine Fisheries Service, Tiburon
Point Reyes Bird Observatory
Port of Oakland
San Francisco Bay Conservation and Development Commission
San Francisco Bay Regional Water Quality Control Board
Save San Francisco Bay Association
State Lands Commission
United States Army Corps of Engineers, San Francisco District
United States Army Corps of Engineers, South Pacific Division
United States Army Corps of Engineers, Waterways Experiment Station
United States Coast Guard
United States Environmental Protection Agency, Office of Research and Development
United States Geological Survey
United States Naval Postgraduate School
United States Navy

Table 5.3-3. Attendance at LTMS Ocean Studies Work Group Meetings, February 1990 to May 1993.

Organization	2/20/90	11/8/90	12/17/90	1/8/91	2/26/91	7/29/91	12/12/91	2/13/92	5/4/92	8/14/92	9/29/92	3/16/93	5/12/93
Bay Conservation and Development Commission		*	X			X	X		X	X	X	X	X
Bay Planning Coalition	X	*							X			X	X
Bill Boland		*								X			
California Coastal Commission	X	*	X			X	X	X	X	X	X	X	X
California Department of Boating and Waterways		*	X		X	X	X	X	X		X	X	X
California Department of Fish and Game		*	X	X	X	X	X	X	X	X		X	X
California Marine Affairs and Navigation Conference (CMANC)		*	X										
Center for Marine Conservation		*										X	X
Citizens for a Better Environment	X	*											
Coastal Advocates		*									X		
Congresswoman Boxer's Office		*			X								
Corps of Engineers	X	*	X	X	X	X	X	X	X	X	X	X	X
Department of the Interior		*								X			
Dutra Construction		*										X	
Environmental Forum of Marin		*										X	
Golden Gate Ports Association	X	*											
Great Lakes Dredge and Dock		*										X	X
Gulf of the Farallones National Marine Sanctuary	X	*		X		X						X	X

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Table 5.3-3. Continued.

Organization	2/20/90	11/8/90	12/17/90	1/8/91	2/26/91	7/29/91	12/12/91	2/13/92	5/4/92	8/14/92	9/29/92	3/16/93	5/12/93
Half Moon Bay Fisherman's Marketing Association	X	*	X		X	X	X	X		X			
Integrated Waste Management Board		*				X							
Marine Mammal Center		*										X	X
Moss Landing Marine Laboratories		*		X								X	
National Marine Fisheries Service	X	*	X	X	X	X	X	X	X	X	X	X	
National Oceanic and Atmospheric Administration (NOAA)		*					X	X					
Naval Postgraduate School		*	X			X		X		X		X	X
Point Reyes Bird Observatory	X	*	X			X	X			X	X	X	X
Port of Oakland		*			X	X	X	X		X	X	X	X
Port of San Francisco		*											X
San Francisco Bay Regional Water Quality Control Board	X	*	X							X			
Sierra Club	X	*											X
State Lands Commission		*			X								
U.S. Fish and Wildlife Service		*						X					
U.S. Geological Survey	X	*	X		X					X		X	X
U.S. Navy		*	X	X	X	X	X	X	X	X	X	X	X
University of California at Davis		*		X									

*Attendance was not recorded.

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results of database analyses performed by the NMFS and the Point Reyes Bird Observatory under contract to EPA also were presented. Other topics of discussion included the need for a second season of biological sampling and the compatibility of EPA field work with studies conducted by the Navy in LTMS Study Area 5.

In order to address concerns about compatibility between EPA and Navy studies, EPA made the Navy studies the focus of an OSWG meeting held on February 13, 1992. At this meeting, the Navy described the types of studies conducted and their preliminary findings. The topic of the May 4, 1992 OSWG meeting also related to this issue. Since the OSWG was very concerned about comparison of data collected with different gear types, EPA presented a synopsis of data types and recommended approaches for analyzing and comparing EPA and Navy data. Following the recommendation of the OSWG, EPA has avoided quantitative comparisons between certain data sets.

On August 14, 1992, EPA held another OSWG meeting to present results from each of the OSP components and to propose alternative sites within the OSP study areas. OSWG members agreed on the locations of alternative sites and voiced their opinions and concerns regarding the comparison of these alternative sites to the EPA site selection criteria (40 CFR Sections 228.5 and 228.6). At an OSWG meeting held on September 29, 1992, EPA presented its tentative selection of Alternate Site 5, within Study Area 5, as the preferred alternative for site designation. The members of the OSWG who attended the meeting (Table 5.3-1) did not react negatively to EPA's selection of Alternative Site 5. While some concerns were raised regarding seabirds and marine mammals, the balance of information did not lead the OSWG members to call for selection of another alternative site.

After the release of the Draft EIS, EPA held an OSWG meeting on March 16, 1993, to open a discussion of site management and monitoring concepts and to obtain guidance from the group in developing a Site Management and Monitoring Plan (SMMP). EPA discussed the philosophy of monitoring, constraints on monitoring design, and options for financing monitoring plans based on examples from other locations in the United States. EPA then presented special conditions from the U.S. Navy's MPRSA Section 103 permit involving site management and monitoring. While the OSWG questioned certain details of the conditions, there was general satisfaction with the scope of the management procedures. However, the OSWG requested more details on the scope and focus of EPA's plans for monitoring the site and emphasized the importance of coordination between the Navy's and EPA's efforts. Finally, EPA presented a summary of comments on the DEIS regarding site management and monitoring issues.

EPA used comments received on the DEIS and discussions at the March 16 meeting to develop a draft SMMP. This draft SMMP was the subject of an OSWG meeting held on May 12, 1993. EPA devoted the meeting to explaining the three-tiered, physical, chemical, and biological plan and taking comments and questions from the OSWG. Reactions to the draft SMMP varied among OSWG members with some thinking the plan was too expansive and some thinking the plan was not comprehensive enough to protect all marine resources. There was consensus within the OSWG that explicit treatment of costs and funding mechanisms for the plan should be incorporated into the next draft. EPA requested that the comments on the SMMP be received by May 26, 1993.

The comment letters on the SMMP were generally supportive of the tiered approach and of the types of studies included in the plan. However, commentors differed on technical details, including the scope of studies necessary to identify the physical impacts (in the water column) and to detect short-term and long-term changes in biological communities following disposal operations. Other issues of concern included long-term funding mechanisms and integration of the SMMP with LTMS policy (e.g., development of a coordinated permit process that considers all disposal alternatives and options for beneficial reuse). EPA will continue to hold OSWG meetings to develop the final SMMP, which will be completed prior to site designation.

5.4 Formal Consultation

The Endangered Species Act requires formal consultation with Federal and State agencies to identify any threatened, endangered, or special status species that may be affected by the proposed action. The formal consultation process with the U.S. Fish and Wildlife Service, the National Marine Fisheries Service, and the California Department of Fish and Game was initiated on July 22, 1992 (Exhibits 2, 3, and 4). Further consultation documentation, including responses from these agencies and additional information on potential impacts to threatened and endangered species, is included in Exhibits 5 through 10. On July 2, 1993, the U.S. Fish and Wildlife Service certified their concurrence of no adverse impacts to local endangered species (Exhibit 11). The National Marine Fisheries Service also concurred with this determination, with the stipulation that any new information that suggests adverse effects to marine mammals or their habitat may necessitate further consultation (Exhibit 12). On June 30, 1993, the California Department of Fish and Game also certified their concurrence, stressing the importance of a comprehensive monitoring and management plan for protection of sensitive species (Exhibit 13).

The National Historic Preservation Act requires consultation with the State Historic Preservation Officer to identify any areas within the study region of architectural, archeological, historic, or cultural value that are currently listed or eligible for listing on the National Register of Historic Places. Coordination with the California State Historic Preservation Officer also was initiated on July 22, 1992 (Exhibit 14). Further documentation of this consultation is included in Exhibits 15 and 16. On July 7, 1993, the State Historic Preservation Officer concurred with EPA's determination that no historic properties exist within the area of potential effects for site use (Exhibit 17).

5.5 Public Distribution of the Draft Environmental Impact Statement

The list of agencies, organizations, and individuals to whom the DEIS was distributed is shown in Table 5.5-1. A Notice of Availability was sent to the approximately 1,000 agencies, companies, and organizations on the Corps of Engineers San Francisco District Environmental Branch's mailing list. Additional copies of the EIS may be requested from EPA or the document can be viewed at any of the libraries listed in Table 5.5-2. After the publication of the Notice of Availability in the Federal Register of the Draft EIS on December 11, 1992, EPA held a public meeting to present the findings of the DEIS and receive public comments. Two sessions were held on January 19 from 1 to 3 p.m. and from 6 to 8 p.m. EPA discussed the background of the project, summarized technical studies, and described the rationale for selecting the preferred alternative.

Comments received from reviewers and responses to these comments are included in Appendix X of the FEIS. A list of individuals and organizations that commented on the DEIS within the formal comment period is shown in Table 5.5-3. The distribution list for the FEIS is shown in Table 5.5-1.

Table 5.5-1. Distribution List for Draft Environmental Impact Statement (DEIS) and Final Environmental Impact Statement (FEIS).
Members listed alphabetically by affiliation.

Name	Organization	DEIS	FEIS
Federal Agencies			
	Federal Maritime Commission	X	X
	Fort Point National Historic Site	X	X
Nancy Homor	Golden Gate National Recreation Area	X	X
Edward Ueber	Gulf of the Farallones National Marine Sanctuary	X	X
Mark Murray-Brown	NOAA, Sanctuaries and Reserves Division		X
Commanding Officer	NCEL (Attn: Marsha Kingsbury)		X
Herb Curl	National Oceanic and Atmospheric Administration Hazardous Materials, NOAA/N/OMA34	X	X
Martin Eckes	National Oceanic and Atmospheric Administration Headquarters, N/SPA	X	
James Bybee	National Marine Fisheries Service	X	X
Dr. Alec MacCall	National Marine Fisheries Service	X	X
Donald Pearson	National Marine Fisheries Service	X	X
Michael Thaubault	National Marine Fisheries Service	X	X
Chris Mobley	National Marine Fisheries Service		X
Admiral Merrill W. Ruck	Naval Base San Francisco		X
Jacqueline Wyland	Office of Federal Activities (E-3)		X
John Coon	Pacific Fishery Management Council		X
Sara Koenig	Point Reyes National Seashore		X
Wade Eakle	Regulatory Branch, SF Dist. ACOE		X
Lt. Col. Len Cardoza	San Francisco District, U.S. Corps of Engineers	X	X
Roderick Chisholm	San Francisco District, U.S. Corps of Engineers	X	X
Calvin Fong	San Francisco District, U.S. Corps of Engineers	X	X
Richard Stradford	San Francisco District, U.S. Corps of Engineers	X	X
Thomas Wakeman	San Francisco District, U.S. Corps of Engineers	X	X
	South Pacific Division, U.S. Corps of Engineers	X	X
	South Pacific Division, U.S. Corps of Engineers	X	X
William McCoy	South Pacific Division, U.S. Corps of Engineers	X	X
B.G. Milton Hunter	South Pacific Division, U.S. Corps of Engineers		X

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Table 5.5-1. Continued.

Name	Organization	DEIS	FEIS
Mary Lamb	U.S. Air Force Reg. Compliance Office		X
	U.S. Coast Guard Marine Safety Office	X	X
Captain Thomas Robinson	U.S. Coast Guard Marine Safety Office		X
Commander Scot Tiernan	U.S. Coast Guard Marine Safety Office	X	X
	U.S. Department of the Interior	X	X
Patricia Sanderson Port	U.S. Department of the Interior	X	X
John Lishman	U.S. EPA Headquarters, WH-556F		X
Marvin Plenert	U.S. Fish and Wildlife Service	X	X
Wayne White	U.S. Fish and Wildlife Service	X	X
Michael Field	U.S. Geological Survey	X	X
Herman Karl	U.S. Geological Survey	X	X
Marlene Noble	U.S. Geological Survey	X	X
John Kennedy	U.S. Naval Facilities Engineering Command	X	X
Curt Collins	U.S. Naval Postgraduate School	X	X
Steven Ramp	U.S. Naval Postgraduate School	X	X
Captain Robert Moeller	U.S. Navy, Western Division		X
Independent Groups (includes businesses, environmental groups, and individuals)			
Don Anderson	individual	X	X
Bill Boland	individual	X	X
Mark Burke	individual		X
Lou Drake	individual	X	X
Tom Jow	individual	X	X
Fred Krieger	individual		X
Gail Rosen	individual		X
Isidore Szczepaniak	individual		X
Margaret Johnson	Aquatic Habitat Institute	X	X
	Audubon Society, Golden Gate Chapter	X	X
Walter Abernathy	Bay Dredging Action Coalition		X
	Bay Institute of San Francisco		X
Michael Herz	Bay Keeper	X	X
Ellen Johnck	Bay Planning Coalition	X	X

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Table 5.5-1. Continued.

Name	Organization	DEIS	FEIS
Selina Bendix	Bendix Environmental Research Inc.		X
George Plant	Benicia Port Terminal	X	X
Philip Plant	Benicia Industries, Inc.	X	X
Charles Adam	Board of Pilot Commissioners		X
	Bodega Marine Laboratory	X	X
Lloyd Dodge	California Association of Harbormasters and Port Captains	X	X
Martin Seldon	California Fisheries Restoration Foundation		X
Ray Krone	California Maritime Affiliation and Naval Conference (CMANC)	X	X
Robert Langner	California Maritime Affiliation and Naval Conference (CMANC)	X	X
	California Academy of Sciences	X	X
Laurel Marcus	California Coastal Conservancy	X	X
	California Marine Mammal Center	X	X
Mike Corker	California Waterfowl Association	X	X
Jill Kauffman	Center for Marine Conservation	X	X
Barbara Miller	Center for Marine Conservation		X
Owen Marron	Central Labor Council of Alameda		X
	Chevron U.S.A., Inc.	X	X
Alan Ramo	Citizens for a Better Environment	X	X
Barbara Sahm	City Planning Department, SF City and		X
Kathleen van Velsor	Coastal Advocates	X	X
Dr. Hilary Feldman	Department of Integrative Biology		X
Bob Baroni	Dredge Rep Operating Engineers Local #3	X	
William Dorresteyn	Dredge Rep Operating Engineers Local #3		X
Bill Dutra	Dutra Construction Co., Inc.		X
	Dutra Construction Company	X	
Chris Peterson	Dutra Construction, Inc.		X
	Earth Island Institute	X	X
Richard Bailey	Engineering-Science		X
	Environmental Defense Fund	X	X

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Table 5.5-1. Continued.

Name	Organization	DEIS	FEIS
Lindsay Rehm	The Environmental Forum of Marin		X
Todd Royer	EXXON Refining Company		X
Levia Stein	EXXON Refining Company	X	
Arthur Feinstein	Golden Gate Audubon Society		X
James Robertson	Golden Gate Fisherman's Association	X	X
Stanley Ekren	Great Lakes Dredge and Dock Company		
John Karas	Great Lakes Dredging Company	X	X
Karen Topakian	Greenpeace Action	X	X
Pietro Parravano	Half Moon Bay Fisherman's Association	X	X
	Headlands Foundation	X	X
Dr. Victor Jones	Intra-Governmental Studies, University of California at Berkeley	X	X
	Latitude 38 Magazine	X	X
	League for Coastal Protection	X	X
	League of Women Voters, Bay Area	X	
Fran Packard	League of Women Voters of the Bay Area		X
Pat Silverman	League of Women Voters of Oakland		X
Stuart Siegal	Levine-Fricke		X
	Manson Construction and Engineering Company	X	X
Barbara Salzman	Marin Audubon Society		X
Barbara Salzman	Marin Audubon Society/Conservation League	X	
Jean Berensmeier	Marin Conservation League		X
Karen Urquhart	Marine Conservation League	X	X
Mike Cheney	Marine Development Consultant	X	X
Krista Hanni	The Marine Mammal Center		X
	Marine Science Institute	X	X
Leslie Rosenfeld	Monterey Bay Aquarium Research Institute		X
	Moss Landing Commercial Fisherman's Association	X	X
Director	Moss Landing Marine Laboratory	X	X
	National Audubon Society, Marin Chapter	X	X
	National Audubon Society, Sequoia Chapter	X	X
Cynthia Koehler	Natural Heritage Institute	X	X

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Table 5.5-1. Continued.

Name	Organization	DEIS	FEIS
	Nature Conservancy, California Field Office	X	X
Daniel Bacher	Northern California Angling Publication	X	X
Mary Kirwin Veloz	Northern California Marine Association		X
	Oakland Chamber of Commerce	X	X
Boyce Miller	Ocean Advocates		X
Margaret Elliot	Ocean Alliance	X	X
	Ocean Research Institute	X	X
Margaret Johnson	Ogden Beeman and Associates		X
Leonard Long	PICYA/RBOC	X	X
Zeke Grader	Pacific Coast Federation of Fishermen's Association	X	X
Robert Allen	Pacific Interclub Yacht Association		X
Miles Butler	Pacific Refinery Company	X	
Terry Henderson	Pacific Refinery Company		X
David Ainley	Point Reyes Bird Observatory	X	X
Sarah Allen	Point Reyes Bird Observatory	X	X
Larry Kerbs	Port Sonoma Marin		X
Captain A.J. Thomas	San Francisco Bar Pilots	X	X
	San Francisco Bay Bird Observatory	X	X
Jane Kay	San Francisco Examiner		X
Dr. Doug Segar	San Francisco State University	X	X
James Haussener	San Leandro Marina	X	X
Barry Nelson	Save San Francisco Bay Association	X	X
John Lunz	Science Applications International Corporation	X	X
Daniel Glaze	Shell Oil Co.	X	
Robert Andrews	Shell Oil Co., Martinez Complex		X
David Nesmith	Sierra Club	X	X
	Sierra Club, San Francisco Bay Chapter	X	X
Michael Krikorian	Sonoma County Sierra Club		X
Wendy Eliot	State Coastal Conservancy	X	X
	Stuyvesant Dredging Company	X	X
Mark Massara	Surfrider Foundation		X

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Table 5.5-1. Continued.

Name	Organization	DEIS	FEIS
Kim Brown	Tetra Tech	X	X
	Tiburon Center for Environmental Studies, San Francisco State University	X	X
Roger Lockwara	Tosco Refining Co.	X	
James Cleary	Tosco Refining Co.		X
Leo Cronin	Trout Unlimited	X	X
Ken Guziak	UNOCAL, San Francisco Refinery	X	X
John Beuttler	United Anglers of America	X	
John Beuttler	United Anglers		X
Richard Peterson	United Surf Riders	X	X
	Western Pacific Dredging Company	X	X
Local Agencies			
Sally Germain	ABAG Clearinghouse	X	X
Steven Szalay	Alameda County	X	X
Darwin Helmuth	Alameda County Public Works Department		X
	Association of Bay Area Governments	X	X
	Board of Port Commissioners, Oakland	X	X
	City and County of San Francisco	X	X
Lois Parr	City of Oakland		X
	City of Redwood City	X	X
	City of Richmond	X	X
William Silva	City of San Leandro		X
Bill Silva	City of San Leandro		X
Sharon Rogers	City of San Francisco		X
	Contra Costa County	X	X
Samuel Herzberg	County of San Mateo, Mail Drop 55		X
Susan Holland	Golden Gate Bridge District		X
	Marin County	X	X
Mark Roddin	Metropolitan Transportation Comm.		X
	Napa County	X	X
Lois Parr	Oakland Office of Economic Development and Employment		X

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Table 5.5-1. Continued.

Name	Organization	DEIS	FEIS
James McGrath	Port of Oakland	X	X
Tom Gwyn	Port of Oakland		X
Charles Roberts	Port of Oakland	X	
Floyd Shelton	Port of Redwood City	X	X
M. Powers	Port of Richmond	X	X
Eugene Serex	Port of Richmond	X	X
Michael Huerta	Port of San Francisco	X	X
Veronica Sanchez	Port of San Francisco	X	X
	Port of Stockton	X	X
Alexander Krygsman	Port of Stockton	X	X
Larry Krebs	Port Sonoma-Marin		X
Dave Jones	San Francisco Department of Public Works		X
Gail Louis	San Francisco Estuary Project	X	
	San Mateo County	X	X
Donald Guluzzy	San Mateo County Harbor District		X
	Santa Clara County	X	X
Karen Wyeth	Solano County Planning Department		X
James Harberson	Sonoma County	X	X
Libraries			
	ABAG/MTC Library	X	X
	Alameda County Library	X	X
	Bancroft Library, University of California	X	X
	Berkeley Public Library	X	X
Karen Soloman	CSU Documents Department		X
	Daly City Public Library	X	X
	Environmental Information Center, San Jose State University	X	X
	Half Moon Bay Library	X	X
	Marin County Library, Civic Center	X	X
	North Bay Cooperative Library System	X	X
	Oakland Public Library	X	X

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Table 5.5-1. Continued.

Name	Organization	DEIS	FEIS
	Richmond Public Library	X	X
	San Francisco Public Library	X	X
	San Francisco State University Library	X	X
	San Mateo County Library	X	X
	Santa Clara County Free Library	X	X
	Sausalito Public Library	X	X
	Stanford University Library	X	X
Linda Vida-Sunnen	Water Resources Center Archives		X
U.S. Representatives			
Honorable Ronald Dellums	U.S. House of Representatives	X	X
Honorable Vic Fazio	U.S. House of Representatives	X	X
Honorable Wally Herger	U.S. House of Representatives	X	X
Honorable Tom Lantos	U.S. House of Representatives	X	X
Honorable George Miller	U.S. House of Representatives	X	X
Honorable Nancy Pelosi	U.S. House of Representatives	X	X
Honorable Fortney Stark	U.S. House of Representatives	X	X
H. Lee Halterman	Office of Congressman Ron Dellums		X
Honorable Norman Mineta	U.S. House of Representatives		X
U.S. Senators			
Honorable Barbara Boxer	U.S. Senate	X	X
Honorable Dianne Feinstein	U.S. Senate	X	X
State Agencies			
James Rote	Assembly Office of Research		X
	Bay Area Air Quality Management District	X	X
	California Coastal Commission	X	
James Raives	California Coastal Commission		X
Mark Delaplaine	California Coastal Commission	X	X
Peter Douglas	California Coastal Commission	X	X
Wes Ervinh	California Commerce Department	X	X
	California Department of Boating and Waterways	X	

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Table 5.5-1. Continued.

Name	Organization	DEIS	FEIS
William Ivers	California Department of Boating and Waterways		X
George Armstrong	California Department of Boating and Waterways	X	X
Carl Covitz	California Department of Business, Transportation and Housing		X
Robert Tasto	California Department of Fish and Game	X	X
John Turner	California Department of Fish and Game	X	
Jim Hardwicke	California Department of Fish and Game		X
Boyd Gibbons	California Department of Fish and Game		X
	California Department of Health Servics	X	X
Bill SooHoo	California Department of Toxic Substance Control		X
Julie Wright	California Department of Trade and Commerce		X
Bob Potter	California Department of Water Resources	X	X
Michael Kahoe	California Environmental Protection Agency	X	X
Mark de Bie	California Environmental Protection Agency		X
George Larsen	California Integrated Waste Management Board	X	X
Douglas Wheeler	California Resources Agency	X	X
	California State Air Resources Board	X	X
	California State Clearinghouse		X
	CALTRANS	X	X
John Geoghegan	Department of Business, Transportation, and Housing	X	
Walt Shannon	Division of Water Quality, SWRCB		X
Robert Tufts	Jackson, Tufts, Cole and Black		X
Rebecca Chew	LA Regional Water Quality Control Board		X
Michael Carlin	San Francisco Bay Regional Water Quality Control Board	X	X
Paul Jones	San Francisco Bay Regional Water Quality Control Board	X	
Marion Otsea	San Francisco Bay Regional Water Quality Control Board	X	X
Steven Ritchie	San Francisco Bay Regional Water Quality Control Board	X	X
Jeptha Wade	San Francisco Bay Regional Water Quality Control Board	X	X

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Table 5.5-1. Continued.

Name	Organization	DEIS	FEIS
Steve Goldbeck	San Francisco BCDC	X	X
Alan Pendleton	San Francisco BCDC	X	X
Linda Martinez	State Lands Commission	X	X
Charles Warren	State Lands Commission	X	X
Fred La Caro	State Water Resources Control Board	X	
Walt Pettit	State Water Resources Control Board		X
California Representatives			
Honorable Tom Bates	California State Assembly	X	X
Honorable Willie Brown, Jr.	California State Assembly	X	X
Honorable John Burton	California State Assembly	X	X
Honorable Robert Campbell	California State Assembly	X	X
Honorable Barbara Lee	California State Assembly	X	X
Honorable Ted Lempert	California State Assembly	X	X
Honorable Jackie Speier	California State Assembly	X	X
James Alford	State of California Assembly, Speaker's Office	X	X
California Senate			
Honorable Barry Keene	California State Senate	X	X
Honorable Quentin Kopp	California State Senate	X	X
Honorable Milton Marks	California State Senate	X	X
Honorable Rebecca Morgan	California State Senate	X	X
Honorable Nicholas Petris	California State Senate	X	

Table 5.5-2. Locations Where the FEIS Can Be Reviewed or Requested.

Copies of this DEIS may be reviewed at the following locations:	
ABAG/MTC Library 101 - 8th Street Oakland, CA 94607	Oakland Public Library 125 - 14th Street Oakland, CA 94612
Alameda County Library 3121 Diablo Avenue Hayward, CA 94545	Richmond Public Library 325 Civic Center Plaza Richmond, CA 94804
Bancroft Library University of California Berkeley, CA 94720	San Francisco Public Library Civic Center, Larkin and McAllister San Francisco, CA 94102
Berkeley Public Library 2090 Kittredge Street Berkeley, CA 94704	San Francisco State University Library 1630 Holloway Avenue San Francisco, CA 94132
Daly City Public Library 40 Wembley Drive Daly City, CA 94015	San Mateo County Library 25 Tower Road San Mateo, CA 94402
Environmental Information Center, San Jose State University 125 South 7th Street San Jose, CA 95112	Santa Clara County Free Library 1095 N. 7th Street San Jose, CA 95112
Half Moon Bay Library 620 Correas Half Moon Bay, CA 94019	Sausalito Public Library 420 Litho Street Sausalito, CA 94965
North Bay Cooperative Library System 725 Third Street Santa Rosa, CA 95404	Stanford University Library Stanford, CA 94035
Marin County Library, Civic Center 3501 Civic Center Drive San Rafael, CA 94903	
Copies of this FEIS may be requested by writing to the following address: U.S. Environmental Protection Agency Region IX Wetlands, Oceans and Estuaries Branch (W-7) ATTN: Allan Ota 75 Hawthorne Street San Francisco, CA 94105	

AK0172.W51

Table 5.5-3. Individuals and Organizations That Provided Comments During the DEIS Formal Review Period.

Organizations are listed alphabetically.

Individual	Organization
James D. Boyd	Air Resources Board, State of California
Walter A. Abernathy	Bay Dredging Action Coalition
Ellen Johnck	Bay Planning Commission
Peter M. Douglas	California Coastal Commission
James M. Strock	California Environmental Protection Agency
Martin M. Seldon	The California Fisheries Restoration Foundation
Martha Vazquez	California Integrated Waste Management Board
Barbara Miller	Center for Marine Conservation
Owen A. Marron	Central Labor Council of Alameda County
Barbara W. Sahm	City and County of San Francisco Department of City Planning
Ronald V. Dellums	Congress of the United States, House of Representatives
Samuel Herzberg	County of San Mateo
Max R. Blodgett	Department of the Army, San Francisco District, Corps of Engineers
Robert N. Tasto	Department of Fish and Game, State of California
John H. Kennedy	Department of the Navy, Western Division
James W. Van Loben Sels	Department of Transportation, State of California
Lindsay Rehm	The Environmental Forum of Marin
Arthur Feinstein	Golden Gate Audubon Society
Edward Ueber	Gulf of the Farallones National Marine Sanctuary
Cynthia L. Koehler	Heller Ehrman White and McAuliffe
Tom Jow	independent
Fran Packard	League of Women Voters of the Bay Area
James D. Levine	Levine-Fricke
Barbara Salzman	Marin Audubon Society
Peigin Barrett	Marine Mammal Center
Lawrence D. Six	Pacific Fishery Management Council

BF0035.W51

Individual	Organization
Daniel Evans	Point Reyes Bird Observatory
James McGrath	Port of Oakland
Michael P. Huerta	Port of San Francisco
Alan R. Pendleton	San Francisco Bay Conservation and Development Commission
James P. Royce	Sierra Club, San Francisco Bay Chapter
Dwight E. Sanders	State Lands Commission
Mark A. Massara	Surfrider Foundation
Julie Meier Wright	Trade and Commerce Agency, State of California

BF0035.W51

EXHIBIT 1

the Commission on its own motion believes that a formal hearing is required, further notice of such hearing will be duly given.

Under the procedure herein provided for, unless otherwise advised, it will be unnecessary for the applicant to appear or be represented at the hearing.

G. Any person or the Commission's staff may, within 45 days after the issuance of the instant notice by the Commission, file pursuant to Rule 214 of the Commission's Procedural Rules (18 CFR 385.214) a motion to intervene or notice of intervention and pursuant to § 157.205 of the Regulations under the Natural Gas Act (18 CFR 157.205) a protest to the request. If no protest is filed within the time allowed therefor, the proposed activity shall be deemed to be authorized effective the day after the time allowed for filing a protest. If a protest is filed and not withdrawn within 30 days after the time allowed for filing a protest, the instant request shall be treated as an application for authorization pursuant to section 7 of the Natural Gas Act.

Lois D. Cashell,

Secretary.

[FR Doc. 89-7648 Filed 3-30-89; 8:45 am]

BILLING CODE 6717-01-M

ENVIRONMENTAL PROTECTION AGENCY

[ER-FRL-3547-4]

Environmental Impact Statements and Regulations; Availability of EPA Comments

Availability of EPA comments prepared March 13, 1989 through March 17, 1989 pursuant to the Environmental Review Process (ERP), under section 309 of the Clean Air Act and section 102(2)(c) of the National Environmental Policy Act as amended. Requests for copies of EPA comments can be directed to the Office of Federal Activities at (202) 382-5076.

An explanation of the ratings assigned to draft environmental impact statements (EISs) was published in FR dated April 22, 1988 (53 FR 13318).

Draft EISs

ERP No. D-COE-E30034-NC, Rating EC2, West Onslow Beach and New River Inlet Beach (Topsail Beach), Erosion Control and Hurricane Wave Protection Plan, Implementation, Pender and Onslow Counties, NC.

Summary: EPA has some environmental concerns about certain secondary/induced consequences of the proposal and would like to see these matters clarified in the final EIS.

ERP No. D-COE-H35018-KS, Rating EC2, Kansas River Commercial Dredging Project, Junction City to Kansas-Missouri State Line, Section 10 Permits, Douglas, Geary, Jefferson, Johnson, Leavenworth, Pottawatomie, Riley, Shawnee, Wabawnsee and Wyandotte Counties, KS.

Summary: EPA supports the Army Corps of Engineers recommendation that the restricted dredging alternative is the preferred option to control commerical dredging on the Kansas River. However, EPA emphasized that the EC-2 rating is based on (1) adherence to the restricted dredging alternative as stated; (2) expeditious implementation of the Monitoring Program; and (3) a phase-in period of restrictions within three years or less. EPA also requested that the COE clarify and discuss the impacts of dredging on the aquatic ecosystem (fishery/benthos) in the upper versus lower reaches of the Kansas River.

ERP No. DS-FHW-E40129-TN, Rating EC1, I-40/I-275 (formerly I-75) Interchange Connector Reconstruction to Henley Street and the Western Avenue Viaduct Replacement, Funding and 404 Permit, Knoxville, Knox County, TN.

Summary: EPA expressed environmental concerns over possible noise impacts of the project. Water quality impacts due to the potential for increased urban runoff and mitigation measures should be discussed. Further documentation is necessary to support the need for a portion of the project. Compliance with NEPA is questioned due to the fact that some project construction continued prior to completion of the EIS process.

Final EISs

ERP No. F-AFS-L65111-WA, Colville National Forest, Land and Resource Managment Plan, Implementation, Perry, Pend Oreille and Stevens Counties, WA.

Summary: EPA's concerns of the draft EIS was repsonded to in this document. EPA's remaining main concern is that the forest-wide water quality and fish resource monitoring plan needs to be further developed specific to the issues on the Colville National Forest.

ERP No. F-BLM-J01070-CO, Northwest Colorado Coal Preference Right Lease Applications, Chapman-Riebold (C-0125366) and Jensen-Miller (C-4275), Leasing, Rio Blanco County, CO.

Summary: EPA agreed with the Preferred Alternative in that it could be implemented without significant impact to the environment.

ERP No. F-BLM-L67020-AK, Forty mile River Watershed, Multiple Placer Mining Management Plan, Approval, Implementation and 404 Permit, Upper Yukon-Canada Subregion, AK.

Summary: EPA requested that site-specific criteria be developed to assist in determining what additional reclamation requirements will be required. EPA also has concerns regarding the limited water quality data incorporated into the final EIS and associated predictive uncertainties pertaining to cumulative effects.

ERP No. F-FHW-E40698-GA, Georgia Project F-111-1 (16) Spur Construction, Abercorn Street/GA-204 to GA-21/I-516/Lynes Parkway, 404 Permit, USGC Permit and Funding, Chatham County, GA.

Summary: EPA expressed concern about impacts to protected wildlife species, water quality, and potential increased noise levels. EPA has requested the development of measures to protect the aquatic environment, and agency coordination to mitigate wetland loss.

ERP No. F-UPS-C81011 NY, Manhattan General Mail Facility Complex Development, Implementation, New York City, New York County, NY.

Summary: EPA believes that implementation of the project as proposed will cause a violation of the National Ambient Air Quality Standards for carbon monoxide. Accordingly, EPA has recommended that the design of the proposed project be altered to provide appropriate mitigation for the air quality impacts, and that documentation of the redesign be forwarded to EPA for review prior to the issuance of the record of decision.

Dated: March 28, 1989.

William D. Dickerson,

Deputy Director, Office of Federal Activities.

[FR Doc. 89-7741 Filed 3-30-89; 8:45 am]

BILLING CODE 6560-50-M

[ER-FRL-3549-3]

Designation of an Ocean Dredged Material Disposal Site (ODMDS) off San Francisco, CA; Intention To Prepare an Environmental Impact Statement

AGENCY: U.S. Environmental Protection Agency (EPA), Region 9.

ACTION: Notice of Intent to prepare an Environmental Impact Statement (EIS) on the designation of an ODMDS off San Francisco, California.

Purpose: The U.S. EPA, Region 9, in accordance with section 102(2)(c) of the National Environmental Policy Act

(NEPA) and in cooperation with the San Francisco District of the U.S. Army Corps of Engineers, will prepare a Draft EIS (DEIS) on the designation of an ODMDS for dredged material off San Francisco, California. An EIS is needed to provide the information necessary to designate a suitable site. This Notice of Intent is issued pursuant to Section 102 of the Marine Protection, Research and Sanctuaries Act (MPRSA) of 1972, and 40 CFR Part 228 (Criteria for the Management of Disposal Sites for Ocean Dumping).

For Further Information and to be Placed on the Mailing List Contact: Patrick Cotter, Oceans and Estuaries Section (W-7-1), U.S. Environmental Protection Agency, Region 9, 215 Fremont Street, San Francisco, California 94105, telephone number (415) 974-0257, or FTS 454-0257.

SUMMARY: Designation of the San Francisco ODMDS is needed to provide a suitable disposal site for dredged material removed from San Francisco Bay and other locations in the vicinity. Disposal of dredged material at any ODMDS is not permitted unless EPA and the Corps determine that the material is acceptable for disposal under EPA's Ocean Dumping criteria at 40 CFR 225 and 40 CFR 227. The Corps issues permits under Section 103 of MPRSA subject to EPA review.

EPA and the Corps are evaluating several geographical areas for suitable disposal sites. These geographical areas include continental shelf to a depth of 100 fathoms (fm), the shelf break from 100-300 fm, the continental slope 300-500 fm, the deep slope area 500-1,000 fm, Pioneer Canyon 300-1,000 fm, and areas deeper than 1,000 fm.

The Corps will complete all environmental and economic studies related to the San Francisco site in support of EIS preparation. EPA is responsible for reviewing the information used in preparation of the DEIS and publishing the document. The Corps will assist EPA in responding to any comments received on the DEIS and subsequent site designation work.

Need for Action: The Corps of Engineers, San Francisco District has requested that EPA designate an ODMDS offshore of San Francisco, California. An EIS is required to provide the necessary information to evaluate disposal alternatives and to designate the preferred ODMDS. If the proposed dredged material from San Francisco Bay and other locations in the vicinity meets the criteria for ocean disposal at 40 CFR Parts 225 and 227 then the material may be disposed at the designated site.

Alternatives: The EIS will characterize environmental parameters, assess environmental impacts and evaluate a reasonable range of alternatives to determine whether designation of an ocean disposal site is acceptable. The alternatives include: (1) No Action, (2) Existing In-Bay Disposal Sites, (3) New In-Bay Disposal Sites, (4) Upland Disposal, (5) Historical Ocean Dumping Sites, and (6) Ocean Disposal at any of the geographical areas described above.

Scoping: Preliminary scoping meetings were held on January 18, 1989 and March 1, 1989 to develop thise NOI. Two scoping meetings for the general public are scheduled on April 11, 1989, from 1:00 to 4:00 p.m., and from 7:00 to 10:00 p.m. The meetings will be held at the Bay Motel, 2100 Bridgeway, Sausalito, California, 94965. Written comments on this Notice of Intent should be sent to the contact person listed above no later than 45 days after the date of publication.

Estimated Date of Release: The DEIS will be made available in March 1991.

Responsible Official:

Daniel W. McGovern,

Regional Administrator, Region 9.

Date: March 28, 1989.

Richard E. Sanderson,

Director, Office of Federal Activities.

[FR Doc. 89-7742 Filed 3-30-89; 8:45 am]

BILLING CODE 6560-50-M

[ER-FRL 3543-1]

Intention To Prepare a Draft Environmental Impact Statement (EIS); City of San Diego Wastewater Treatment Facilities, California

AGENCY: U.S. Environmental Protection Agency (EPA) Region IX.

ACTION: Preparation of a Draft Environmental Impact Statement on the conversion of San Diego's wastewater treatment facilities from advanced primary treatment to secondary treatment and water reclamation.

Purpose: In accordance with section 511(c) of the Clean Water Act (CWA) and section 102(2)(c) of the National Environmental Policy Act (NEPA), EPA has identified a need to prepare an EIS and therefore issues this Amended Notice of Intent.

For Further Information and to be Placed on the Project Mailing List Contact: Mr. Enio Sebastiani, Construction Grants Branch, U.S. EPA, (W-2-2), 215 Fremont St., San Francisco, CA 94105, Telephone: (Commercial) 415-974-8316 or (FTS) 454-8316.

SUMMARY: The City of San Diego has initiated a new program, the Clean Water Program for Greater San Diego, with a goal of attaining full compliance with the CWA and NEPA. The program is currently in the facilities planning stage. The resulting plan will recommend both secondary treatment and water reclamation facilities of sufficient size to serve the San Diego metropolitan area through the middle of the twenty-first century. Facilities covered by the plan will include an upgrade of the City's Point Loma wastewater treatment plant, one or two other secondary treatment plants, a number of water reclamation plants, sludge handling and disposal facilities, and associated pump stations and pipelines.

Need for Action: On September 30, 1986, EPA announced its decision to tentatively deny the City of San Diego's 1979 and 1983 applications for a waiver under Section 301(h) of the CWA. On November 3, 1986, the City Council authorized the City Manager to send EPA a letter of intent to file a revised waiver application. On February 17, 1987, the City Council decided to discontinue waiver efforts and to pursue secondary treatment.

Alternatives: Six alternatives plus the No Project alternative are presently under consideration for providing secondary treatment in the San Diego area. The alternatives involve variations in the size and extent of treatment facilities in the North City area, at the existing Point Loma treatment site, at locations near Lindbergh Field, and at sites along the U.S./ Mexico border. Alternative sites are also being considered for a number of reclamation plants throughout the San Diego metropolitan area.

Scoping: The City of San Diego has held initial public scoping meetings and continues to seek public input that will be used to analyze the alternatives. The next scoping meeting will be held on Wednesday, April 26, 1989 at 7:30 p.m. at the Ramada Hotel, Grand Ballroom, Eighth Floor, 660 K" Street, San Diego, CA.

Estimated Date of Draft EIS Release: June 15, 1990.

Responsible Official: Daniel W. McGovern, Regional Administrator.

Dated: March 28, 1989.

Richard E. Sanderson,

Director, Office of Federal Activities.

[FR Doc. 89-7743 Filed 3-30-89; 8:45 am]

BILLING CODE 6560-50-M

EXHIBIT 2

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION IX
75 Hawthorne Street
San Francisco, Ca. 94105-3901

22 JUL 1992

Mr. William Lehman
Endangered Species Coordinator
U.S. Fish and Wildlife Service
2800 Cottage Way, Room E-1823
Sacramento, CA 95825

Dear Mr. Lehman:

The Environmental Protection Agency Region IX (EPA) is preparing an Environmental Impact Statement (EIS) for the designation of an ocean dredged material disposal site off San Francisco, California. The site will be selected as part of the Long-Term Management Strategy (LTMS) for San Francisco Bay and will have the capacity to accomodate an estimated 400 million cubic yards of dredged material over a 50-year period. The proposed action will involve only the designation of the site itself; before disposal is permitted, dredged material must be evaluated in accordance with the Marine Protection, Research and Sanctuaries Act of 1972 and its implementing regulations and guidance.

EPA began the site designation process by evaluating four study areas on the Farallon Shelf and Slope at distances of 20 to 55 miles offshore and at depths of 300 to 6000 feet. The four study areas are delineated on the enclosed map (areas 2-5) and coordinate list. With the recent designation of the Monterey Bay National Marine Sanctuary Study Areas 2 and the eastern third of Study Area 3 are no longer being considered as potential sites. However, since data have been collected for all four study areas, a characterization of each area is being developed. In the draft EIS, which is scheduled for release in November 1992, EPA will identify candidate sites within Study Areas 3, 4 and 5 and will choose a preferred alternative site.

In accordance with Section 7(c) of the Endangered Species Act, please advise EPA of the presence of any listed, or candidate, threatened or endangered species in the vicinity of the four study areas identified above. In addition, please advise EPA of any critical habitat for these species which may be impacted by the proposed action. Similar requests have been forwarded to the National Marine Fisheries Service and the California Department of Fish and Game. EPA would appreciate your response prior to October 1, 1992. Please direct any questions or requests for further information to Shelley Clarke at (415) 744-1162.

Sincerely,

Janet Y. Hashimoto

Janet Y. Hashimoto, Chief
Marine Protection Section

Enclosures (2)

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EXHIBIT 3

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION IX
75 Hawthorne Street
San Francisco, Ca. 94105-3901

22 JUL 1992

Mr. James Bybee
Environmental Coordinator, Northern Area
National Marine Fisheries Service
777 Sonoma Avenue, Room 325
Santa Rosa, CA 95404

Dear Mr. Bybee:

The Environmental Protection Agency Region IX (EPA) is preparing an Environmental Impact Statement (EIS) for the designation of an ocean dredged material disposal site off San Francisco, California. The site will be selected as part of the Long-Term Management Strategy (LTMS) for San Francisco Bay and will have the capacity to accomodate an estimated 400 million cubic yards of dredged material over a 50-year period. The proposed action will involve only the designation of the site itself; before disposal is permitted, dredged material must be evaluated in accordance with the Marine Protection, Research and Sanctuaries Act of 1972 and its implementing regulations and guidance.

EPA began the site designation process by evaluating four study areas on the Farallon Shelf and Slope at distances of 20 to 55 miles offshore and at depths of 300 to 6000 feet. The four study areas are delineated on the enclosed map (areas 2-5) and coordinate list. With the recent designation of the Monterey Bay National Marine Sanctuary Study Areas 2 and the eastern third of Study Area 3 are no longer being considered as potential sites. However, since data have been collected for all four study areas, a characterization of each area is being developed. In the draft EIS, which is scheduled for release in November 1992, EPA will identify candidate sites within Study Areas 3, 4 and 5 and will choose a preferred alternative site.

In accordance with Section 7(c) of the Endangered Species Act, please advise EPA of the presence of any listed, or candidate, threatened or endangered species in the vicinity of the four study areas identified above. In addition, please advise EPA of any critical habitat for these species which may be impacted by the proposed action. Similar requests have been forwarded to the U.S. Fish and Wildlife Service and the California Department of Fish and Game. EPA would appreciate your response prior to October 1, 1992. Please direct any questions or requests for further information to Shelley Clarke at (415) 744-1162.

Sincerely,

Janet Y. Hashimoto

Janet Y. Hashimoto, Chief
Marine Protection Section

Enclosures (2)

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EXHIBIT 4

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION IX
75 Hawthorne Street
San Francisco, Ca. 94105-3901

22 JUL 1992

Mr. John Turner, Acting Chief
Environmental Services Division
California Department of Fish and Game
1416 Ninth Street
Sacramento, CA 95814

Dear Mr. Turner:

The Environmental Protection Agency Region IX (EPA) is preparing an Environmental Impact Statement (EIS) for the designation of an ocean dredged material disposal site off San Francisco, California. The site will be selected as part of the Long-Term Management Strategy (LTMS) for San Francisco Bay and will have the capacity to accomodate an estimated 400 million cubic yards of dredged material over a 50-year period. The proposed action will involve only the designation of the site itself; before disposal is permitted, dredged material must be evaluated in accordance with the Marine Protection, Research and Sanctuaries Act of 1972 and its implementing regulations and guidance.

EPA began the site designation process by evaluating four study areas on the Farallon Shelf and Slope at distances of 20 to 55 miles offshore and at depths of 300 to 6000 feet. The four study areas are delineated on the enclosed map (areas 2-5) and coordinate list. With the recent designation of the Monterey Bay National Marine Sanctuary Study Areas 2 and the eastern third of Study Area 3 are no longer being considered as potential sites. However, since data have been collected for all four study areas, a characterization of each area is being developed. In the draft EIS, which is scheduled for release in November 1992, EPA will identify candidate sites within Study Areas 3, 4 and 5 and will choose a preferred alternative site.

EPA is requesting an endangered species consultation pursuant to the State Endangered Species Act. Therefore, please advise EPA of the presence of any listed, or candidate, threatened or endangered species, or species of special concern, in the vicinity of the four study areas identified above. In addition, please advise EPA of any critical habitat for these species which may be impacted by the proposed action. EPA will use this information in the preparation of the Draft Environmental Impact Statement and will forward this information to the California Coastal Commission as part of the site

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designation coastal consistency package we will prepare. Similar Federal consultations have been initiated with the U.S. Fish and Wildlife Service and the National Marine Fisheries Service. EPA would appreciate your response prior to October 1, 1992. Please direct any questions or requests for further information to Shelley Clarke at (415) 744-1162.

Sincerely,

Janet Y. Hashimoto

Janet Y. Hashimoto, Chief
Marine Protection Section

Enclosures (2)

United States Department of the Interior

TAKE PRIDE IN AMERICA

FISH AND WILDLIFE SERVICE
Fish and Wildlife Enhancement
Sacramento Field Office
2800 Cottage Way, Room E-1803
Sacramento, California 95825-1846

In Reply Refer To:
1-1-92-SP-1217

August 20, 1992

8/24/92

Ms. Janet Y. Hashimoto
Chief, Marine Protection Section
U.S. Environmental Protection Agency
Region IX
75 Hawthorne Street
San Francisco, California 94105-3901

Subject: Species List for the Proposed Ocean Dredged Material Disposal Site Off the Coast of San Francisco, California

Dear Ms. Hashimoto:

As requested by letter from your agency, you will find enclosed a list of the listed endangered and threatened species that may be present in the subject project area (See Enclosure A). To the best of our knowledge, no proposed species occur within the area. This list fulfills the requirement of the Fish and Wildlife Service to provide a species list pursuant to Section 7(c) of the Endangered Species Act, as amended (Act).

Some pertinent information concerning the distribution, life history, habitat requirements, and published references for the listed species is also enclosed. This information may be helpful in preparing the biological assessment for this project, if one is required. Please see Enclosure B for a discussion of the responsibilities of Federal agencies under Section 7(c) of the Act and the conditions under which a biological assessment must be prepared by the lead Federal agency or its designated non-Federal representative.

Formal consultation, pursuant to 50 CFR § 402.14, should be initiated if you determine that a listed species may be affected by the proposed project. Informal consultation may be utilized prior to a written request for formal consultation to exchange information and resolve conflicts with respect to listed species. If a biological assessment is required, and it is not initiated within 90 days of your receipt of this letter, you should informally verify the accuracy of this list with our office.

Please contact the Section 7 Coordinator of this office at (916) 978-4866 if you have any questions regarding the enclosed list or your responsibilities under the Act.

Sincerely,

for Wayne S. White
Field Supervisor

Enclosures

ENCLOSURE A

LISTED AND PROPOSED ENDANGERED AND THREATENED SPECIES AND CANDIDATE SPECIES THAT MAY OCCUR IN THE AREA OF THE PROPOSED OCEAN DREDGED MATERIAL DISPOSAL SITE OFF SAN FRANCISCO, CALIFORNIA (1-1-92-SP-1217, AUGUST 20, 1992)

Listed Species

Birds
California brown pelican, *Pelecanus occidentalis californicus* (E)

Proposed Species

None

Candidate Species

None

(E)--Endangered (T)--Threatened (P)--Proposed (CH)--Critical Habitat
(1)--Category 1: Taxa for which the Fish and Wildlife Service has sufficient biological information to support a proposal to list as endangered or threatened.
(2)--Category 2: Taxa for which existing information indicated may warrant listing, but for which substantial biological information to support a proposed rule is lacking.
(1R)-Recommended for Category 1 status.
(2R)-Recommended for Category 2 status.
(•)--Listing petitioned.
(*)--Possibly extinct.

ENCLOSURE B

FEDERAL AGENCIES' RESPONSIBILITIES UNDER
SECTIONS 7(a) and (c) OF THE ENDANGERED SPECIES ACT

SECTION 7(a) Consultation/Conference

Requires: 1) Federal agencies to utilize their authorities to carry out programs to conserve endangered and threatened species; 2) Consultation with FWS when a Federal action may affect a listed endangered or threatened species to insure that any action authorized, funded or carried out by a Federal agency is not likely to jeopardize the continued existence of listed species or result in the destruction or adverse modification of critical habitat. The process is initiated by the Federal agency after determining the action may affect a listed species; and 3) Conference with FWS when a Federal action is likely to jeopardize the continued existence of a proposed species or result in destruction or adverse modification of proposed critical habitat.

SECTION 7(c) Biological Assessment--Major Construction Activity[1]

Requires Federal agencies or their designees to prepare a Biological Assessment (BA) for major construction activities. The BA analyzes the effects of the action[2] on listed and proposed species. The process begins with a Federal agency requesting from FWS a list of proposed and listed threatened and endangered species. The BA should be completed within 180 days after its initiation (or within such a time period as is mutually agreeable). If the BA is not initiated within 90 days of receipt of the list, the accuracy of the species list should be informally verified with our Service. No irreversible commitment of resources is to be made during the BA process which would foreclose reasonable and prudent alternatives to protect endangered species. Planning, design, and administrative actions may proceed; however, no construction may begin.

We recommend the following for inclusion in the BA: an on-site inspection of the area affected by the proposal which may include a detailed survey of the area to determine if the species or suitable habitat are present; a review of literature and scientific data to determine species' distribution, habitat needs, and other biological requirements; interviews with experts, including those within FWS, State conservation departments, universities and others who may have data not yet published in scientific literature; an analysis of the effects of the proposal on the species in terms of individuals and populations, including consideration of indirect effects of the proposal on the species and its habitat; an analysis of alternative actions considered. The BA should document the results, including a discussion of study methods used, any problems encountered, and other relevant information. The BA should conclude whether or not a listed or proposed species will be affected. Upon completion, the BA should be forwarded to our office.

---

[1] A construction project (or other undertaking having similar physical impacts) which is a major Federal action significantly affecting the quality of the human environment as referred to in NEPA (42 U.S.C. 4332(2)C).

[2] "Effects of the action" refers to the direct and indirect effects on an action on the species or critical habitat, together with the effects of other activities that are interrelated or interdependent with that action.

CALIFORNIA BROWN PELICAN

(Pelicanus occidentalis californicus)

CLASSIFICATION: Endangered - **Federal Register** 35:16047.

CRITICAL HABITAT: None designated.

DESCRIPTION:

The California brown pelican is a large bird weighing about 9 pounds, with a wingspan of over 6 feet. Adults have long dark bills, about 1.5 feet long, with an elastic gular pouch for catching and holding fish, which turns bright red during the breeding season. Coloration is generally brownish, with white patterning on the head and neck.

DISTRIBUTION:

One of six recognized subspecies, nesting distribution is restricted to islands in the Gulf of California, and along the outer coast from Baja California to the Southern California Bight. In the U.S., nesting rookeries are located on Anacapa Island and Santa Barbara Island. During the non-breeding season, the California brown pelican ranges northward along the Pacific coast from the Gulf of California to Washington and southern British Columbia.

SPECIAL CONSIDERATION:

The California brown pelican also is listed as endangered by the State of California, and therefore, is protected by State law. The entire species was listed, except breeding populations along the U.S. Atlantic coast, Florida, and Alabama, because of widespread pollutant-related reproductive failures during the late 1960's and early 1970's. Although breeding populations have rebounded since the elimination of DDT use, persistent residues in the coastal environment continue to cause chronic reproductive problems.

REFERENCES FOR ADDITIONAL INFORMATION:

U.S. Fish and Wildlife Service. 1983. The California brown pelican recovery plan. Portland, OR. Prepared under contract with Frank Gress and Dan Anderson.

Anderson, D. and F. Gress. 1983. Status in a northern population of California brown pelicans. Condor 85:79-88.

Anderson, D. F. Gress and K. Mais. 1982. Brown pelicans: influence of food supply on reproduction. Oikos 39:23-31.

Anderson, D., J. Jehl, R. Risebrough, L. Woods, L. Deweese, and W. Edgecomb. 1975. Brown pelicans: improved reproduction off the southern California coast. Science 190:806-808.

UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL MARINE FISHERIES SERVICE

EXHIBIT 6

Southwest Region
501 West Ocean Blvd., Suite 4200
Long Beach, CA 90802-4213
(310) 980-4001, FAX 980-4018

OCT 19 1992 F/SW031:TDW

Ms. Janet Y. Hashimoto
Marine Protection Section (W-7-1)
Environmental Protection Agency
Region IX
75 Hawthorne Street
San Francisco, California 94105-3901

Dear Ms. Hashimoto:

This letter responds to your request for information regarding the presence of any endangered, threatened, or candidate species within the four study areas that are being evaluated in the Environmental Protection Agency's (EPA) Long Term Management Strategy (LTMS) Environmental Impact Statement (EIS) for the designation of an ocean dredged material disposal site off San Francisco, California. Numerous marine mammal species occur within the LTMS study areas that are both listed under the Federal Endangered Species Act (ESA) and under the management authority of the National Marine Fisheries Service. These species include: (1) the endangered blue, fin, gray, humpback, right, sei, and sperm whales, and (2) the threatened northern (Steller) sea lion. Critical habitat has not been designated for any of these species.

If you have questions concerning these comments, please contact Ms. Diane Windham at (707) 578-7513.

Sincerely,

Gary Matlock

Gary Matlock, Ph.D.
Acting Regional Director

cc: Gulf of the Farallones NMS
USFWS, Sacramento
CDFG, Yountville
Corps of Engineers, San Francisco District
Diane Windham, NMFS, Santa Rosa

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EXHIBIT 7

STATE OF CALIFORNIA—THE RESOURCES AGENCY

PETE WILSON, Governor

DEPARTMENT OF FISH AND GAME
1416 NINTH STREET
P.O. BOX 944209
SACRAMENTO, CA 94244-2090
(916) 653-4875

September 25, 1992

Ms. Janet Y. Hashimoto, Chief
Marine Protection Section
U.S. Environmental Protection Agency
75 Hawthorne Street
San Francisco, California 94195-3901

Dear Ms. Hashimoto:

I wish to respond to your letter requesting endangered species consultation pursuant to the California Endangered Species Act (CESA) for the proposed ocean dredged material disposal site off San Francisco, California. The U.S. Environmental Protection Agency (EPA) in preparing an Environmental Impact Statement (EIS) for this project should consider the potential impacts to both State- and federally-listed species, candidate species, and species of special concern, that may occur in the vicinity of the four study areas. The Department has prepared a list of species that we believe may be found in the vicinity of the project (attached).

The CESA does not require Federal agencies to formally consult with the Department, however, at your request we will prepare an informal CESA Biological Opinion for this project similar to the formal opinion discussed below. In order for the Department to prepare an informal biological opinion, EPA must first evaluate potential impacts to listed species and develop avoidance and or mitigation measures in a biological assessment, and forward that assessment to the Department. See the attached list of information needed to complete a consultation (Appendix II to California Endangered Species Act Consultation Agency Responsibilities).

Since the EIS and other supporting information will be forwarded to the California Coastal Commission (CCC) as part of the site designation coastal consistency package, the CCC will be requested as the State lead agency to initiate formal CESA consultation with the Department. The results of the State consultation will be a formal CESA Biological Opinion including findings as to whether the proposed project would jeopardize the future existence of any State-listed species, or cause adverse modification of the habitat essential to its continued existence. The Department will also recommend reasonable and prudent alternative to prevent jeopardy, if necessary.

Ms. Janet Y. Hashimoto
September 25, 1992
Page Two

The CESA encourages the Department to enter into cooperative and simultaneous consultation with State agencies in order to develop a coordinated Federal biological opinion that reflects consistent and compatible findings between State and Federal agencies, and to adopt, whenever possible, the Federal opinion as the CESA written findings. To that end, the Department will attempt to work closely with the National Marine Fisheries Service to develop coordinated biological opinions that reflect consistent and compatible findings.

The Department looks forward to working closely and cooperatively with the EPA and the other State and Federal agencies involved in the review of the proposed ocean dredged material disposal site. If you or your staff have further questions please feel free to contact Mr. Pete Phillips, Environmental Services Division, Department of Fish and Game, 1416 Ninth Street, Sacramento, California 95814, telephone (916) 653-9714.

Sincerely,

John L. Turner, Acting Chief
Environmental Services Division

Attachments

cc: Mr. Pete Phillips
Department of Fish and Game
Sacramento, California

California Coastal Commission
45 Fremont Street, Suite 2000
San Francisco, California 94105-2219

National Marine Fisheries Service
777 Sonoma Avenue, Suite 325
Santa Rosa, California 95404

California Endangered Species Act (CESA) Consultation Agency Responsibilities

The California Endangered Species Act (CESA) as amended in 1987 (California Fish and Game Code Sections 2050 - 2098) includes provisions intended to improve the protection afforded endangered and threatened species affected by development projects subject to the California Environmental Quality Act (CEQA).

CESA states that it is the policy of the state that state agencies should not approve projects as proposed which would jeopardize the continued existence of any endangered species or threatened species or result in the destruction or adverse modification of habitat essential to the continued existence of those species, if there are reasonable and prudent alternatives available consistent with conserving the species or its habitat which would prevent jeopardy. To accomplish this CESA introduces the concept of state lead agency consultation for endangered and threatened species. Section 2090(a) provides that "Each state lead agency shall consult with the [Fish and Game] department, in accordance with guidelines developed by the department, to ensure that any action authorized, funded, or carried out by that state lead agency is not likely to jeopardize the continued existence of any endangered or threatened species." This provision which has a sunset of January 1, 1994 is intended as a pilot program.

The Department of Fish and Game (Department), trustee agency for endangered and threatened species under CEQA, and other state agencies now have a more clearly defined mutual responsibility to avoid potential conflicts and resolve actual conflicts.

CESA mandates that the Department shall issue a written finding as to whether a proposed project would jeopardize any endangered or threatened species whenever it consults with a state lead agency during the CEQA review process.

Early (informal) consultation is encouraged by CESA in order to identify and resolve potential conflicts as early as possible. Formal consultation is required of state lead agencies at the EIR stage or functionally equivalent stage of a Certified Regulatory Program.

Before initiating consultation with the Department, the agency should evaluate the sufficiency of data regarding the project and its effects on any threatened or endangered species. It is the responsibility of the state lead agency to ensure that the Department is provided the information necessary to adequately evaluate whether the proposed project will jeopardize any state-designated threatened or endangered species. The information required is identified in Appendix II of the CESA Consultation Guidelines (attached).

A state agency initiates formal consultation by sending a written request to the Director. Informal consultation may be initiated by a written request to either the Director or the Regional Manager of the affected Region.

When received by the Director, Environmental Services Division (ESD) logs in the request and refers it to the affected Region f action. When the request is received by the Regional Manager (informal only), the Region will send a copy of the request to ESD.

Upon receipt of the request, the Department will provide a written response acknowledging the initiation of consultation and identifying any additional information (including studies) required.

Actual consultation typically occurs at the Regional level and includes conversations, meetings, site visits, etc., between the lead agency, project consultants, and project proponents. All relevant materials received or otherwise available and potential project impacts, alternatives, and mitigation measures will be reviewed by the Department in making its determination.

For projects in which there are federally-listed species and which include an action authorized, funded, or carried out by a federa agency, that agency must consult with the FWS and obtain their Biological Opinion. For species which are both state- and federally-listed; CESA directs that, whenever possible, the Department adopt the federal Biological Opinion as its written findings. If a project affects both a state- and federally-listed species and a state-(only) listed species, and the Department concurs with the federal Biological Opinion, the Department must still prepare a separate Biological Opinion for the state-listed species.

Based upon its determination the Department's written finding wi be one of the following:

1. The project as proposed is "not likely to jeopardize" any listed species.
2. The project as proposed is "not likely to jeopardize" any listed species provided the conditions stipulated in the Department's State Biological Opinion are fully implemented and adhered to.
3. When information available to the Department is insufficient to support a finding of "not likely to jeopardize," then the conservative finding that the project as proposed "may jeopardize" is required.
4. The project as proposed is "likely to jeopardize" one or more listed species.

The stated Biological Opinion and/or adopted federal Biological Opinion (where appropriate) along with a cover memo from the Director is sent to the consulting agency.

Consultation is concluded.

APPENDIX II

Information Required to Determine Whether A Proposed Project Could Jeopardize Endangered And Threatened Species

3000. The Department of Fish and Game needs detailed information in order to fully and accurately the effects of a proposed project on endangered and threatened species. Although there is no required format, the following data must be clearly presented:

3000.1. A full description of the project area and project impact area, including maps.

3000.2. Known and potential distribution of endangered and threatened species in the project area and project impact area, based on recent field surveys (See Appendix III for survey guidelines).

3000.3. Additional information on species distribution and habitat, based upon literature, and scientific data review, and discussions with experts.

3000.4. Analysis of possible effects of the proposed project on listed species, including cumulative effects.

3000.5. Analysis of alternatives designed to reduce or eliminate impacts to endangered and threatened species.

3010. To resolve potential conflicts as early as possible, state agencies are strongly encouraged to provide the above information to DFG during the Initial Study/Preliminary Review (or comparable) stage.

Post-It™ brand fax transmittal memo 7671	# of pages ▸ 1
To Shelly Clark	From Pete Phillips
Co. EPA	Co DFG
Dept.	Phone # (916) 653-9714
Fax # (415) 744-1072	Fax # (916) 652-2588

TO: Pete Phillips
FROM: Deborah Johnston
SUBJECT: Endangered Species which have been Documented in the Vicinity of the Proposed Dredge Disposal Locations

Here's the information on endangered species which could be affected by the proposed dredge disposal sites.

Species of Special Concern

1. *Oncorhynchus tshawytscha*, Spring-run Chinook Salmon -matures in Pacific Ocean
2. *Cerorhinca monocerata*, Rhinoceros Auklet -nests on Farallon Islands
3. *Fratercula cirrhata* Tufted Puffin -nests of Farallon Islands
4. *Oceanodroma furcata*, Fork-tailed Storm Petrel -possibly breeds on Farallon Islands, few found in breeding condition in 1992
5. *Oceanodroma homochroa*, Ashy Storm-Petrel -70-80% of world's breeding population occurs on the Farallon Islands
6. *Gavia immer*, Common Loon -several observed feeding in the vicinity of the Farallon Islands
7. *Phalacrocorax auritus*, Double-crested Cormorant -nests on the Farallon Islands
8. *Oncorhynchus gorbuscha*, Pink Salmon -matures in Pacific Ocean
9. *Oncorhynchus kisutch*, Coho Salmon -matures in Pacific Ocean

State Listed Species

1. *Brachyramphus marmoratus*, Marbled Murrelet -infrequent sightings around the Farallon Islands and along coast
2. *Oncorhynchus tshawytscha*, Winter-run Chinook Salmon -matures in Pacific Ocean
3. *Pelecanus occidentalis californicus*, California Brown Pelican -feeds along coast and feeds and roosts in large numbers (up to 1,500) at certain times of year in Farallon Islands
4. *Falco peregrinus anatum*, American Peregrine Falcon -does not breed on Farallon Islands but feeds on petrels which do nest on Farallon Islands (has been sited in Farallon Island vicinity)

Federal Listed Species (all described in vicinity of Farallon Islands in MMS document Sale 91)

1. *Chelonia mydas*, Green Sea Trutle -occasional visitor to disposal areas
2. *Caretta caretta*, Loggerhead Sea Trutle -occasional visitor to disposal areas
3. *Lepidochelys olivacea*, Ridley Sea Turtle -occasional visitor to disposal areas
4. *Dermochelys coriacea* Leatherback Sea Turtle -occasional visitor to disposal areas
5. *Eschrichtius robustus*, Gray Whale -migrates and feeds in offshore waters
6. *Balaenoptera borealis*, Sei Whale -migrates and feeds in offshore waters
7. *Balaenoptera musculus*, Blue Whale -migrates and feeds in offshore waters
8. *Balaenoptera physalus*, Fin Whale -migrates and feeds in offshore waters
9. *Megaptera novaengliae*, Humpback Whale -migrates and feeds in offshore waters
10. *Balaena glacialis*, Right Whale -migrates and feeds in offshore waters
11. *Physeter catodon*, Sperm Whale -migrates and feeds in offshore waters
12. *Eumetopias jubatus*, Steller Sea Lion -breeds on Farallon Islands

All whales have been sighted in the Farallon Islands vicinity.

EXHIBIT 8

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION IX
75 Hawthorne Street
San Francisco, CA 94105-3901

2 JUN 1993

Wayne S. White
Field Supervisor
Fish and Wildlife Service
United States Department of the Interior
2800 Cottage Way, Room E-1803
Sacramento, CA 95825-1846

RE: Endangered Species Act Coordination for Designation of an Ocean Dredged Material Disposal Site Offshore San Francisco

Dear Mr. White:

Thank you for your response to the Environmental Protection Agency Region IX's (EPA) letter which requested information concerning any listed, or candidate, threatened or endangered species in the vicinity of potential ocean dredged material disposal sites off San Francisco. EPA understands from your letter that the California brown pelican (*Pelecanus occidentalis californicus*) is the only species under your jurisdiction which requires special consideration under the Endangered Species Act. As mentioned in our previous letter, similar coordination has been initiated with the National Marine Fisheries Service and the California Department of Fish and Game for species under their jurisdiction.

EPA released the draft Environmental Impact Statement (DEIS) for site designation in December 1992. This document presented summaries of more than ten separate oceanographic studies conducted in support of the site designation effort. Based on these studies and other existing information, EPA chose alternative site 5, located approximately 50 nmi from the Golden Gate and 30 nmi from the Farallon Islands, as the preferred alternative site. This site is located in 2,500 to 3,000 meters of water and was chosen due to its location away from productive fishery areas and in an area that has been used historically for disposal of low-level radioactive waste and chemical and conventional munitions.

A section of the DEIS addressed the distribution, abundance and ecology of California brown pelicans (Section 3.3.4.1.) This discussion utilized breeding season (May-June) research by the Point Reyes Bird Observatory (PRBO) over a seven-year period and data collected by a team of EPA

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observers during five seasons in 1990-1991. The PRBO data confirmed the coastal distribution of this species, with populations concentrated nearshore, over water shallower than 180 meters. In the seven-year dataset, no individuals were sighted west of the Farallon Islands . The seasonal surveys also showed that abundances were greatest over the continental shelf and upper slope waters. In the seasonal surveys, California brown pelican were never sighted within Study Area 5 and on only one occasion were sighted in water depths similar to the proposed ocean disposal site.

In the DEIS, impacts from the proposed site designation action to threatened and endangered species are estimated to be Class III - insignificant to none. This estimation is based on modelled predictions that turbidity impacts will be confined to depths below which California brown pelican are likely to be feeding and will be diluted to ambient levels well before reaching national marine sanctuary boundaries or upper continental slope or shelf areas. In addition, EPA's ocean dumping criteria allow only dredged material that has been shown to cause no adverse effects to marine organisms to be ocean disposed. Therefore, even if a disposal plume is contacted, the expected impact from contaminants is minimal. Finally, EPA is currently designing a site management and monitoring plan which will include a component for biological monitoring of pelagic species including seabirds. This plan will be available for review and comment either as part of the final Environmental Impact Statement or as a separate document supporting the proposed site designation rule.

In summary, information presented in the DEIS indicates that there will be no effect on California brown pelican from designation and use of the proposed ocean disposal site. This species' predominant habitat is located well inshore of the proposed site, and the water quality impacts associated with site use are expected to be short-lived and insignificant. Further, EPA will monitor disposal activities to ensure protection of marine species. Due to these findings and commitments, EPA has determined that no further consultation concerning California brown pelican is required under the Endangered Species Act.

EPA will continue to involve the U.S. Fish and Wildlife Service in future site designation and monitoring activities through the Long-Term Management Strategy (LTMS) Ocean Studies Work Group. This group was convened in November 1990 and has provided input to EPA on the design and interpretation of the technical studies and on administrative decisions supporting the ocean site designation. The OSWG will continue to assist EPA with the development of the site management and monitoring plan and with periodic review of monitoring study results. EPA looks forward to U.S. Fish and Wildlife Service participation in this advisory forum as the project progresses.

EPA requests that the FWS concur or non-concur by letter with the above finding concerning the California brown pelican prior to July 1, 1993. This will allow EPA to publish the results of the coordination process in the FEIS. EPA appreciates your office's comments on our DEIS and your support for designation of the preferred alternative site. EPA will be pleased to furnish supporting technical reports for the DEIS or additional copies of the DEIS should your office require them. Please contact me at (415) 744-2125, or have your staff contact Janet Hashimoto at (415) 744-1156, with any questions or comments concerning EPA's site designation process.

Sincerely,

Alexis Strauss

for Harry Seraydarian, Director
Water Management Division

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UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION IX
75 Hawthorne Street
San Francisco, CA 94105-3901

2 JUN 1993

Dr. Gary Matlock
Acting Regional Director
Southwest Region
National Marine Fisheries Service
501 West Ocean Boulevard, Suite 4200
Long Beach, CA 90802-4213

RE: **Endangered Species Act Coordination for Designation of an Ocean Dredged Material Disposal Site Offshore San Francisco**

Dear Dr. Matlock:

Thank you for your response to the Environmental Protection Agency Region IX's (EPA) letter which requested information concerning any listed, or candidate, threatened or endangered species in the vicinity of potential ocean dredged material disposal sites off San Francisco. EPA understands from your letter that the endangered blue, fin, gray, humpback, right, sei and sperm whales, and the threatened northern (Steller) sea lion comprise the species under your management authority which require special consideration under the Endangered Species Act. As mentioned in our previous letter, similar coordination has been initiated with the U.S. Fish and Wildlife Service and the California Department of Fish and Game for species under their jurisdiction.

EPA released the draft Environmental Impact Statement (DEIS) for site designation in December 1992. This document presented summaries of more than ten separate oceanographic studies conducted in support of the site designation effort. Based on these studies and other existing information, EPA chose alternative site 5, located approximately 50 nmi from the Golden Gate and 30 nmi from the Farallon Islands, as the preferred alternative site. This site is located in 2,500 to 3,000 meters of water and was chosen due to its location away from productive fishery areas and in an area that has been used historically for disposal of low-level radioactive waste and chemical and conventional munitions.

Two sections of the DEIS addressed the distribution and abundance of cetaceans and pinnipeds (Sections 3.3.5.1 and 3.3.5.2.) This discussion utilized May-June survey data from the Point Reyes Bird Observatory (PRBO) over a seven-year period and data collected by a team of EPA observers during five seasons in 1990-1991. Historical data from the early 1980's were also discussed.

Generally, the species listed in your letter fall into one of two categories in terms of use of the preferred alternative ocean disposal site. The fin whale, right whale, sei whale and sperm whale rarely occur in the region in which the alternative disposal sites are located. No individuals of any of these species were observed in either the PRBO or the EPA surveys. In addition, while historic surveys sighted fin and sperm whales off central California during the years 1980-1983, neither right whales nor sei whales were sighted by these surveys. In contrast, the blue whale, gray whale, humpback whale and northern sea lion were observed in the recent PRBO and EPA surveys as well as the historical surveys. A description of the occurrence patterns in the vicinity of the preferred alternative ocean disposal site of these four species is provided below:

Blue Whale - This species was not observed in the PRBO surveys, probably due to the fact that blue whales occur in the region primarily in summer and early fall whereas the PRBO surveys were conducted in the May-June timeframe. The EPA surveys sighted blue whales in August 1990 and 1991 in six locations on the continental shelf and slope off San Francisco. Four of these locations were within the Gulf of the Farallones or the Monterey Bay National Marine Sanctuary; the other two locations were well south of the preferred alternative disposal site. All locations were at least 14 nmi from the preferred alternative site. Historical surveys indicate that most blue whales are found on the shelf or near the shelf break in the Gulf of the Farallones. EPA believes that the proposed disposal site does not lie within preferred habitat of the blue whale.

Gray Whale - The PRBO surveys sighted few gray whales, all of which were within the boundaries of the Gulf of the Farallones National Marine Sanctuary. All sightings were greater than 10 nmi from the preferred alternative disposal site. No gray whales were observed during the EPA seasonal surveys. Historical surveys suggest that while there may be year-round resident gray whales in the Gulf of the Farallones, this species tends to avoid turbid waters in its southern migration and to remain close to shore during its northern migration. For all of these reasons, EPA does not believe that the preferred alternative disposal site lies within valuable habitat for the gray whale. (EPA also notes that the gray whale has been de-listed from the federally endangered species list.)

Humpback Whale - This species was observed in both the PRBO and EPA surveys. Although the number of individuals observed was roughly equivalent in the two surveys, the PRBO May-June survey observed a more southerly distribution for gray whales than did the EPA seasonal cruises from August 1990 and 1991. The August surveys observed one individual within the preferred alternative disposal site. Otherwise all observations in both surveys were at least 12 nmi from the preferred alternative disposal site. While it may be inferred from these data that humpback whales use the preferred alternative disposal site as habitat, it is evident that many other areas of potential and actual habitat occur within the region and humpback whales do not show a demonstrated preference for the environs of the preferred alternative disposal site.

Northern Sea Lion - Most northern sea lions in the region are found either in the vicinity of Cordell Bank or on the continental slope between the Farallon Islands and Ano Nuevo Island. Each of the two recent surveys sighted only two individuals: the PRBO surveys found individual northern sea lions on Cordell Bank and off Bolinas Lagoon; the EPA surveys found individuals at the shelf break near Pioneer Canyon and just south of the preferred alternative disposal site. EPA believes that since the preferred alternative disposal site is not in close proximity to any of the known haul-out areas for the northern sea lion, and since only one individual has been sighted in the vicinity of the site, the preferred alternative site will not impinge on prime northern sea lion habitat.

In the DEIS, impacts from the proposed site designation action to threatened and endangered species are estimated to be Class III - insignificant to none. This estimation is based on modelled predictions that turbidity impacts will be of short duration and will be diluted to ambient levels well before reaching national marine sanctuary boundaries or upper continental slope or shelf areas. In addition, EPA's ocean dumping criteria allow only dredged material that has been shown to cause no adverse effects to marine organisms to be ocean disposed. Therefore, even if a disposal plume is contacted, the expected impact from contaminants is minimal. Finally, EPA is currently designing a site management and monitoring plan which will include a component for biological monitoring of pelagic species including marine mammals. This plan will be available for review and comment either as part of the final Environmental Impact Statement or as a separate document supporting the proposed site designation rule.

In summary, information presented in the DEIS indicates that there will be no effect on threatened and endangered cetaceans and pinnipeds from designation and use of the proposed ocean disposal site. Species' distributions do not indicate that the site lies within preferred habitat areas, and the water quality impacts associated with site use are expected to be short-lived and insignificant. Further, EPA will monitor disposal activities to ensure protection of marine species. Due to these findings and commitments, EPA has determined that no further consultation concerning the threatened and endangered species identified in your letter is required under the Endangered Species Act.

EPA will continue to involve the National Marine Fisheries Service in future site designation and monitoring activities through the Long-Term Management Strategy (LTMS) Ocean Studies Work Group. This group was convened in November 1990 and has provided input to EPA on the design and interpretation of the technical studies and on administrative decisions supporting the ocean site designation. The OSWG will continue to assist EPA with the development of the site management and monitoring plan and with periodic review of monitoring study results. EPA looks forward to National Marine Fisheries Service participation in this advisory forum as the project progresses.

EPA requests that the National Marine Fisheries Service concur or non-concur by letter with the above finding prior to July 1, 1993. This will allow EPA to publish the results of the coordination process in the FEIS. EPA appreciates your office's comments on our DEIS and your support for designation of the preferred alternative site. EPA will be pleased to furnish supporting technical reports for the DEIS or additional copies of the DEIS should your office require them. Please contact me at (415) 744-2125, or have your staff contact Janet Hashimoto at (415) 744-1156, with any questions or comments concerning EPA's site designation process.

Sincerely,

for Harry Seraydarian, Director
Water Management Division

cc: Jim Bybee, NMFS Santa Rosa

EXHIBIT 10

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION IX
75 Hawthorne Street
San Francisco, CA 94105-3901

2 JUN 1993

John L. Turner
Acting Chief
Environmental Services Division
California Department of Fish and Game
1416 Ninth Street, P.O. Box 944209
Sacramento, CA 94244-2090

RE: Endangered Species Act Coordination for Designation of an Ocean Dredged Material Disposal Site Offshore San Francisco

Dear Mr. Turner:

Thank you for your response to the Environmental Protection Agency Region IX's (EPA) letter which requested information concerning any State of California listed, or candidate, threatened or endangered species or species of special concern in the vicinity of potential ocean dredged material disposal sites off San Francisco. EPA understands from your letter that Marbled Murrelet, Winter-run Chinook Salmon, California Brown Pelican and Peregrine Falcon comprise the listed species. The species of special concern include Spring-run Chinook Salmon, Rhinoceros Auklet, Tufted Puffin, Fork-tailed Storm-Petrel, Ashy Storm-Petrel, Common Loon, Double-crested Cormorant, Pink Salmon and Coho Salmon. As mentioned in our previous letter, similar coordination has been initiated with the National Marine Fisheries Service and the U.S. Fish and Wildlife Service for species under their jurisdiction. EPA voluntarily pursues coordination on State endangered, threatened and special concern species with the Department of Fish and Game in order to facilitate this project's Coastal Consistency Determination from the California Coastal Commission.

EPA released the draft Environmental Impact Statement (DEIS) for site designation in December 1992. This document presented summaries of more than ten separate oceanographic studies conducted in support of the site designation effort. Based on these studies and other existing information, EPA chose alternative site 5, located approximately 50 nmi from the Golden Gate and 30 nmi from the Farallon Islands, as the preferred alternative site. This site is located in 2,500 to 3,000 meters of water and was chosen due to its location away from productive fishery areas and in an area that has been used historically for disposal of low-level radioactive waste and chemical and conventional munitions.

EPA's DEIS did not identify any impacts to State listed species, species of special concern or habitat of these species due to the proposed action. Of the fish species listed, the Winter-run Chinook Salmon, the Spring-run Chinook Salmon and the Coho Salmon may occur in the vicinity of the preferred alternative site. In contrast, Pink Salmon are listed by Miller and Lea, 1972 as "uncommon" and are unlikely to occur in significant numbers at the preferred alternative site. Even though Chinook and Coho Salmon have been caught commercially in the CDFG catch block located just south of the preferred alternative site, the amount caught is a fraction of commercial catches elsewhere and probably varies greatly from year to year. Neither commercial fishermen nor the CDFG staff reviewing the DEIS identified any adverse impacts to existing or potential fisheries associated with designation of the site.

Of the avian species identified as State listed species, none have been found to inhabit the vicinity of the preferred alternative site. According to Ainley and Allen, 1992, the Marbled Murrelet is confined to waters within several kilometers offshore southern San Mateo County in the vicinity of Ano Nuevo. EPA's DEIS and supporting data confirm that the Peregrine Falcon has only been sighted in the vicinity of the Farallon Islands, and the California Brown Pelican population is concentrated nearshore, over water shallower than 180 meters. In the two studies sponsored by EPA for this project, none of these species were found in the vicinity of the preferred alternative site (Ainley and Allen, 1992; Jones and Szczepaniak, 1992.)

The same holds true for the special concern species Tufted Puffin, Fork-tailed Storm-Petrel, Common Loon, and Double-crested Cormorant. Tufted Puffin have been sighted near but not within EPA's Study Area 5 and are considered uncommon breeders in the region. The Fork-tailed Storm-Petrel is a pelagic species that is numerous during sporadic periods but was not sighted in significant numbers in the two EPA studies. The Common Loon and Double-crested Cormorant are both limited to waters over the Continental Shelf where they are considered to occur uncommonly.

The Rhinoceros Auklet and Ashy Storm-Petrel are special concern species which do occur within the vicinity of the preferred alternative site. Both are species which breed in the area, are year-round residents of the region and are considered abundant or common. In addition, both species are found at equal or higher densities within at least one of the EPA study areas other than Study Area 5 which contains the preferred alternative site.

In summary, the information supporting EPA's site designation environmental impact statement indicates that, of the species identified in your letter, only the Chinook Salmon, Coho Salmon, Rhinoceros Auklet and Ashy Storm-Petrel occur within the vicinity of the preferred alternative site.

In the DEIS, impacts from the proposed site designation action to threatened and endangered species are estimated to be Class III - insignificant to none. EPA believes this finding also applies to species of special concern. This estimation is based on modelled predictions that turbidity impacts will be confined to depths below which seabirds, such as the Rhinoceros Auklet and Ashy Storm-Petrel, are likely to be feeding and will be diluted to ambient levels well before reaching national marine sanctuary boundaries or upper continental slope or shelf areas. Although the salmon species discussed above may occur at depths that could be impacted by disposal plumes, EPA feels these potential impacts are also insignificant due to the small percentage of these species' populations which occur in these areas and the low amount of commercial and recreational effort targeted on these areas.

In addition, EPA's ocean dumping criteria allow only dredged material that has been shown to cause no adverse effects to marine organisms to be ocean disposed. Therefore, even if a disposal plume is contacted, the expected impact from contaminants is minimal. EPA is currently designing a site management and monitoring plan which will include components of biological monitoring of pelagic species and physical tracking of the disposal plume. This plan will be available for review and comment either as part of the final Environmental Impact Statement or as a separate document supporting the proposed site designation rule.

EPA will continue to involve the California Department of Fish and Game and the California Coastal Commission in future site designation and monitoring activities through the Long-Term Management Strategy (LTMS) Ocean Studies Work Group. This group was convened in November 1990 and has provided input to EPA on the design and interpretation of the technical studies and on administrative decisions supporting the ocean site designation. The OSWG will continue to assist EPA with the development of the site management and monitoring plan and with periodic review of monitoring study results. EPA looks forward to State participation in this advisory forum as the project progresses.

For all of the above reasons, EPA finds that the proposed site designation action represents no significant impact to any State listed species or species of special concern. EPA requests that CDFG concur or non-concur by letter with the above finding concerning State listed and special concern species prior to July 1, 1993. This will allow EPA to publish the results of the coordination process in the FEIS. EPA appreciates CDFG's comments on our DEIS and your support for designation of the preferred alternative site. EPA will be pleased to furnish supporting technical reports for the DEIS or additional copies of the DEIS should your office require them. Please contact me at (415) 744-2125, or have your staff contact Janet Hashimoto at (415) 744-1156, with any questions or comments concerning EPA's site designation process.

Sincerely,

for Harry Seraydarian, Director
Water Management Division

cc: Jim Raives, California Coastal Commission

References cited:

Ainley, D.G. and S.G. Allen. 1992. Abundance and Distribution of Seabirds and Marine Mammals in the Gulf of the Farallones: Final Report to the Environmental Protection Agency (Region IX) LTMS Study Group, submitted July 30, 1992. Point Reyes Bird Observatory, Stinson Beach, CA.

Jones, P.A. and I.D. Szczepaniak. 1992. Report on the Seabird and Marine Mammal Censuses Conducted for the Long-Term Management Strategy (LTMS) August 1990 Through November 1991. Prepared for the U.S. EPA, Region IX, San Francisco, CA, July 1992.

Miller, D.J. and R. N. Lea. 1972. Guide to the Coastal Marine Fishes of California. Calif. Fish and Game, Fish Bull. 157. 249 pp.

EXHIBIT 11

United States Department of the Interior

TAKE PRIDE IN AMERICA

FISH AND WILDLIFE SERVICE

Ecological Services
Sacramento Field Office
2800 Cottage Way, Room E-1803
Sacramento, California 95825-1846

In Reply Refer To:
1-1-93-I-1074

July 2, 1993

Mr. Harry Seraydarian
Environmental Protection Agency
75 Hawthorne Street
San Francisco, California 94105-3901

Subject: Informal Endangered Species Consultation on Designation of an Ocean Dredged Material Disposal Site Offshore San Francisco

Dear Mr. Seraydarian:

This responds to your letter, dated June 2, 1993, requesting concurrence with the determination that designation and use of proposed ocean disposal site 5, located 50 nmi from the Golden Gate and 30 nmi from the Farallon Islands, are not likely to adversely effect the endangered California brown pelican (Pelecanus occidentalis californicus). We concur with this determination. Therefore, unless new information reveals effects of the proposed action that may affect listed species in a manner or to an extent not considered, or a new species or critical habitat is designated that may be affected by the proposed action, no further action pursuant to the Endangered Species Act of 1973, as amended, is necessary.

If you have any questions, please contact Karen Miller of my staff at (916) 978-4866.

Sincerely,

for Wayne S. White
Field Supervisor

cc: Reg. Dir., (AES), FWS, Portland, OR

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UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL MARINE FISHERIES SERVICE
Southwest Region
501 West Ocean Boulevard, Suite 4200
Long Beach, California 90802-4213
TEL (310) 980-4000; FAX (310) 980-4018

EXHIBIT 12

JUL 01 1993

F/SW031:IVL

Mr. Harry Seraydarian
Director
Water Management Division
U.S. Environmental Protection Agency
Region IX
75 Hawthorne Street
San Francisco, California 94105-3901

Dear Mr. Seraydarian:

I concur with your determination that no further section 7 consultation is required under the Endangered Species Act (ESA) because utilization of an ocean material dredge disposal site located offshore from San Francisco will not have an adverse impact on marine mammals listed as endangered or threatened species under the ESA. This concludes the consultation process for this project. However, if new information becomes available indicating that the listed marine mammals, or their critical habitat, may be adversely affected by the project, further consultation will be necessary.

I look forward to continued participation in the future site designation and monitoring activities through the Long-Term Management Strategy Ocean Studies Work Group as the project progresses. If you have any questions concerning these comments, please contact Ms. Irma Lagomarsino at (310) 980-4016.

Sincerely,

Gary Matlock, Ph.D.
Acting Regional Director

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7/7/72 Attn Ota

STATE OF CALIFORNIA—THE RESOURCES AGENCY

PETE WILSON, Governor

DEPARTMENT OF FISH AND GAME
1416 NINTH STREET
P.O. BOX 944209
SACRAMENTO, CA 94244-2090
(916) 653-4875

June 30, 1993

Mr. Harry Seraydarian
Water Management Division
U.S. Environmental Protection Agency
75 Hawthorne Street
San Francisco, California 94105-3901

Dear Mr. Seraydarian:

The Department of Fish and Game (DFG) has reviewed your response to our letter regarding California Endangered Species Act coordination for the designation of a deep-water ocean disposal site for dredged material from San Francisco Bay. We concur with your initial findings that there appear to be no potential significant impacts to threatened and endangered species or species of special concern in the vicinity of the preferred alternative disposal site as it is identified and described in the Draft Environmental Impact Statement. However, it is of particular importance to the DFG that the Environmental Protection Agency (EPA) adequately monitor these sensitive species over the operational life of the disposal site, as well as determine the fate of the dredged material disposed there under a wide variety of seasonal and annual oceanic conditions. As longtime participants in the EPA's Ocean Studies Work Group, we are committed to assisting your agency in the development of a comprehensive and thorough monitoring and management plan for this site and look forward to its timely implementation in 1994.

As always, DFG personnel are available to discuss our comments and concerns in greater detail. To arrange for discussion, contact Mr. Robert N. Tasto, Environmental Specialist, California Department of Fish and Game, Marine Resources Laboratory, 411 Burgess Drive, Menlo Park, California 94025, telephone (415) 688-6360.

Sincerely,

John L. Turner, Chief
Environmental Services Division

cc: See attached list

cc: Mr. Michael A. Kahoe
California Environmental Protection Agency
Sacramento, California

Mr. Robert N. Tasto
Department of Fish and Game
Menlo Park, California

EXHIBIT 14

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION IX
75 Hawthorne Street
San Francisco, Ca. 94105-3901

22 JUL 1992

Mr. Steade Craigo
Acting State Historic Preservation Officer
P.O. Box 942896
Sacramento, CA 94296-0001

Dear Mr. Craigo:

The Environmental Protection Agency Region IX (EPA) is preparing an Environmental Impact Statement (EIS) for the designation of an ocean dredged material disposal site off San Francisco, California. The site will be selected as part of the Long-Term Management Strategy (LTMS) for San Francisco Bay and will have the capacity to accomodate an estimated 400 million cubic yards of dredged material over a 50-year period. The proposed action will involve only the designation of the site itself; before disposal is permitted, the dredged material must be evaluated in accordance with the Marine Protection, Research and Sanctuaries Act of 1972 and its implementing regulations and guidance.

EPA began the site designation process by evaluating four study areas on the Farallon Shelf and Slope at distances of 20 to 55 miles offshore and at depths of 300 to 6000 feet. The four study areas are delineated on the enclosed map (areas 2-5) and coordinate list. With the recent designation of the Monterey Bay National Marine Sanctuary Study Areas 2 and the eastern third of Study Area 3 are no longer being considered as potential sites. However, since data have been collected for all four study areas, a characterization of each area is being developed. In the draft EIS, which is scheduled for release in November 1992, EPA will identify candidate sites within Study Areas 3, 4 and 5 and will choose a preferred alternative site.

In accordance with section 106 of the National Historic Preservation Act and Executive Order 11593, please advise EPA of any sites of historic, architectural, archeological or cultural value listed on, or eligible for listing on the National Register of Historic Places in the vicinity of the four study areas identified above. EPA would appreciate your response prior to October 1, 1992. Please direct any questions or requests for further information to Shelley Clarke at (415) 744-1162.

Sincerely,

Janet Y. Hashimoto

Janet Y. Hashimoto, Chief
Marine Protection Section

Enclosures (2)

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STATE OF CALIFORNIA — THE RESOURCES AGENCY

PETE WILSON, Governor

OFFICE OF HISTORIC PRESERVATION

DEPARTMENT OF PARKS AND RECREATION

P.O. BOX 942896
SACRAMENTO 94296-0001
(916) 653-6624
FAX: (916) 653-9824

916) 653-6624
FAX (916) 653-9824

10 August 1992

Reply to: EPA 920724A

Janet Hashimoto
Marine Protection Section
US Environmental Protection Agency
75 Hawthorne Street
SAN FRANCISCO CA 94105-3901

Subject: EIS FOR OCEAN DREDGED MATERIALS SITES, LONG TERM MANAGEMENT PLAN

Dear Ms. Hashimoto:

Thank you for your letter notifying me that the Army Corps of Engineers is studying possible ocean dredged materials sites near San Francisco Bay. While I commend your concern for historic preservation, I cannot conduct the research you need. The Army Corps of Engineers is responsible for identifying historic properties which may be affected.

Section 106 of the National Historic Preservation Act of 1966 requires that federal agencies consider how their activities might effect historic resources and the Advisory Council on Historic Preservation's procedures for complying with the Section 106 (36 CFR Part 800) outline the steps a federal agency must take to fulfill its Section 106 responsibilities. It is up to you to conduct the necessary research.

The California State Lands Commission maintains a computerized inventory of all shipwrecks, sunken vessels, and stranded hulks in California waters. While the inventory is not comprehensive, it is currently the best source of accurate information on submerged historic maritime resources in state waters. Because your undertaking has a potential to affect submerged cultural resources, we recommend you consult the State Lands Commission's submerged cultural resources inventory by calling Goodyear "Kirk" Walker at (916) 322-0530.

Please send us a copy of either agency's written response. Be sure to include a map which shows the project area as well as the Area of Potential Effect (36 CFR 800.2). When replying to us, always use the reference number in the upper right corner of this letter.

Are there any structures on or near the project site? Could they be fifty or more years old? If so, please include photographs of each such structure and its surroundings. Will the project require or result in moving, altering, abandoning, or demolishing any structures?

If you have any questions, please telephone Nicholas Del Cioppo of my staff at (916) 653-9696.

Sincerely,

Steade R. Craigo, AIA, Acting
State Historic Preservation Officer

EXHIBIT 16

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION IX
75 Hawthorne Street
San Francisco, CA 94105-3901

2 JUN 1993

Steade R. Craigo
Acting State Historic Preservation Officer
Office of Historic Preservation
Department of Parks and Recreation
P.O. Box 942896
Sacramento, CA 94296-0001

RE: **Compliance with the National Historic Preservation Act for Designation of an Ocean Dredged Material Disposal Site Offshore San Francisco in reference to project EPA 920724A**

Dear Mr. Craigo:

Thank you for your response to the Environmental Protection Agency Region IX's (EPA) letter which requested information concerning any sites of historic, architectural, archaeological or cultural value on, or eligible for listing on, the National Register of Historic Places in the vicinity of four areas being studied by EPA for potential ocean dredged material disposal site designation. In your letter, you requested EPA coordinate with the California State Lands Commission, pursue a site survey with the Corps of Engineers, provide a map showing the area of impact and address potential impacts to structures. However, EPA understands from the National Historic Preservation Act (NHPA) regulations that some of this information must be provided only when historic properties have been identified (36 CFR Sections 800.4 and 800.8.)

Under NHPA, the Agency Official, in this case myself, must determine whether the proposed action is an "undertaking" and if so, the extent of the "undertaking's" impact. I have determined that the proposed site designation action constitutes an "undertaking" as defined at 36 CFR § 800.2 (o). Further, the "undertaking's" area of potential effect is expected to lie within the model-predicted 10-cm thick dredged material footprint on the seafloor for each of the alternative sites (Exhibit A.) EPA has delineated the alternative site boundaries to coincide with this 10-cm thick footprint area. Although dredged material may contact the water column outside these sites, substantial deposition, and hence potential effect upon historical structures, is expected only within the boundaries of the alternative sites.

EPA's draft Environmental Impact Statement (DEIS) for site designation, released in December 1992, presents summaries of more than ten separate oceanographic studies conducted in support of the proposed action. Based on these studies and other existing information, EPA chose alternative site 5, located approximately 50 nmi from the Golden Gate and 30 nmi from the Farallon Islands, as the preferred alternative site. This site is located in 2,500 to 3,000 meters of water and was chosen due to its location away from productive fishery areas and in an area that has been used historically for disposal of low-level radioactive waste and chemical and conventional munitions. Therefore, EPA defines the area of potential effects from this action to be the area contained within Alternative Site 5.

According to NHPA regulations, the next step involves identifying historic properties by reviewing existing information, seeking information from local governments, Indian tribes, public and private organizations and other parties, and consulting with the State Historic Preservation Officer (36 CFR § 800.4 (a)).

At your request, EPA contacted the California State Lands Commission (SLC) to determine if they had information regarding historic properties in the vicinity of Alternative Site 5. Mr. Kirk Walker of the SLC referred us to the Minerals Management Service (MMS) which maintains a better database of archaeological resources for offshore waters. Sheet 27-E of Volume 5: Small-scale Maps of the MMS's California, Oregon and Washington Archaeological Resource Study, OCS Study MMS 90-0091 indicated a shipwreck in the vicinity of Alternative Site 5 (Exhibit B.) EPA asked the MMS to verify whether this shipwreck indicator corresponded to the S.S. John F. Shafroth which was intentionally disposed in 1964 by the U.S. Navy after being loaded with chemical munitions (Exhibit C.) The MMS responded that their database indicated that the mark on Sheet 27-E corresponds to the S.S. John F. Shafroth (Exhibit D.)

EPA also investigated the U.S. Geological Survey's Comprehensive Geological and Geophysical Survey of the Gulf of the Farallones Region, Administrative Report, November 1992 for evidence of shipwrecks in the vicinity of Alternative Site 5. This study surveyed each of the alternative sites using 3.5 kHz and 4.5 kHz high resolution seismic-reflection profiles and 10 kHz seafloor/bathymetry profiles. Chapter 3 of the report discusses two large non-geologic targets found during the survey. These targets are believed to be the U.S.S. Independence and the S.S. Puerto Rican. Both targets were found southeast of Alternative Site 5; no targets were identified in the vicinity of Alternative Site 5.

EPA has conducted extensive public involvement activities through the Long-Term Management Strategy's Ocean Studies Work Group (OSWG.) The OSWG consists of representatives of federal, state and local agencies as well as representatives of environmental and business interests (Exhibit E.) This group was first convened in November 1990 and provided significant input to EPA on the design and interpretation of the technical studies and on administrative decisions supporting the ocean site designation. Issues concerning preservation of historic structures have not been raised in any of the 13 OSWG meetings nor in any of the approximately 35 comment letters EPA received in the DEIS.

EPA believes our coordination with the SLC, the MMS, the U.S. Geological Survey, the agencies of the OSWG and with your office per our July 22, 1992 letter satisfies the requirements of 36 CFR § 800.4. Since none of these efforts have identified any historical properties, EPA submits that no further documentation is necessary for compliance with NHPA according to 36 CFR §800.4 (d). EPA requests that the SHPO concur or non-concur by letter with the above finding prior to July 1, 1993. This will allow EPA to publish the results of the coordination process in the FEIS. EPA will be pleased to furnish supporting technical reports for the DEIS or additional copies of the DEIS should your office require them. Please contact me at (415) 744-2125, or have your staff contact Janet Hashimoto at (415) 744-1156, with any questions or comments concerning EPA's site designation process.

Sincerely,

for Alexis Strauss
Harry Seraydarian, Director
Water Management Division

Enclosures (5)

EXHIBIT A (from Draft Environmental Impact Statement (EIS) for San Francisco Bay Deep Water Dredged Material Disposal Site Designation, December 1992, EPA Region IX.)

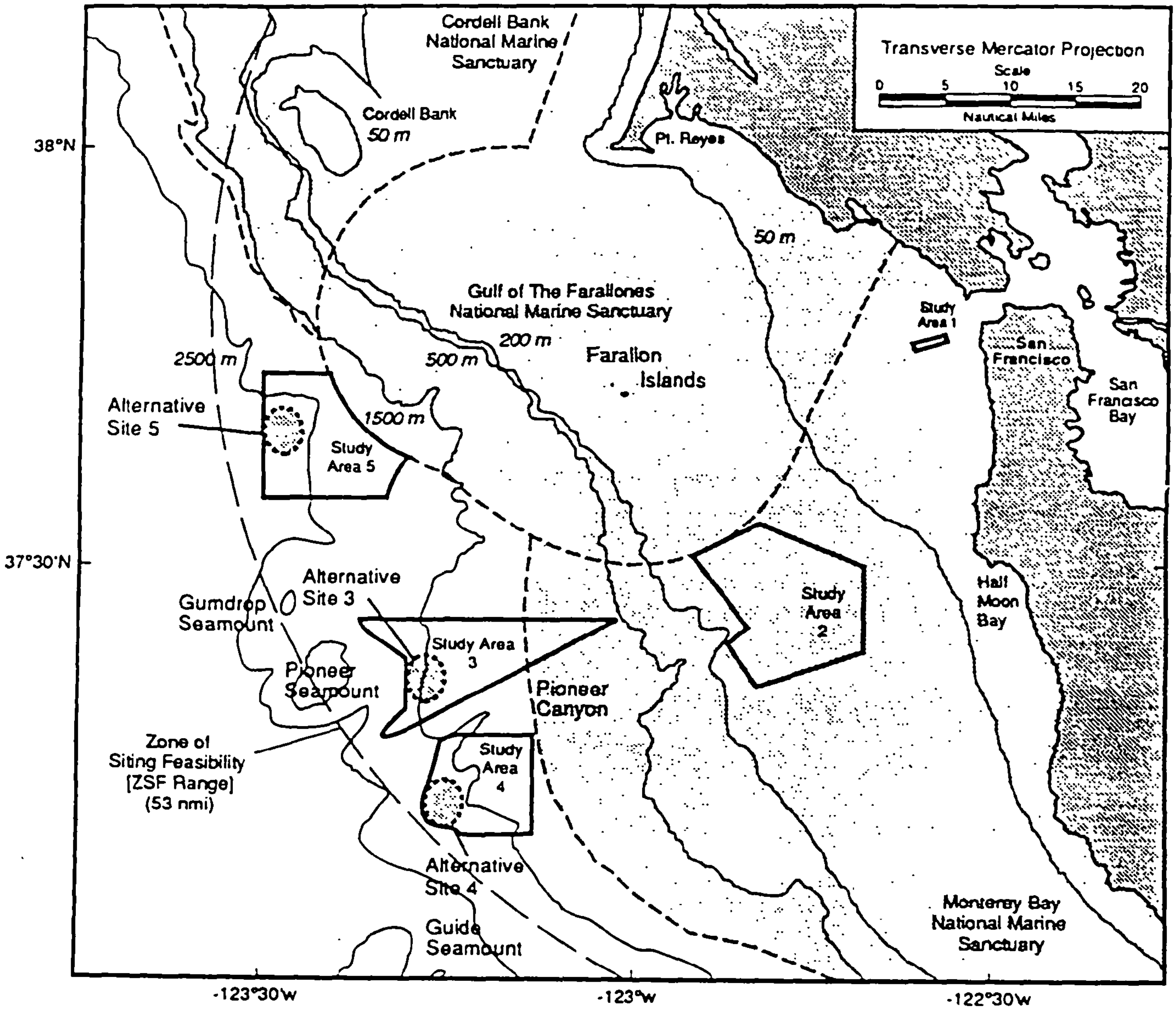
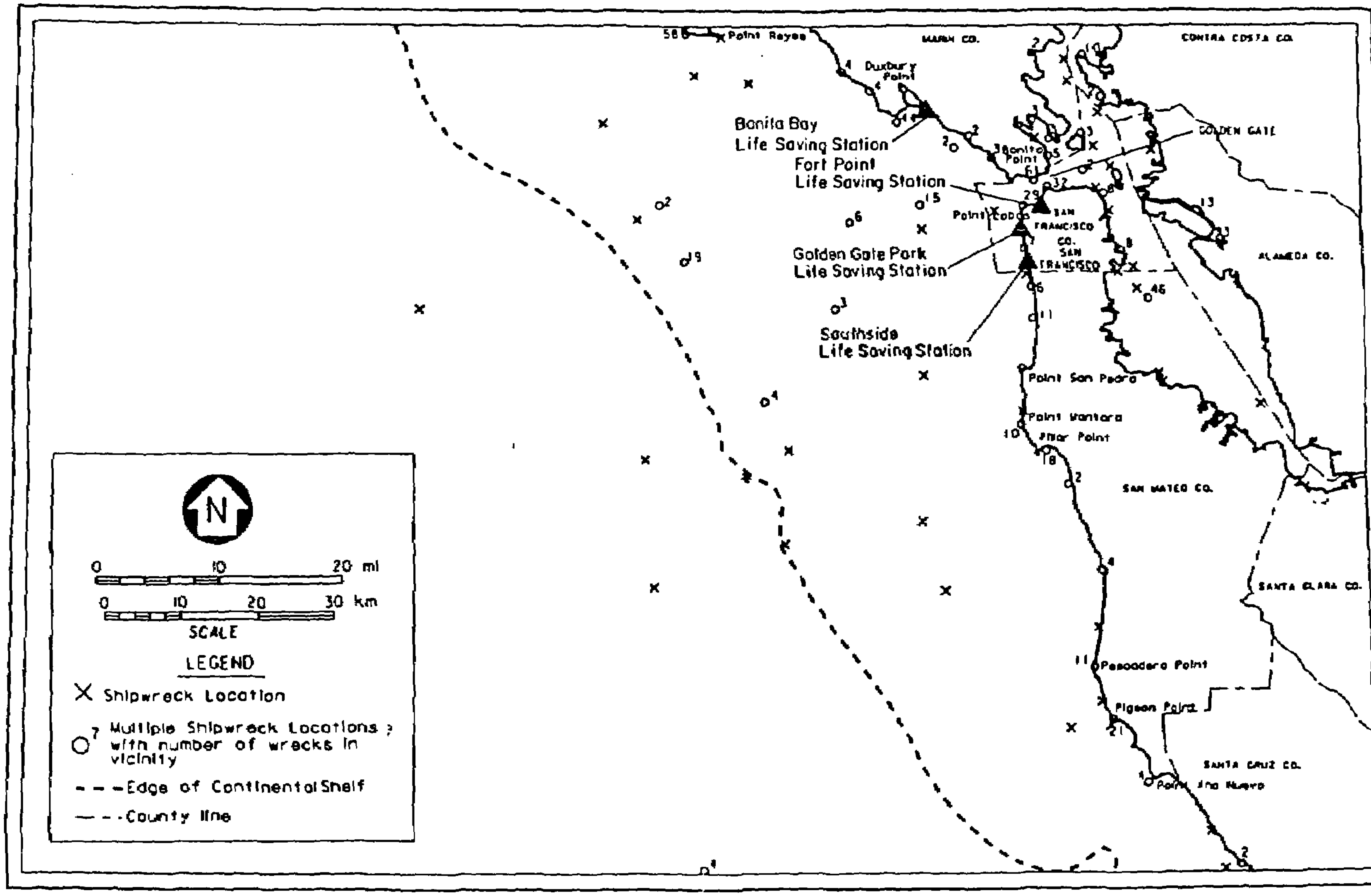


EXHIBIT B. (From Volume 5: Small-scale maps, California, Oregon and Washington Archaeological Resource Study, OCS Study MMS 90-0091)



Shipwreck Locations, San Francisco, California, Sheet 27-E

EXHIBIT C

ocean disposal
OF BARGE-DELIVERED LIQUID AND SOLID WASTES FROM U.S. COASTAL CITIES

This publication (SW-19c) was written for the Solid Waste Management Office by DAVID D. SMITH and ROBERT P. BROWN Applied Oceanography Division, Dillingham Corporation, La Jolla, California under Contract No. PH 86-68-203

U.S. ENVIRONMENTAL PROTECTION AGENCY
Solid Waste Management Office

1971

TABLE 3
SUMMARY OF U.S. NAVY CHASE DISPOSAL OPERATIONS, 1964 - 1968[a]

Chase Number	I	II	III	IV	V	VI
Year	1964	1964	1965	1965	1966	1967
Vessel Name	S.S. John F. Shafroth	S.S. Village	M.V. Coastal Mariner	S.S. Santiago Iglesias	S.S. Isaac Van Zandt	S.S. Robert L. Stevenson
Total Cargo	9,799 tons	7,535 tons	4,040 tons	8,715 tons	7,500 tons	6,600 tons
Net Explosive	Unknown	Unknown	512.19 tons	408 tons	1,625 tons	2,327 tons
Disposal Area	Pacific Coast Lat: 37° 40' N Long: 123° 25' W	Atlantic Coast Lat: 38° 49' N Long: 72° 14' W	Atlantic Coast Lat: 37° 12' N Long: 74° 21' W	Atlantic Coast Lat: 37° 11' N Long: 74° 26' W	Pacific Coast Lat: 39° 33' N Long: 125° 46 W	Pacific Coast Lat: 51° 22' N Long: 178° 19' E
Hull Preparation Cost	$7,949	$3,608	$5,991	$2,235	$50,156	$64,354
Towing Cost[a]	$5,000	$1,000	$ 990	$1,075	0 (Navy Tug)	$39,000[b]
Loading Cost	$102,021	$158,235	$132,978	$178,112	91,859	$91,034
TOTAL COST	$114,970	$162,843	$139,959	$181,422	142,015	$155,388
Cost per ton of Total Waste Cargo	$12	$21	$34	$20	$19	$23

For Footnotes See End of Table

TABLE 3-(Continued)
SUMMARY OF U.S. NAVY CHASE DISPOSAL OPERATIONS, 1964-1968[a]

EXHIBIT D

United States Department of the Interior

MINERALS MANAGEMENT SERVICE
Pacific OCS Region
770 Paseo Camarillo
Camarillo, CA 93010-6064

IN REPLY REFER TO 7300

APR 26 1993

Ms. Shelly Clark
Mail Code W71
EPA Region IX
75 Hawthorne
San Francisco, California 94105

Dear Ms. Clark:

The Minerals Management Service is pleased to respond to your verbal request to research any known archaeological resource located in the approximate area of 37°40'N and 123°25'W.

During your inquiry, you stated that you knew that a shipwreck located at 37° 40'N and 123° 25'W is the *SS. John F. Shafroth*. The Minerals Management Service archaeological database indicates that this is in fact the *John Shafroth*. Please note that the *Shafroth* is a Class 4 Cultural Resource, defined as "value not established".

If you have any further questions or comments, please contact Ralph Snyder at (805) 389 - 7826.

Sincerely,

Steven C Alcorn
for Richard L. Wilhelmsen
Regional Supervisor
Office of Leasing and Environment

EXHIBIT E. (from Environmental Impact Statement (EIS) for San Francisco Bay Deep Water Dredged Material Disposal Site Designation, December 1992, EPA Region IX.)

Table 5.3-1. LTMS Ocean Studies Work Group (OSWG) Members.
Members listed alphabetically by affiliation.

Name	Organization
Bill Boland	independent
Tom Jow	independent
Ellen Johnck	Bay Planning Coalition
Mark Delaplaine	California Coastal Commission
Jim Raives	California Coastal Commission
George Armstrong	California Department of Boating and Waterways
Pete Phillips	California Department of Fish and Game
Robert Tasto	California Department of Fish and Game
Tracy Wood	California Integrated Waste Management Board
Mary Bergen	California State Lands Commission
Alan Ramo	Citizens for a Better Environment
Kathleen van Velsor	Coastal Advocates
Marie White	Entrix
Jeffrey Cox	Evans-Hamilton, Inc.
Jan Roletto	Gulf of the Farallones National Marine Sanctuary
Ed Ueber	Gulf of the Farallones National Marine Sanctuary
Pietro Parravano	Half Moon Bay Fisherman's Association
Cynthia Koehler	Heller, Ehrman, White and McAuliffe
Robert Battalio	Moffatt and Nichol
Greg Cailliet	Moss Landing Marine Laboratories
James Nybakken	Moss Landing Marine Laboratories
Herb Curl	National Oceanic and Aeronautical Administration Hazardous Materials
Alec MacCall	National Marine Fisheries Service
Chris Mobley	National Marine Fisheries Service
Don Pearson	National Marine Fisheries Service
Gail Blaise	Office of Congresswoman Barbara Boxer
Lynelle Johnson	Office of Congressman George Miller
Catherine Courtney	PRC Environmental Management Inc.
David Cobb	PTI Environmental Services

Table 5.3-1. **Continued.**

Name	Organization
Zeke Grader	Pacific Coast Federation of Fish Association
David Ainley	Point Reyes Bird Observatory
Sarah Allen	Point Reyes Bird Observatory
Jim McGrath	Port of Oakland
Charles Schwarz	Port of Oakland
Jody Zaitlin	Port of Oakland
Steve Goldbeck	San Francisco BCDC
Scott Rouillard	San Francisco Bay Keeper
Michael Carlin	San Francisco Regional Water Quality Control Board
Paul Jones	San Francisco Regional Water Quality Control Board and U.S. Environmental Protection Agency
Andrew Lissner	Science Applications International Corporation
John Lunz	Science Applications International Corporation
David Nesmith	Sierra Club
Kim Brown	Tetra Tech
John Beuttler	United Anglers of America
Commander Scot Tiernan	U.S. Coast Guard Marine Safety Office
Rod Chisholm	U.S. Corps of Engineers
Bill McCoy	U.S. Corps of Engineers
Lynn O'Leary	U.S. Corps of Engineers
Richard Stradford	U.S. Corps of Engineers
Tom Wakeman	U.S. Corps of Engineers
William Allen	U.S. Department of the Interior
Jean Takakawa	U.S. Fish and Wildlife Service
Herman Karl	U.S. Geological Survey
Marlene Noble	U.S. Geological Survey
Curt Collins	U.S. Naval Postgraduate School
Steven Ramp	U.S. Naval Postgraduate School
Sherman Seelinger	U.S. Navy Western Division

EXHIBIT 17

STATE OF CALIFORNIA — THE RESOURCES AGENCY

PETE WILSON, *Governor*

OFFICE OF HISTORIC PRESERVATION
DEPARTMENT OF PARKS AND RECREATION
P O. BOX 942896
SACRAMENTO 94296-0001
(916) 653-6624
FAX. (916) 653-9824

7 July 1993

7/13/93

Reply to: EPA 920724A

Harry Seradarian, Director
Water Management Division
Environmental Protection Agency - Region IX
75 Hawthorne Street
SAN FRANCISCO CA 94105-3901

Subject: OCEAN DREDGED MATERIAL OFFSHORE DISPOSAL SITE

Dear Mr. Seradarian:

Thank you for requesting my review of the undertaking noted above and for including the documentation which justifies your determination.

I concur in your determination that there are no historic properties in the Area of Potential Effects for this undertaking. Accordingly, you have fulfilled federal agency responsibilities pursuant to 36 CFR 800, the regulations implementing Section 106 of the National Historic Preservation Act. Please note that your agency may have additional responsibilities under 36 CFR 800 under any of the following circumstances:

1. If any person requests that the Advisory Council on Historic Preservation review your findings in accordance with 36 CFR 800.6(e);
2. If this undertaking changes in ways that could affect historic properties [36 CFR 800.5(c)];
3. If previously undocumented properties are discovered during the implementation of this undertaking or if a known historic property will be affected in an unanticipated manner [36 CFR 800.11];
4. If a property that was to be avoided has been inadvertently or otherwise affected [36 CFR 800.4(c);800.5];
5. If any condition of the undertaking, such as a delay in implementation or implementation in phases over time, may justify reconsideration of the current National Register status of properties within the undertaking's Area of potential Effects [36 CFR 800.4(c)].

Thank you for considering historic properties during project planning. If you have any questions, please call staff archaeologist Nicholas Del Cioppo at (916) 653-9696.

Sincerely,

Steade R. Craigo, AIA, Deputy
State Historic Preservation Officer

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CHAPTER 6
PREPARERS AND CONTRIBUTORS

This chapter provides a list of EIS preparers (Table 6-1) and contributors (Table 6-2).

Table 6-1. List of EIS Preparers.

NAME	EXPERTISE	EXPERIENCE	RESPONSIBILITY
U.S. Environmental Protection Agency			
Shelley Clarke, M.S.	Fisheries Marine Policy	Seven years conducting research and preparation and review of technical reports.	Technical Program Manager and EIS review.
Allan Ota, M.S.	Biological Oceanography	Twelve years conducting research and preparation and review of technical reports.	Field Studies Manager and EIS review.
Contractor: **Science Applications International Corporation**			
James Blake, Ph.D.	Benthic Biology/Ecology	Over 20 years conducting ecological research in benthic environments.	Preparation and review of EIS section: Affected Environment
John Clayton, Ph.D.	Biological Oceanography Environmental Chemistry	Over 20 years research in environmental chemistry and marine sciences.	Preparation of EIS section: Affected Environment
Debra Davison, M.S.	Marine Biology	Seven years conducting research and preparation of technical reports.	Preparation of EIS sections: Affected Environment Environmental Consequences Coordination EIS review
Joseph Germano, Ph.D.	Marine Sciences Dredged Material Impacts	Over 15 years conducting environmental studies focusing on dredged material impacts.	EIS review
Peter Hamilton, Ph.D.	Physical Oceanography	20 years conducting research in physical oceanography.	Preparation of EIS section: Environmental Consequences

NAME	EXPERTISE	EXPERIENCE	RESPONSIBILITY
Mike Hart (M.S., in Progress)	Environmental Chemistry	Over four years conducting research and preparation of technical reports.	Preparation of EIS section: Affected Environment
Daniel J. Heilprin, M.S.	Marine Ecology Ichthyology Fisheries Biology	Over six years conducting ecological studies and preparation of technical reports.	Preparation of EIS sections: Affected Environment Environmental Consequences List of Preparers and Contributors EIS review
Robert Kelly, Ph.D.	Marine Sciences Dredged Material Impacts EIS Preparation	Over 15 years conducting environmental studies, including EIS preparation and impact assessment.	Preparation of EIS sections: Introduction Affected Environment Environmental Consequences
Andrew Lissner, Ph.D.	Marine Biology Dredged Material Impacts EIS Preparation	Over 15 years conducting environmental studies, including EIS preparation and impact assessment.	Work Assignment Manager Preparation of EIS sections: Affected Environment Environmental Consequences EIS review
John Lunz, M.S.	Marine Sciences Dredged Material Impacts	Over 15 years conducting dredged material research studies and impact assessment.	Preparation of EIS section: Affected Environment EIS review
Scott McDowell, Ph.D.	Physical Oceanography Pollution Transport	Twenty years conducting environmental studies and oceanographic research, including EIS preparation.	Preparation of EIS section: Environmental Consequences
Joann Muramoto, Ph.D.	Marine Geochemistry	Over 10 years conducting geochemical research.	Preparation of EIS section: Affected Environment

AK0140.W51

NAME	EXPERTISE	EXPERIENCE	RESPONSIBILITY
Charles Phillips, M.A.	Biology Chemistry EIS Preparation	15 years conducting environmental studies, including EIS preparation and impact assessment.	EIS Task Manager Preparation of EIS sections: Introduction Alternatives Affected Environment Environmental Consequences EIS review
William J. Reynolds, Ph.D.	Coastal Geomorphology	Almost 30 years conducting research in coastal geomorphology, project management, and teaching.	Preparation of EIS section: Affected Environment EIS review
Donald Rhoads, Ph.D.	Benthic Processes	More than 30 years conducting benthic studies and assessing marine environmental impacts.	Preparation of EIS sections: Affected Environment Environmental Consequences EIS review
Bo Shmorhay	Technical Editing	Over 10 years performing editing and production of technical reports and studies.	Editing and Production of EIS
Sridhar Srinivasan, M.A.	Economics Political Science	Two years environmental and institutional analyses.	Preparation of EIS sections: Affected Environment Environmental Consequences
Isabelle Williams, M.S.	Marine Biology	More than 20 years in marine sciences.	Preparation of EIS section: Affected Environment

AK0140.W51

Table 6-2. List of EIS Contributors.

NAME	AFFILIATION
David Ainley	Point Reyes Bird Observatory
Sarah Allen	Point Reyes Bird Observatory
James Barry	Monterey Bay Aquarium Research Institute
James Bence	National Marine Fisheries Service, Tiburon Laboratory
Sue Benech	Benech Biological and Associates
Gregor Cailliet	Moss Landing Marine Laboratories
John Chin	U.S. Geological Survey
Curtis Collins	Naval Postgraduate School
David Drake	U.S. Geological Survey
Brian Edwards	U.S. Geological Survey
Paul Jessen	Naval Postgraduate School
Newell Garfield	Naval Postgraduate School
Paul Jones	U.S. Environmental Protection Agency, Region IX, San Francisco
Herman Karl	U.S. Geological Survey
William Lenarz	National Marine Fisheries Service, Tiburon Laboratory
Guillermo Moreno	Moss Landing Marine Laboratories
Marlene Noble	U.S. Geological Survey
James Nybakken	Moss Landing Marine Laboratories
Steve Osborn	Moss Landing Marine Laboratories
Steven Ramp	Naval Postgraduate School
Dale Roberts	National Marine Fisheries Service, Tiburon Laboratory
Leslie Rosenfeld	Naval Postgraduate School
William Schwab	U.S. Geological Survey
Franklin Schwing	Naval Postgraduate School
Isidore Szcezepaniak	California Academy of Sciences

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CHAPTER 7
BIBLIOGRAPHIC REFERENCES

Abbott, M.R. and P.M. Zion. 1985. Satellite observations of phytoplankton variability during an upwelling event. Cont. Shelf Res. 4:661-680.

Ainley, D.G. and S.G. Allen. 1992. Abundance and Distribution of Seabirds and Marine Mammals in the Gulf of the Farallones: Final Report to the Environmental Protection Agency (Region IX) LTMS Study Group, submitted July 30, 1992. Point Reyes Bird Observatory, Stinson Beach, CA.

Ainley, D.G. and R.J. Boekelheide. 1990. Seabirds of the Farallon Islands: Ecology, Dynamics, and Structure of an Upwelling-System Community. Stanford University Press, Stanford, CA. 450 pp.

Ainley, D.G., L.B. Spear, J.F. Penniman, C.S. Strong, and I. Gaffney. 1987. Foraging Ecology of Sea Birds in the Gulf of the Farallones. Point Reyes Bird Observatory, Stinson Beach, CA.

Allen, S.G., D.G. Ainley, L. Fancher, and D. Shuford. 1987. Movement and Activity Patterns of Harbor Seals (*Phoca vitulina*) from the Drakes Estero Population, 1985-86. Final Report to Office of Ocean and Coastal Resource Management, Marine and Estuarine Management Division, NOAA, Washington, D.C. Point Reyes Bird Observatory, Stinson Beach, CA. 21 pp.

Allen, S.G. and H.R. Huber. 1984. Pinniped Assessment in Point Reyes, California, 1983-1984. Point Reyes Bird Observatory, Stinson Beach, CA.

Allen, S.G. and H.R. Huber. 1983. Pinniped Assessment in the Point Reyes/Farallon Islands National Marine Sanctuary, 1982-1983. Point Reyes Bird Observatory, Stinson Beach, CA. Contribution #270.

Allen, S.G., J.F. Penniman, and D.G. Ainley. 1987. Movement and Activity Patterns of Harbor Seals at Drakes Estero, California, 1986-1987. Annual Report to the Marine and Estuarine Division, NOAA, Washington, D.C.

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APPENDIX

RESPONSES TO COMMENTS

The DEIS was published on December 11, 1992. A 45-day public review and comment period extended from the publication date through January 25, 1993. Thirty-five comment letters from various individuals, organizations, and agencies were received during the public review and comment period. The thirty-five comment letters, numbered Exhibits 1 through 35, are included in this appendix, organized alphabetically by sender's name. Key individual paragraphs within each exhibit are marked by circled call-outs. Responses to each of the letters are also contained in this appendix, and follow the letters. Responses are tagged with their associated call-outs.

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Exhibit (1)

STATE OF CALIFORNIA PETE WILSON, Governor

AIR RESOURCES BOARD
2020 L STREET
P.O. BOX 2815
SACRAMENTO, CA 95812

RECEIVED
JAN 12 1993
ENVIRONMENTAL PROTECTION

MEMORANDUM

TO: Michael A. Kahoe
Assistant Secretary

FROM: James D. Boyd
Executive Officer
Air Resources Board

DATE: January 12, 1993

SUBJECT: COMMENTS ON EIS FOR SAN FRANCISCO BAY DEEP WATER DREDGED MATERIAL DISPOSAL SITE DESIGNATION

We have received the December 15, 1992 notice of the release of the Draft EIS for the San Francisco Bay Deep Water Dredged Material Disposal Site Designation. We have no comment on this document.

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GENERAL CHAIR
James Herman
President Emeritus, *ILWU*
Port of San Francisco
Ferry Building, Suite 3100
San Francisco, CA 94111
415-274-0499

LEADERSHIP COUNCIL CHAIR
W.B. Seaton, Ret. Chairman
American President Co.

LEADERSHIP COUNCIL
Philip F. Anschutz
Southern Pacific Transportation Company
Donald D. Doyle
San Francisco Chamber of Commerce
William I. Edlund
Pillsbury, Madison & Sutro
Michael D. Hannan
Chevron USA
John F. Henning
California AFL-CIO
Frank C. Herringer
Transamerica Corporation
Conrad W. Hewitt
Ernst & Young
M. Arthur Gensler Jr.
Gensler & Associates
Thomas B Kelly
Arthur Andersen
Sam Kimura
New United Motor Mfg Co.
Donald G. Fisher
The Gap, Inc.
George Hayashi
American President Lines
Dr. Julius R. Krevans
Shirley W. Nelson
Summit Bank
Donald E Moffitt
Consolidated Freightways
C. Bradley Mulholland
Matson Navigation Company
Richard M Rosenberg
Bank of America
RADM (Ret.) Robert Toney
Oakland Chamber of Commerce
James A. Vohs
Kaiser Permanente

STEERING COMMITTEE
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Michael Huerta
Ellen Johnck
Secretary
Owen Marron
C.R Redlich, Sr.
W.B. Seaton
President
M.K. Veloz

COORDINATOR
Walter A. Abernathy

Exhibit (2)

Bay Dredging Action Coalition
725 Washington St. Suite 211 . Oakland, CA 94607
Tel (510) 272 9662 . FAX (510) 272 0808

January 25, 1993

Mr. Harry Seraydarian
Director, Water Management Division
U.S. Environmental Protection Agency
75 Hawthorne Street, (W-7-1)
San Francisco, CA 94105

Dear Seraydarian:

We are pleased to comment on the draft EIS for San Francisco Bay Deep Water Dredged Material Disposal Site Designation.

Our coalition is a unique combination of organized labor, major Bay Area business leaders, shipping lines, ports and community based organizations that have joined forces to seek realistic solutions to the dredging crisis that has threatened the survival of the maritime industry in this region.

We appreciate EPA's thoughtful analysis of a deep-ocean alternative for dredged sediment disposal. Our coalition has endorsed a program of multiple disposal alternatives including deep-ocean, in-bay and upland. EPA's role in making the ocean alternative viable is appreciated, particularly given that the study was completed on time and on budget.

One area of concern that we believe needs to be addressed formally as part of the EIS process is the issue of monitoring at the selected site and as dredged material is transported through the Gulf of the Farallones National Marine Sanctuary. The requirements for monitoring need to be considered as part of the EIS. It is important that the industry and environmental community jointly participate in the monitoring decision making process to ensure the adoption of realistic and cost effective procedures. (2-A)

Our interest is in having a realistic ocean disposal alternative with all costs understood and agreed to intially so that extra expense burdens are not

SUPPORTING ORGANIZATIONS (partial list)

A.N.Z.D.L.
American Waterways Operators
American President Companies
Arco Products Company
Arthur Andersen & Company
Bank of America
Bay Planning Coalition
Benicia Industries
Brickyard Cove Marina
California Trucking Association
California Labor Federation AFL-CIO
California Marine Parks & Harbor
CERT
Chevron USA
Clipper Yacht Harbor
The Clorox Company
COLAB
Consolidated Freightways, Inc
Contra Costa Council
Crowley Maritime Corp
DEEP
Encinal Terminals
The Gap, Inc.
GATX Terminals Corp
ILWU International
Interdenominational
Ministerial Alliance
K-Line America, Inc
Kaiser Permanente
Latitude 38
Levin Richmond Terminal Corp
Maersk Pacific Ltd
Marine Terminals Corp
Master Contracting Stevedore Association
Matson Navigation Company
Mitsui O.S.K. Lines
Nedlloyd Lines, Inc
Neptune Orient Lines Ltd
New United Motor Mfg Co
No. Calif Marine Assoc
NYK Line
Oakland Chamber of Commerce
OOCL (USA), Inc
Ortiz International
Pacific Gas & Electric
Pacific Inter-Club Yacht Assn
Pacific Merchant Shipping
Paktank Corporation
Paradise Cay Homeowners
Paramount Export Company
The Pasha Group
Peninsula Marina
Port of Oakland
Port of Sacramento
Port of San Francisco
Post Newspapers
San Francisco Custom Brokers & Freight Forwarders
San Francisco Chamber of Commerce
San Francisco Bar Pilots
Santa Fe Railroad
Schnitzer Steel
Sea-Land Service
Southwest Marine, Inc
S P Transportation Co
Star Shipping, Inc
State Board of Pilot Commissioners
Stevedoring Services of America
Strawberry Recreation District
Tidewater Sand & Gravel
Time Oil Company
Tosco Refining Company
Trans Pacific Container Service
Transamerica Corporation
TransBay Container Terminal
United Auto Workers
Viking Industrial Corporation
West Oakland Commerce Association
Yusen Terminals, Inc

determined on an ad hoc project by project basis.

We would appreciate being advised as you complete the EIS process.

Sincerely,

Walter A. Abernathy
Coordinator

Exhibit

3

WORLD TRADE CENTER, SUITE 303 SAN FRANCISCO CALIFORNIA 94111 (415) 397-2293 FAX (415) 986-069-

January 25, 1993

1/27/93 PM 1/25

Mr. Harry Seraydarian, Director
Water Management Division
U.S. Environmental Protection Agency
75 Hawthorne Street (W-7-1)
San Francisco, CA 94105

Subject: BPC Support for Draft Environmental Impact Statement on Deep Material Disposal Site

Dear Mr. Seraydarian:

The Bay Planning Coalition is writing to expresses its strong support for the effort to designate a deep water ocean disposal site for material dredged from San Francisco Bay. Founded in 1983, the Coalition is a non-profit, public interest organization representing more than 200 ports, marinas, businesses, local government entities and property owners in the San Francisco Bay region and shoreline environs.

As a convener of and active participant in the Long Term Management Strategy (LTMS) for dredged material disposal, we are committed to the goal of providing an array of disposal options for material dredged from S.F. Bay over the next 50 years. The designation of this ocean site will represent a significant milestone in the LTMS effort.

We concur in the findings of the Draft Environmental Impact Statement (DEIS) which has designated as the preferred alternative disposal site the former Naval chemical munitions site. This proposed ocean site will provide a viable disposal option for an estimated 6 million cubic yards per year of dredged material. Further, the site is located in deep water approximately 50 miles from shore, away from productive fishery areas.

As representatives of the maritime community, the navigability of San Francisco Bay's channels and the crisis over the future of available dredged sediment disposal sites gravely concerns us. Even though we are very supportive of a deep water ocean site, we are concerned about the additional cost, not only of transporting the material 55 miles west but also the costs of site monitoring. 3-A

We recommend that a serious dialogue be initiated among EPA, the maritime industry and environmental interests during the process of finalizing the EIS, in order to develop a workable, cost-effective monitoring program. We look forward to hearing from you.

Sincerely yours,

Ellen Johnck

Ellen Johnck
Executive Director

STATE OF CALIFORNIA—THE RESOURCES AGENCY PETE WILSON, Governor

CALIFORNIA COASTAL COMMISSION
45 FREMONT, SUITE 2000
SAN FRANCISCO, CA 94105 2219
VOICE AND TDD (415) 904-5200

January 21, 1993

Harry Seraydarian, Director
Water Management Division
EPA Region IX
75 Hawthorne Street (W-7-1)
San Francisco, CA 94105

RE: Coastal Zone Management Act requirements for proposed ocean disposal site - San Francisco Bay Deep Water Dredged Material Disposal Site Designation

Dear Mr. Seraydarian:

The Coastal Commission staff has recently received a Draft Environmental Impact Statement (EIS) for the above-referenced project. In that Draft EIS, EPA states that it will submit a consistency determination, pursuant to the federal Coastal Zone Management Act (CZMA) (16 U.S.C. 1456), to the Coastal Commission. Although the disposal site is located approximately 42 miles from the mainland coast and 22 miles from the Farallon Islands, the Commission staff agrees that a consistency determination is needed because of the potential that disposal at the site will affect coastal resources. (4-A)

The potential effects you should focus on in your consistency analysis include:

1. Effects on Endangered Species.

The disposal of contaminated material at the ocean disposal site has the potential to affect federally listed endangered and threatened species. If material to be disposed of at the site is contaminated, these contaminates may be absorbed into the food chain and accumulate in the tissues of some species, including the listed endangered and threatened species. There are several federally listed endangered and threatened species in the vicinity of the disposal site, including the California gray whale and the northern fur seal. The gray whale is also a regular visitor to nearshore areas including the coastal zone, and therefore, is a coastal zone resource. In addition, the northern fur seal is known to use the area around the Farallon Islands and is known to come onshore during its breeding season. Therefore, the northern fur seal is also a coastal zone resource. Since the disposal activities at this site could affect both the gray whale and the northern fur seal, the project could affect natural resources of the coastal zone. (4-B)

2. Transportation Through the Coastal Zone.

The proposed disposal activities could affect the coastal zone during transportation of the material from the dredge site to the disposal site. Transportation concerns are two-fold: (1) the risks of accidental spills (and since some of the dredged material may be contaminated, the impact from accidental spills could be significant); and (2) the potential dumping of material before the barge reaches the disposal site. Both spillage and "short dumping" have commonly occurred at other disposal sites (such as LA-5 and LA-2) in the past. If these events occur in or near the coastal zone, they will affect the coastal zone.

The Draft EIS states on page 4-87 that a Site Management and Monitoring Plan will be included in the FEIS, as an Appendix, but is not available for review at this time. We would appreciate being involved in the evolution of this plan before it is finalized, and we hope the plan and Final EIS will address the following questions:

Page 3-17 of the DEIS states that the site could be used "except when wave heights exceed 3 meters and wave periods are 9 seconds or less (approximately 10% of the time, typically from February through May ...)". How will this be enforced? Will there be a total ban when waves reach this state? How and when will the determination be made as to unsuitability of sea conditions? What will happen if a dredge vessel is in transit when waves reach this sea state? Will dredge vessels be filled to less than capacity if sea conditions approach this state? What independent monitoring will assure that these measures will be complied with? Why were these sea conditions selected as the constraints? 4-C

It is our understanding in reviewing dredging in southern California that 6 ft. waves trigger constraints on dredging operations. If this is the case, is there an explanation for the discrepancy in treatment between dredging in northern and southern California? 4-D

What records has EPA (or the Corps) collected from monitoring of past dredging activities involving ocean disposal in California (or if that information is not available, then other parts of the country), indicating the frequency and amount of spillage or accidents that occur during different sea conditions? 4-E

Pages 4-89 and 4-90 of the DEIS discuss possible management options for, among other things, assuring that dredge vessels dispose of the material in the desired location. No particular options are committed to in the Draft EIS, so it is difficult at this time to comment intelligently. We believe it is critical that assurances be built into the site management and monitoring plan that will, independent of operator/applicant assurances and certifications, 4-F

Letter to Mr. Seraydarian
January 21, 1993
Page 3

guarantee that short dumping and excessive spillage do not occur outside the designated site. The importance of this issue is underscored by the statement in the Draft EIS that the Coast Guard cannot track vessels outside 45 km from shore, (based on p. 3-19 of the DEIS, which states: The Coast Guard's marine radar ... has an operational range of approximately 45 km (27 mi) from Point Bonita (i.e., the approximate distance to the Farallon Islands).)"

If you have any questions about the Commission's concerns or the federal consistency process, please contact James Raives of the Commission staff at (415) 904-5280.

Sincerely,

PETER M. DOUGLAS
Executive Director

cc: North Coast Area Office
BCDC

MPD/mcr
1964p

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Exhibit (5)

California Environmental Protection Agency

Air Resources Board • Department of Pesticide Regulation • Department of Toxic Substances Control • Integrated Waste Management Board
Office of Environmental Health Hazard Assessment • State Water Resources Control Board • Regional Water Quality Control Boards

Pete Wilson
Governor

James M. Strock
Secretary for Environmental Protection

January 25, 1993

Mr. Harry Seraydarian
Director
Water Management Division
U.S. Environmental Protection Agency
Region IX
75 Hawthorne Street (W-7-1)
San Francisco, California 94105

Dear Mr Seraydarian

As Secretary for Environmental Protection and Governor Pete Wilson's designated State Coordinator for San Francisco Bay dredging issues, I am pleased to have this opportunity to comment on the Draft Environmental Impact Statement (DEIS) for San Francisco Bay Deep Water Dredged Material Disposal Site Designation issued in December 1992 by the USEPA. This letter serves as a compilation of comments directly related to the adequacy of the DEIS, which I received from State of California agencies involved in the dredging and dredged material disposal processes. Attached please find copies of the individual agency comment letters.

In general, the State is pleased with USEPA's efforts throughout this lengthy site designation process and appreciates the timely production of the DEIS. Tens of thousands of jobs, and a major portion of the San Francisco Bay Area's economy, are dependent on a thriving port-related industry. USEPA's efforts to produce this and other environmental documents related to this project on-schedule are critical to the timely designation of an dredged material disposal site.

Furthermore, the State supports the DEIS preferred alternative -- Alternative Site No. 5 -- for the proposed designation of a deep water dredged material disposal site. It appears to be the best selection in terms of providing an environmentally acceptable ocean disposal site and in providing adequate capacity for material dredged from San Francisco Bay.

555 Capitol Mall, Suite 235 • Sacramento, California 95814 • (916) 445-3846 • Fax: (916) 445-6401

The following are the key points raised about the DEIS in comments received from State agencies, and which the State of California requests the USEPA address in the Final EIS. We also urge you and your staff to refer to the attached comments from the involved State agencies for comments on some of the more technical issues and for more detailed discussion on the issues outlined below. The additional points raised in the attached comments would help improve the usefulness of the DEIS. However, the key points related to the adequacy of the DEIS are as follows:

- Include a statement assuring that the proposed consistency determination to be submitted by the USEPA to the California Coastal Commission pursuant to the Coastal Zone Management Act will address the potential effects ocean disposal of contaminated material will have on federally endangered and threatened species in the region, specifically the California gray whale and the northern fur seal. Our understanding is that contaminated material will be disposed at other than the proposed ocean site. This clarification in the DEIS would address the Coastal Commission's concern. 5-A

- Include a statement assuring that the consistency analysis will address possible repercussions of transporting the material from the dredge site to the disposal site. Specifically, these concerns are: (1) the risks of accidental spills; and (2) the potential dumping of material before the barge reaches the disposal site. 5-B

- Address the San Francisco Bay Conservation and Development Commission's regulation of the siting and use of in-Bay sites for the disposal of dredged material. While the proposed Ocean Dredged Material Disposal Site is outside the Commission's jurisdiction, Section 2.1.3.1 of the DEIS addresses San Francisco Bay disposal alternatives and regulation of these projects, and should mention the role of the Commission in permitting these alternative sites. 5-C

- o Improve the discussion of site management and monitoring with respect to specific actions that may be taken by -- or opportunities available to -- USEPA and the Corps of Engineers. While we understand the monitoring plan will be developed as part of the final site designation and that public review will be provided through the normal regulatory process for that designation, the types of monitoring options should be included in the Final EIS to serve as the basis for those reviews. 6-D

On this final point, we urge USEPA to include the State of California in the development of the proposed Site Management and Monitoring Plan. In addition, the Department of Fish and Game has raised the opportunity that is available through the use of the Navy's proposed 103 site. The results of the monitoring program for this activity will not be available in time for the Final EIS, and therefore will not be critical to the adequacy of that document, but it could provide a useful basis for determining the final details of the monitoring program for USEPA's proposed permanent ocean disposal site.

Thank you for providing agencies of the State of California this opportunity to comment on the Draft EIS for San Francisco Bay Deep Water Dredged Material Disposal Site Designation. If my office can be of any assistance in clarifying the State's position, or if you wish to arrange a meeting with the involved State agencies to discuss these comments, please do not hesitate to contact Assistant Secretary Michael Kahoe at (916) 322-5844.

Sincerely,

James M. Strock
Secretary for Environmental Protection

Attachments

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Exhibit (6)

THE CALIFORNIA FISHERIES RESTORATION FOUNDATION CFRF

12-26-92

1146 Pulora Court
Sunnyvale, CA 94087-2312

USEPA, Region IX
75 Hawthorne Street (W-7-1)
San Francisco, CA 94105
ATTN: H. Seraydarian, Director, Water Management Division

SUBJECT: San Francisco Bay Dredge Spoils Dumping
DEIS Deep Water Disposal Site

Dear Sir:

The California Fisheries Restoration Foundation is concerned with all classes of waters and all species of fish.

The fisheries of the San Francisco Bay and tributaries waters have declined to the point of criticality. Spoils in the Bay contribute to toxicity and turbidity. They can no longer be tolerated.

We are opposed to dumping of spoils material anywhere in the waters of San Francisco Bay.

The USEPA has located a 50 mile offshore site for 6 million cu yds of material/year. We urge that this site be used.

Very truly yours,

Martin M. Seldon
President

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Exhibit (7)

State of California

California Environmental Protection Agency

Memorandum

To : Mike Kahoe
CAL EPA
555 Capitol Mall, Suite 235
Sacramento, CA 95814

Date: January 14, 1993

From : Martha Vázquez
Martha Vázquez, Deputy Director
Permitting & Compliance Division
California Integrated Waste Management Board

Subject: Environmental Impact Statement (EIS) for the San Francisco Bay Deep Water Dredged Material Disposal Site Designation (DMDSD).

California Integrated Waste Management Board (CIWMB) staff have reviewed the document for the project cited above and offer the following comments:

Project Description ("Abstract")

The EIS evaluates the proposed designation of a deep-water ocean dredged material disposal site as part of the Long-Term Management Strategy (LTMS) for the San Francisco Bay. The LTMS is a Federal and State partnership responsible for addressing options for dredged material disposal, including ocean sites, sites within the Bay, nonaquatic sites, and beneficial uses of dredged material. Once designated, the proposed ocean site will provide a disposal option for an estimated 6 million cubic yards (cy) per year of dredged material over a 50-year period. Before ocean disposal may take place, proposed projects must demonstrate a need for ocean disposal and material must be acceptable according to United States Environmental Protection Agency (USEPA) and United States Army Corps of Engineers criteria and regulations.

The preferred alternative site is located on the continental rise off San Francisco approximately 50 nautical miles from shore and in 2,500 to 3,000 meters of water. Selection of the preferred alternative site, as compared to two alternative ocean sites and the No-Action alternative, is based on evaluation of the 5 general and 11 specific criteria of the Ocean Dumping Regulations listed at Code of Federal Regulations, Title 40, Sections 228.5 and 228.6, respectively.

Because other options will be evaluated by ongoing LTMS Work Group efforts, concerning disposal within the Bay, nonaquatic/reuse sites, and implementation, the EIS evaluates only the ocean disposal and No-Action alternatives. Evaluation of non-ocean disposal options are scheduled for completion in 1994. If disposal within the Bay or at a nonaquatic/reuse site is feasible, a decision whether an ocean dredged material disposal site is the best disposal option will be made during the National Environmental Policy Act (NEPA) and permit review process according to the existing regulations and other guidelines developed by the LTMS.

CIWMB Comments

The EIS does not consider the alternative "nonaquatic/reuse sites" for evaluation as described in the EIS on page 2-2 and 2-18. If a nonaquatic upland disposal site is considered, the CIWMB will be a Responsible Agency and compliance with the California Environmental Quality Act (CEQA) will be necessary. The CIWMB is the California agency responsible for the regulation of solid waste management as they pertain to the California Code of Regulations (CCR), Title 14. Issues related to the CEQA preparation and review process are affected by the following: 7-A

A.) Identification of facilities/locations targeted for handling and/or disposal of solid wastes and materials associated with the proposed DMDSD project. Page 2-25 of the EIS identifies the Redwood Sanitary Landfill (RSL), Solid Waste Facilities Permit (SWFP) #21-AA-0001, as a potential site for using dredge materials as a cover material. This cover material would be considered as an alternative cover. An application for the use of alternative cover material needs to be submitted to CIWMB for approval. If the application is approved, then a one year demonstration period for studying the alternative cover material is done. RSL is proposing an expansion of the disposal site capacity and circulation of an environmental document is pending. Comments relevant to this document are not intended to imply concurrence on a proposed expansion at the RSL. Many sites throughout the Bay Area could benefit from additional source material for cover and should also be considered by the Nonaquatic/ Reuse Work Group. 7-B

B.) Identification of the anticipated constituents of the solid waste (physical and chemical make-up) and the average and maximum daily tonnages of solid wastes and materials to be received upon implementation of the project, including any additional increases in the material to be diverted for beneficial use. Mitigation should be incorporated or included in the event that the materials to be disposed of are determined to be hazardous. 7-C

C.) Identification of the potential impacts of these quantities on the permitted daily tonnages at the targeted landfills, remaining landfill capacities and the calculated site-life associated thereof. CCR, Title 14, Section 18211, requires that any permittee proposing to make a significant change in the operation of the facility shall, at least 120 days prior to the proposed modification, apply for a revision of the Solid Waste Facilities Permit (SWFP). A change shall be deemed significant for purposes of this section if and only if it does not conform to terms or conditions of the SWFP as it relates to the project under CEQA. The CIWMB will need Waste Discharge Requirements (WDRs) from the Regional Water Quality Control Board (RWQCB) permitting the use of dredged sediment for disposal and use as an cover material at sanitary landfills. The WDRs would be necessary before any dredged material could be disposed of at disposal facility/ location. 7-D

Risk of Upset / Human Health and Safety

Page 2-23 of the EIS states that "...key factors affecting the feasibility [of nonaquatic disposal and reuse alternatives] typically include site access and capacity, compatibility of the dredged material with construction or engineering requirements, contaminant levels in dredged material, presence of critical habitat or endangered species, habitat replacement value, and regulatory requirements of local, state, and federal governments (COE 1992a)." Dredged materials have the potential to harbor organic hydrocarbon and/or inorganic heavy metal contamination. An approved testing program should be considered if the nonaquatic upland disposal option is considered. 7-E

The CIWMB requests that dredge spoils material be tested by a certified laboratory for organic and inorganic constituents in compliance with CCR, Title 22, Article 11. A determination whether the material is hazardous, designated or non-hazardous in accordance with the standards set forth by the California Department of Substances Control should be attained before the material is allowed to be stored, processed, used or disposed of at a sanitary landfill. 7-F

Thank you for the opportunity to review and comment on this project. The CIWMB staff ask that you keep the Board apprised of solid waste generation, disposal, and source reduction/recycling issues associated with the proposed project. If you have any questions regarding these comments or would like additional assistance from CIWMB staff, please contact John Loane of the Facility Review Branch at (916) 255-2439.

cc: Don Wallace, CIWMB Chief Deputy Director

Exhibit (8)

Center for Marine Conservation
Formerly Center for Environmental Education Est 1972

J. 1/27/93

January 22, 1993

Mr. Harry Seraydarian, Director
Water Management Division
U.S. Environmental Protection Agency
75 Hawthorne Street (W-7-1)
San Francisco, CA 94105

Comments on the Draft Environmental Impact Statement (Dec. 1992) for San Francisco Bay Deep Water Dredged Material Disposal Site Designation.

Dear Mr. Seraydarian:

The Center for Marine Conservation (CMC), a national non-profit citizen's organization dedicated to conserving marine species and their habitats, welcomes this opportunity to offer the following comments on the Draft Environmental Impact Statement (DEIS) for San Francisco Deep Water Dredged Material Disposal Site Designation.

We are pleased that the EPA has eliminated on-shelf alternatives for ocean disposal. We look the EPA to rigorously review its preferred off-shelf deep water site that is to be included as one option in a range of disposal alternatives.

NON-OCEAN DISPOSAL OPTIONS

Before disposal begins at the proposed deep water dredged material disposal site, it is very important that the full range of disposal alternatives, including nonaquatic sites and beneficial uses, be evaluated. We are concerned that, as stated at the EPA's public meeting on January 19, 1993, utilization of the site will begin in January 1994. According to the DEIS, evaluations of non-ocean disposal options are scheduled for completion by the LTMS for sometime in 1994. As noted in the DEIS, "Ocean disposal is permitable only if there are no practical alternatives." (p. 4-87) Clearly, all alternatives must be available before making such a determination. (8-A)

312 Sutter Street, Suite 606 San Francisco, CA 94108 (415) 391-6204 Telefax (415) 956-7441

We believe that having a wide range of alternatives is necessary in order to wisely choose the most practical and least environmentally damaging site. Because the deep water site is situated in close proximity to three national marine sanctuaries which contain nationally significant resources, careful consideration must be given to all alternatives before permitting disposal at this site.

INTER-AGENCY CONSULTATION

According to the Sanctuary Program reauthorization legislation passed last fall, "Federal agency action internal or external to a national marine sanctuary, including private activities authorized by licenses, leases, or permits, that are likely to destroy, cause the loss of, or injure any sanctuary resource are subject to consultation with the Secretary (of Commerce)." Accordingly, the Center looks to the EPA to consult closely with the National Oceanic and Atmospheric Administration regarding permitting for disposal at the deep water dredged material disposal site. 8-B

MONITORING PLAN

We are also concerned about the DEIS's failure to outline an adequate monitoring plan. Although the DEIS acknowledges the importance of monitoring, it does not set out a concise, agreed-upon plan. Careful monitoring must be a priority and must be addressed in the Final EIS, not at the permit level. Because monitoring is vital to ensuring the protection of resources, dredged material disposal should be allowed only if a monitoring system has been established and funded. 8-C

We recommend that the monitoring plan include the monitoring of: environmental impacts, especially impacts to sanctuary resources, of dredged material disposal; proper disposal of dredged materials and proper transit to the disposal site; and any cumulative or synergistic effects.

As data is collected from monitoring efforts, the EPA must take this new information into account and should revise regulations if necessary to minimize impacts to the environment and, in particular, to the nearby national marine sanctuaries. The Final EIS should include provisions that call for such action. Revisions may include, for example: regulating disposal activities based on seasons and currents, altering the pattern of disposal, reducing the amount of material disposed. 8-D

Environmental Impacts

As the DEIS states, "Effects from dredged material disposal at deep-water sites are not well known." (p. 4-7) Furthermore, because no specific data were available, the EPA based its predictions about the effects of dredged material disposal on models. Because so little is currently known, it is extremely important that the effects of disposal be carefully monitored to evaluate the accuracy of the predictions and to determine whether or not dredged material disposal has created any significant ecological impacts. 8-E

Furthermore, because of the proximity of the site to three national marine sanctuaries, extra care must be taken to ensure that dredged material disposal does not adversely affect sanctuary resources. National Marine Sanctuaries are selected for their outstanding marine resource values and these values should not be placed at risk by activities associated with unmonitored dredged material disposal. Indeed, the DEIS points out that, "...any site selected as an ODMDS may require a more intensive monitoring effort because of its proximity to the Sanctuary resources." (p. 1-12) We strongly believe that intensive monitoring of disposal effects on sanctuary resources must be an integral component of the monitoring plan. 8-F

In consultation with the National Oceanic and Atmospheric Administration's Sanctuaries and Reserves division, the EPA should identify and establish monitoring sites within the sanctuaries, on the perimeters of the sanctuaries, and outside the sanctuaries in order to maximize the ability to detect any environmental effects on sanctuary resources caused by dredged material disposal. The plume resulting from the dredged material disposal must be adequately tracked, especially as that plume approaches sanctuary boundaries. 8-G

Furthermore, monitoring must be comprehensive and should include the monitoring of biological resources all the way up the food chain in addition to traditional sediment and water column monitoring. 8-H

Finally, if modeling is to be used on a continuing basis, the EPA should endeavor to use the best models available as the art of modeling improves over time. 8-I

Proper Transit and Disposal

EPA's Draft EIS contemplates transit through the Gulf of the Farallones National Marine Sanctuary. It is imperative that the operators are monitored by an independent source to ensure proper transit and disposal of the material. Independent monitors may 8-J include, for example, independent, trained observers on board every trip and/or special equipment that is feasible and able to track the barge's route and the location of disposal.

The FEIS should specify transit routes which avoid the vicinity of the Farallon Islands, should specify strict loading guidelines, and should prohibit transit during particularly rough weather or wave conditions. 8-K

We would like to emphasize that sanctuary regulations prohibit the dumping of dredged material within sanctuary boundaries. Therefore, all precautions should be taken to avoid overflow or premature dumping within the sanctuary. We believe that independent monitoring of the operators will be the most effective way to accomplish this goal.

Cumulative effects

Finally, the plan should incorporate monitoring of any cumulative or synergistic effects that may occur due to the disposal of dredged materials onto previously disposed waste materials, as well as of any cumulative effects of disposal in conjunction with the Navy's 103 project. 8-L

CONTAMINANT LEVELS

We also have some concerns about the contaminant levels of the materials to be disposed of at this site. If the data collected from monitoring efforts indicates that contaminants may be harming marine resources, more stringent contaminant standards should be adopted. 8-M

In no case should the contaminant standards be weakened. It is our understanding that the contaminant levels are now measured by Greenbook standards. Should the Greenbook standards be weakened in the future, it is important that the contaminant levels for the dredged material not be weakened as well. Contaminant levels should be explicitly stated in the Final EIS with provision made for application of stricter standards. No waivers should be allowed. 8-N

CONTINGENCY PLANNING

The EPA's Final EIS for the deep water dredged material disposal site designation should outline in detail a contingency plan that will be adopted should monitoring data indicate that the dredged material disposal at this site is adversely affecting the marine environment. In order to reduce the impact of the disposal, a contingency plan might include, for example: 8-O

- Adopting more stringent contaminant standards
- Reducing the amount of material to be disposed
- Imposing seasonal restrictions
- Closing the site

We appreciate this opportunity to comment and your attention to our concerns. Please keep us apprised of the status of this project.

Sincerely,

Barbara Miller, Assistant
Pacific Habitat Conservation Program

cc:

Rachel Saunders, Center for Marine Conservation
Director, Pacific Habitat Conservation Program

Burr Heneman, Center for Marine Conservation
Director, Pacific Region

Jack Sobel, Center for Marine Conservation
Director, Habitat Conservation Program

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EXHIBIT 9

Central Labor Council of Alameda County

AFL-CIO

7992 CAPWELL DRIVE | OAKLAND, CALIFORNIA 94621 | *Telephone* (510) 632-4242

RICHARD K. GROULX,
Executive Secretary-Treasurer Emeritus

JUDITH M. GOFF,
President

OWEN A. MARRON,
Executive Secretary-Treasurer

MICHAEL K. HENNEBERRY,
Assistant Secretary

January 19, 1993

Harry Seraydarian 1/21/93
Director, Water Management Division
U.S. Environmental Protection Agency
75 Hawthorne Street, (W-7-1)
San Francisco, CA 94105

Dear Mr. Seraydarian:

On behalf of the Central Labor Council of Alameda County, AFL-CIO, our 130 affiliated unions and their 70,000 union members in Alameda County I write to support the EPA's designation of an ocean disposal site for dredge material. The Council believes that it is essential to ending the "mudlock" that has gripped the maritime community's ability to get dredging done that the EPA go forward with this designation.

We applaud you for your successful work to bring this designation to the public. We share the view of many that the ocean site should be just one of a number of approved sites for deposition of dredge material, but that it is an important and essential element of such a group.

We also support the views of environmental and fishing concerns that monitoring should be addressed in the EIS. To this point, we hope you will include reference to the need for monitoring of the effects of disposal, monitoring to ensure that dumping occurs where it is supposed to, and monitoring of the effects of transit through the marine sanctuary. 9-A

Let me reiterate our absolute concern that the ocean site be approved as quickly as possible in order for important dredging projects to be undertaken. Without it, we will be faced with stagnation of the maritime industry and a decline in the hundred thousand jobs it supports.

Sincerely,

Owen A. Marron
Executive Secretary Treasurer

OAM:pd
opeiu 29
afl-cio
cc: Ron Dellums, Congressman

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Exhibit (10)

City and County of San Francisco
Department of City Planning

450 McAllister Street
San Francisco, CA 94102

January 22, 1993

Mr. Harry Seraydarian, Director
Water Management Division
U.S. Environmental Protection Agency
75 Hawthorne Street (W-7-1)
San Francisco, CA 94105

RE: COMMENTS ON THE ENVIRONMENTAL PROTECTION AGENCY DOCUMENT- DEIS ON SF BAY DEEP WATER DREDGED MATERIAL DISPOSAL SITE DESIGNATION

Our office, particularly in our capacity as the agency responsible for environmental review for the Port of San Francisco, welcomes the opportunity to comment on the DEIS for the Deep Water Dredged Material Disposal Site. In general, the EPA is to be commended for the comprehensive coverage and readability of this very technical document. The least accessible sections (that is to the informed lay reader) are those that deal with the operation of the model used to determine effects of disposal on water quality (SAIC 1992e), and what the implications of that are for the project and principles of environmental protection that are the purpose of this effort. (10-A)

The content of the DEIS has the stated goal of providing documentation for the identification of an acceptable ocean dredged material disposal site which would not cause "unreasonable degradation". This document examines very closely five study areas outside of the entrance to the Bay, and as far as 50 miles off-shore. There is one preferred and two alternative sites, the preferred site being that which is furthest from shore. Assuming that the preferred site would be designated, what, if any, status (in terms of future use) would the alternatives have? (10-B)

The analysis includes a discussion of the necessity for and a proposal to carry out monitoring and surveillance of the chosen site. It is not clear to this reader how compliance would be assured, or what penalties would follow if there is a lack of compliance with the rules and location for dredged materials disposal. <u>see pages S-11 and 3-19 and sections 3.1.4.1 and 3.1.4.2</u> (10-C)

A major issue for the Port of San Francisco also involves the implementation of the monitoring and surveillance program. Neither the costs, nor who would pay them, are spelled out in this document. It is of great interest and concern that this be clearly spelled out before the final EIS is published. The Port is willing to assist in seeking a funding authority for the monitoring and surveillance program, but it is essential that it be defined and put out for public review and discussion. Their expanded remarks on this point will be sent to you under separate cover. We believe it will be necessary to recirculate at least a discussion of alternative monitoring and surveillance programs and the potential economic impacts of those programs. (10-D)

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IMPLEMENTATION / ZONING (415) 558-6377
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San Francisco Department of City Planning
Office of Environmental Review
Response to the EPA'S DEIS
SF Bay Deep Water Dredged Material Disposal Site Designation
January 19, 1993

This document only examines the ocean alternatives for dredged materials disposal. Is it the case that the recommendations of this DEIS, in combination with the results of the the Long Term Management Study (LTMS) that is still underway, would take care of forseeable needs for locations to dispose of dredged materials from San Francisco Bay? This document indicates that one site would not be adequate for even the near term. Are we to assume that with the additional utilization of in-bay, non-aquatic, and re-use sites that would be recommended by the LTMS, predictable future needs would be taken care of? If it is true that it is unlikely that a single site can accomodate planned volumes and varying characteristics of dredged materials, what would that mean in practical operational terms? Would the alternative disposal sites be next in line, or would the whole question have to be re-examined when the chosen site is no longer viable? page 1-7 10-E

It is stated that the "factors controlling dispersion of slurried dredge materials in the bay is poorly understood". Is this also true of the dispersion of such materials in the ocean? If it is true, what are the implications of this for ocean disposal? How can impacts be fully evaluated? Would there be slurried dredge materials likely proposed for ocean dumping? page 2-21 10-F

The Bay Farm Borrow Area is referred to as a receptor site for spoils located in the Bay. Since this is not analyzed or evaluated in this document, is the use of that site "approved" and/or covered in some other environmental document? page 2-22

There is a comparison of the Alternatives to EPA's 11 specific criteria for site selection found at 40 Code of Federal Regulations Section 228.6(a). The preferred site differs from the others by being "more difficult to monitor", the only site with previously dumped radioactive wastes, and the "dredge barge traffic could interfere with recreational boat traffic." Do the facts that it is a much deeper site and much further out than the others compensate for the above negative characteristics? This issue appears to warrant further discussion in the EIS. pages 2-33 through 2-41 10-H

Using Criteria #5, "feasibility of surveillance and monitoring" it appears that the deepest, least understood area that already contains hazardous wastes has been chosen as the "preferred site". Please explain how this site could be overseen and monitored. The following could be construed by some as a "red flag" page 2 - 36: 10-I

> Monitoring feasible but possibly the most difficult because of greater water depths, generally larger footprint, limited knowledge of deep-water communities, and potential hazards from historical disposal of radioactive waste containers and chemical and conventional munitions.

This statement does not explain how monitoring is feasible; the basis for the conclusion is not supplied.

There is a discussion regarding the presence of sediment radionuclides which are being evaluated for necessary remediation? pages 3-93 and 3-94 What does THIS mean? Again, this seems like a red flag. When would this analysis be completed? It also seems that much of the research in this particular area is quite old, does that matter? 10-J

It is stated that the presence of the whales would be disturbed if Area 5 is chosen. Are we to assume that the disturbance would not be significant? page 3-192 10-K

These statements (page 4-7) are of concern:

> Other sources of information concerning environmental impacts of dredged material disposal are based almost exclusively on research and monitoring of nearshore, shallow-water sites. Effects from dredged material disposal at deep-water sites are not well known. Of the more than 150 dredged material disposal sites in U.S. coastal waters, most are in water depths of less than 20 meters (EPA 1989). Some limited information on environmental consequences of dredged material disposal in deep water areas is available. For example, information exists for the Yabucoa Harbor, Puerto Rico, ... and sites located off of southern California...

And in the next paragraph it states that:

> The following discussions of potential impacts are therefore based primarily on results of shallow water disposal site studies ... . However, the deep continental slope and rise environment, within which the preferred and alternative sites are located, represents a unique combination of geological, hydrographic, and biological features that must be considered when evaluating the consequences of ocean disposal of dredged material in these environments. Therefore, as appropriate, limits of present knowledge are identified along with the uncertainties of extrapolating this information to the deep water environments of the LTMS study region.

One wonders what the research on deeper disposal sites showed. Again, conclusions are presented without providing data and assumptions so the reader is left to accept the conclusion or perform research in the EPA's library. This seems like limited compliance with the public input and disclosure intents of NEPA. 10-L

Would you please clarify what the context of the "limits of present knowledge" is and what it means as it relates to the model. The technical model discussion on pages 4-7 10-M through 4-63 is nearly incomprehensible to the lay reader. It is particularly difficult to make sense of the charts on pages 4-24 through 4-27. If we, "the public" need to understand them, please explain them further.

Why is it that the location of the radioactive wastes cannot be determined? page 4-93. 10-N

Chapter Five is a most welcome explanation of the very complicated story regarding co-ordination of agencies and regulations. It is also most appreciated that you have included the names of the individuals and their respective agencies and responsibilities who have worked, and, we presume, will continue to work on this project. Thank you.

This office looks forward to your responses to our comments. There is much very useful information contained in this document for those of us concerned with the issues of dredging, appropriate disposal of dredged materials, and adequate environmental protection of our Bay and the ocean. If you have questions regarding our comments, please call Barbara Sahm or Sharon Rogers at 558-6382.

Very truly yours,

Barbara W. Sahm

Barbara W. Sahm
Environmental Review Officer
San Francisco Department of City Planning
Office of Environmental Review

RONALD V. DELLUMS
8TH DISTRICT, CALIFORNIA

CHAIRPERSON,
COMMITTEE ON THE
DISTRICT OF COLUMBIA

ARMED SERVICES COMMITTEE

CHAIRPERSON
SUBCOMMITTEE ON
RESEARCH AND DEVELOPMENT

PERMANENT SELECT COMMITTEE
ON INTELLIGENCE

Exhibit (11)

Congress of the United States
House of Representatives

ANY REPLY TO THIS LETTER
SHOULD BE ADDRESSED TO
OFFICE CHECKED:

CARLOTTIA SCOTT
ADMINISTRATIVE ASSISTANT

ROBERT BRAUER
SPECIAL COUNSEL

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January 15, 1993

Mr. Harry Seraydarian
Director, Water Management Division
U.S. Environmental Protection Agency
75 Hawthorne Street, (W-7-1)
San Francisco, CA 94105

Dear Mr. Seraydarian:

I write to commend the Environmental Protection Agency for its careful and productive search for an environmentally sound ocean disposal site for dredge material disposal. I believe that the identification of such a site, and its addition to a broad menu of other sites, to include upland and some carefully considered in bay options, is critical to the achievement of both environmental and economic objectives associated with necessary maritime dredging operations.

I concur with the priority that EPA has given to designating a site that is at the continental rise, in deep water. It is of obvious importance, both commercially and environmentally, that the site selected have negligible or zero impact on fisheries and on habitat that support species essential to the maintenance of our fisheries. I believe that your designation has achieved this goal, while providing an important addition to the necessary management of dredge disposal.

I would only add that the final EIS issued by the EPA should include provisions to ensure the monitoring of the effects of the disposal at the site; to monitor dredge material disposal to ensure that it occurs at the site; and, to monitor the effects of transportation of dredge material through the Gulf of The Farallones National Marine Sanctuary. I firmly believe that transit and dumping can be conformed to be consistent with our sanctuary goals, and that the EIS must establish this as a policy incident to issuing permits for disposal at the designate site. (11-A)

Finally, I am pleased that the EPA has managed to craft a solution to this difficult problem that seems to have acquired the cautious support of most who are concerned with protecting the ocean and its inhabitants as well as those in the shipping, port and business community who have faced the dire economic consequences of a seemingly endless process to identify a suitable dredge disposal site. The significant economic and jobs dislocation that has occurred so far, and the dire economic consequences of a failure to resolve this issue, are apparent to us all. This significant development will help us to complete the work of the Long Term Management Strategy and other efforts to ensure that the ocean site represents only one of a number of permitable options available to ports and marinas in our estuary.

I applaud you on your work and look forward to the adoption of the final EIS and the work that it will allow to follow.

Sincerely,

Ronald V. Dellums
Member of Congress

RVD:hlh

Exhibit (12)

Congress of the United States
House of Representatives
Washington, DC 20515

January 25, 1993

X 1/29/93 Pm ?

Mr. Harry Seraydarian
Director, Water Management Division
U.S. Environmental Protection Agency
75 Hawthorne Street, (W-7-1)
San Francisco, CA 94105

Dear Mr. Seraydarian:

We write to commend the Environmental Protection Agency for its careful and productive search for an environmentally-sound ocean disposal site for dredge material. We believe that the identification of such a site, and its addition to a broad menu of alternative sites, is critical to the achievement of both environmental and economic objectives associated with necessary maritime dredging operations in the Bay Area.

We concur with the priority EPA has established in recommending the designation of a deep ocean disposal site. It is important, both commercially and environmentally, that the site selected have negligible or no impact on fisheries. We believe that the designation would advance this important goal, while continuing the essential management of dredge material from Bay Area ports and marinas.

It is our expectation that the final EIS issued by the EPA will include provisions to monitor the effects of disposal at the site; to monitor dredge material disposal to ensure that it occurs at the site; and, to monitor the effects of transportation of dredge material through the Gulf of the Farallones National Marine Sanctuary. We firmly believe that transit and dumping can be consistent with sanctuary goals, and that the EIS must establish this as a policy for issuing permits for disposal at the designated site. (12-A)

We are pleased that the EPA has been diligent in its efforts to seek environmentally-sound ocean disposal alternatives for dredge material. This significant development will help us complete the work of the Long Term Management Strategy and other efforts to ensure that the ocean site is included in the array of sites available to Bay Area dredgers.

Developing an array of possible alternatives is paramount to maintaining the environmental health of the Bay and economic vitality of the Bay Area. We applaud your work in this effort and look forward to the adoption of a final Environmental Impact Statement that will allow important dredging projects to continue.

Sincerely,

Ronald V. Dellums
Member of Congress

Nancy Pelosi
Member of Congress

George Miller
Member of Congress

Don Edwards
Member of Congress

Pete Stark
Member of Congress

Tom Lantos
Member of Congress

Anna Eshoo
Member of Congress

Vic Fazio
Member of Congress

Lynn Woolsey
Member of Congress

13

1/27/93 PM 1/25

Environmental Services Agency
Planning and Building Division

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County of San Mateo

Mail Drop 5500 · 590 Hamilton Street, 2nd Floor · Redwood City · California 94063

January 25, 1993

Harry Seraydarian, Director
Water Management Division
U.S. Environmental Protection Agency
75 Hawthorne Street (W-7-1)
San Francisco, CA 94105

Dear Mr. Seraydarian:

Staff has reviewed the Environmental Impact Statement (EIS) for San Francisco Bay Deep Water Dredged Materials Disposal Site Designation. The long-term management strategy is to provide an array of disposal options for dredged materials from San Francisco Bay over the next 50 years. Once a disposal site is designated, the proposed ocean dredged material disposal site will provide a disposal option for an estimated 6 million cubic yards per year of dredged material.

We recognize the need to find a long-term solution for dredged materials, as well as a need to mitigate the existing radioactive and munitions waste sites offshore; however, there are concerns regarding the potential of disturbance to these hazardous waste materials by virtue of the disposal of the proposed dredged materials discussed in the EIS.

The EIS has planned for the safe disposal of the dredged materials with data that only addresses normal environmental conditions, such as average tidal movements and average current flows; however, the EIS does not consider extreme environmental conditions which may cause turbulence in deeper waters which could affect the stability of the dredged materials. While the dredged materials may help to bury and contain low level radioactive and munitions waste there is the potential that downwelling of ocean water, pushed by the disposal of a large load of colloidal dredged materials, may stir up the hazardous materials on the ground, thus releasing and dispersing some of these hazardous wastes. Once some of these wastes are mixed with mobile water, these wastes may find themselves flowing southward along the coastal current, and pushed east onto San Mateo County's coast by wave action and tidal movements. 13-A

Before any ocean disposal may take place, dredging projects must demonstrate a need for ocean disposal, and materials must be acceptable according to the Environmental Protection Agency and the U.S. Army Corps of Engineers' criteria and regulations. (13-B)

The County is interested in reviewing any further documents regarding the disposal of dredged spoils offshore.

Sincerely,

Samuel Herzberg
Planner I

SH:cdn - SFHD0156.ACN

cc: Paul M. Koenig, Director of Environmental Services
Terry Burnes, Planning Administrator
Mike Murphy, Deputy County Counsel

Exhibit (14)

DEPARTMENT OF THE ARMY
SAN FRANCISCO DISTRICT, CORPS OF ENGINEERS
211 MAIN STREET
SAN FRANCISCO, CALIFORNIA 94105 – 1905

Regulatory Branch

JAN 22 1993

1/29/93 PM 1/22

Mr. Harry Seraydarian, Director
Water Management Division
U.S. Environmental Protection Agency
75 Hawthorne Street (W-7-1)
San Francisco, California 94105

Dear Mr. Seraydarian:

Thank you for the opportunity to review the Environmental Protection Agency Region IX (EPA), Draft Environmental Impact Statement (EIS) for San Francisco Bay Deep Water Dredged Material Disposal Site Designation. Staff from the San Francisco District's Regulatory Branch, with assistance from the Environmental and Programs and Project Management branches, have reviewed the Draft EIS and provided extensive comments. Those comments are attached for your consideration in preparing the Final EIS for designation of an ocean dredged material disposal site for the San Francisco Bay area.

If you have any questions concerning our comments, please contact Wake Eakle (415) 744-3325 ext. 222 of my Regulatory Branch.

Sincerely,

for
Max R. Blodgett
Acting Chief, Construction Operations
Division

Enclosure

Review Comments on Draft Environmental Impact Statement (EIS) for San Francisco Bay Deep Water Dredged Material Disposal Site Designation

1. The following comments on the U.S. Environmental Protection Agency's (EPA) Draft EIS (DEIS) for San Francisco Bay Deep Water Dredged Material Disposal Site Designation were prepared in accordance with 40 CFR 1503.2 and 1503.3, and 33 CFR 230.19(e). These comments are as specific as possible, and generally restricted to areas of U.S. Army Corps of Engineers (Corps) jurisdiction by law and special expertise, particularly Corps regulatory responsibilities.

2. 40 CFR 1502.23 provides that when cost considerations are relevant and important to a decision, the EIS should at least indicate those considerations. The Corps believes that costs of ocean disposal are relevant and important since all of the alternatives could significantly increase the annual and long-term costs of maintaining and improving navigation in the San Francisco Bay area. The Final EIS should provide the cost considerations (including monitoring costs) between alternatives, as well as the cost differentials between each alternative and other on-going and potential non-ocean disposal options. In addition, the Corps believes the Final EIS should contain an economic analysis of commercial and recreational fisheries values between the alternative disposal sites. This type of information has been routinely requested of the Corps for Section 103 site designations. 14-A

3. The comments that follow are keyed to sections and pages (in parentheses) in the DEIS.

S.4.2 (S-13). The U.S. Navy's application for a Department of the Army (DA) permit to dredge up to 1.6 million cubic yards (cy) of sediment at NAS Alameda and NSC Oakland, and dispose of the dredged material at a site west of the Farallon Islands in the Pacific Ocean, is be being processed pursuant to the provisions of Section 10 of the Rivers and Harbors Act of 1899 and Section 103 of the Marine Protection, Research, and Sanctuaries Act of 1972 (MPRSA). The Navy is preparing a Supplemental EIS (SEIS) in pursuing the designation of an ocean disposal site by the Corps in accordance with Section 103 of the MPRSA. As a cooperating agency, the Corps retains a responsibility for ensuring the SEIS adequately addresses the criteria and technical requirements for ocean disposal. If the project complies with these requirements, the Final SEIS may be adopted by the Corps for the purpose of exercising its regulatory authority. The Corps has not yet determined whether to issue, modify, condition, or deny a permit for the Navy's proposed activity. EPA's DEIS should accurately reflect the status of this action. 14-B

S.4.2 (S-14). The agency, and regulatory authority, that would require barges to avoid the Farallones vicinity to 14-C minimize potential impacts should be specified in the Final EIS (FEIS).

S.5 (S-15). See comment S.4.2 (S-13).

1.1 (1-2). Dredged material disposal into ocean waters is regulated by the Corps using the criteria of applicable sections of 40 CFR 227 and 228 (40 CFR 227.13). In accordance with 40 CFR 225, applications and authorizations for dredged material permits under Section 103 of the MPRSA for the transportation of dredged material for the purpose of dumping it in ocean waters is evaluated by the Corps in accordance with the criteria in 40 CFR 227 and processed in accordance with 33 CFR 320 through 330. Only the Corps is authorized to issue or deny permits for dredged material disposal, in accordance with 33 CFR 320 through 330, and Section 103 of the MPRSA. EPA does not have a permitting authority for dredged material disposal under the MPRSA, and the criteria at 40 CFR 227 are used by the Corps to evaluate permit applications. This section should clearly reflect Corps regulatory authorities. 14-D

Table 1.2-1 (1-8). The projected volumes seem to be grossly over-estimated. The Navy has applied to dredge 1.6 million cy from NAS Alameda and NSC Oakland and dispose of the material in the ocean. The Port of San Francisco currently does not have a permit for dredging and disposal. Annual dredged material disposal volumes for the 3 in-Bay sites have been 2,555,610 cy for SF-11, 8,810 cy for SF-10, and 344,167 cy for SF-9 in 1992; 1,199,854 cy for SF-11, 28,080 cy for SF-10, and 359,848 cy for SF-9 in 1991; and 2,061,206 cy for SF-11, 63,060 cy for SF-10, and 986,658 cy for SF-9 in 1990. These volumes, particularly for permit projects regulated by the Corps, should be verified by the San Francisco District's Regulatory Branch. 14-E

1.2 (1-9). The State Water Resources Control Board (SWRCB) statement implies that projects are being certified for compliance with state water quality standards that should not receive state Clean Water Act (CWA) Section 401 water quality certification. If so, this statement should be clarified with the SWRCB. 14-F

1.6.2.3 (1-15). Ocean disposal of dredged material is regulated by the Corps in accordance with Section 103 of the MPRSA, 33 CFR 320 through 330, and 40 CFR 225, 227, and 228, and is not subject to Section 404 of the CWA. Therefore, Section 401 of the CWA, and compliance with state water quality standards are not applicable. Actions regulated in accordance with Section 103 of the MPRSA are not in waters of the territorial sea. This section should be clarified to reflect the non-applicability of CWA Sections 401 and 404 to ocean disposal regulated in accordance with Section 103 of the MPRSA. 14-G

1.7 (1-21). See comment S.4.2 (S-13). The Corps is a cooperating agency with the Navy in the preparation of a SEIS for the Navy's proposed action, and designation of an ocean disposal site in accordance with Section 103 of the MPRSA. The DEIS should reflect this relationship. 14-H

2.1 (2-2). The Corps is responsible for evaluations made in accordance with 40 CFR 227 for applications and authorizations for dredged material permits under Section 103 of the MPRSA. The Corps is also responsible for making factual determinations of compliance with CWA Section 404(b)(1) Guidelines. Corps regulations for National Environmental Policy Act (NEPA) implementation procedures for the Regulatory Program are found at 33 CFR 325, Appendix B. Corps responsibilities should be accurately reflected in this section. 14-I

2.1.2 (2-4). See comment 3.2.5.5 (3-90) regarding comparability of EPA and Navy methods. 14-J

2.1.2.1 (2-11). The Corps will likely make a decision regarding the Navy's Section 103 permit application in early to mid-1993. Site management is not an outstanding issue for this permit application. 14-K

2.1.3.1 (2-21). Dredged material disposal at SF-9 (Carquinez Strait DMDS) was 344,167 cy in 1992, 212,257 cy in 1991, 986,658 cy in 1990, 284,722 cy in 1989, 613,225 cy in 1988, 614,508 cy in 1987, and 184,682 cy in 1986. Dredged material disposal at SF-10 (San Pablo Bay DMDS) was 8,810 cy in 1992, 18,300 cy in 1991, 63,060 cy in 1990, 28,600 cy in 1989, 720 cy in 1988, 977,749 cy in 1987, and 32,772 cy in 1986. Dredged material disposal at SF-11 (Alcatraz DMDS) was 2,555,610 cy in 1992, 1,240,661 cy in 1991, 2,061,206 cy in 1990, 3,044,091 cy in 1989, 1,968,241 cy in 1988, 5,025,213 cy in 1987, and 1,218,341 cy in 1986. Good records and data for dredged material disposal prior to 1986 are not available. The cited volumes should be verified since they may not be accurate. EPA does not regulate the use of the in-Bay disposal sites. The regulatory agencies for dredging and dredged material disposal in San Francisco Bay are the Corps, San Francisco Bay Regional Water Quality Control Board (RWQCB), and San Francisco Bay Conservation and Development Commission (BCDC). This section should be clarified to accurately reflect these regulatory responsibilities. 14-L

2.1.3.2 (2-25). See comment 2.1 (2-2) regarding Corps responsibilities for evaluations made in accordance with 40 CFR 227. 14-M

2.2 (2-27). Navy (1992) should be the Draft SEIS or Final SEIS, not an Administrative Draft SEIS. The Draft SEIS has been released by the Navy, and the Final SEIS should be available 14-N soon (early 1993).

2.2.2.1 (2-28 to 2-29). See comment S.4.2 (S-14) regarding agency authorities for requiring barges to stay within certain navigation lanes. 14-O

2.2.2.5 (2-31). Reference to U.S. Army should probably be U.S. Navy. See Table 3.1-2 (3-7). 14-P

2.2.4 (2-32). The process used by EPA to select the Preferred Alternative should be discussed in detail, particularly since different field methods were employed by the Navy in Study Area 5 [See comment 3.2.5.5. (3-90) below]. 14-Q

Table 2.2-1 (2-37). The statement that potentials for cumulative effects of previous discharges and dumping in the area of Alternative Site 5 are considered unlikely should be better supported, especially since the potential environmental effects are stated as being unknown [See 3.1.3 (3-18)]. 14-R

2.2.4 (2-42). See comment 2.1.2.1 (2-11) regarding the Navy's Section 103 permit application. 14-S

3.1.4.2 (3-20). A specific schedule should be presented for developing the site monitoring plan. 14-T

3.2.3.3 (3-50). Explain in the text why total suspended solids (TSS) were not measured during the EPA surveys. 14-U

3.2.3.5 (3-53). Explain in the text why nutrient concentrations were not measured during the EPA surveys. 14-V

3.2.3.6 (3-53). Explain in the text why trace metal concentrations were not measured during the EPA surveys. 14-W

3.2.5.5 (3-90). Reference is made to different methods used to collect data in Study Area 5 by the Navy, and those used by EPA to collect data in Study Areas 2, 3, and 4, and the comparability (or lack of comparability) of these data. Since many of the EPA and Navy data sets are probably not comparable because of different methods employed during ocean research cruises, the process used by EPA for selecting the Preferred Alternative [2.2.4 (2-32)] should be clearly described in the FEIS. 14-X

3.3.1.2 (3-103). Additional support should be provided for the statement that "effects of dredged material disposal on plankton populations are likely to be transitory at most and should not result in impacts to food webs in the Gulf of the Farallones". 14-Y

3.3.2.1 (3-104). See comment 3.2.5.5 (3-90) regarding the 14-Z lack of comparability between EPA and Navy field methods and data sets.

3.3.2.2 (3-122). See comment 3.2.5.5 (3-90) regarding study methods used by EPA and the Navy, and the inappropriateness of comparing these data sets. 14-AA

3.3.2.2 (3-134). See comment 3.3.2.2 (3-122). Its probably inappropriate to make comparisons between data sets and Study Areas because of the different methodologies. 14-BB

Table 3.3.3-2 (3-147). Another example of incomparable data sets. The incomparability of data should be stressed, and not foot-noted. 14-CC

3.3.3.1 (3-156 to 3-157). See comment 3.3.2.2 (3-134) regarding different methods and data interpretation. 14-DD

Table 3.3.4-1 (3-168). Legal status should be defined, in terms of Federal (Endangered Species Act of 1973) and state law. For example, the American osprey (Pandion haliaetus) is not listed as a threatened or endangered species under the Endangered Species Act of 1973. 14-EE

3.3.4 (3-173). Explain why only 10 species of birds were selected to be "Key Species". 14-FF

3.3.6.1 (3-225). Federal agencies are required to consult with the U.S. Fish and Wildlife Service (USFWS) and/or National Marine Fisheries Service (NMFS) in accordance with Section 7 of the Endangered Species Act of 1973 (ESA) to insure that any action authorized, funded, or carried out by such agencies are not likely to jeopardize the continued existence of any threatened or endangered species (T/E), or result in the destruction or adverse modification of critical habitat. Formal consultation with the California Department of Fish and Game (CDFG) is not required by the ESA of 1973. This should be clarified in the FEIS. 14-GG

3.3.6.1 (3-227). Clarify the statement that CDFG has jurisdiction over T/E species in state waters. How are state waters defined (i.e. are any of the Study Areas in state waters?), and is reference made to Federal or state listed T/E species? 14-HH

3.3.6.2 (3-232). The American osprey is not listed as a T/E species under the ESA of 1973 (see 50 CFR 17.11 and 17.12). This should be corrected in the FEIS. The current listing status of the marbled murrelet (Brachyramphus marmoratus) should also be verified. 14-II

3.4.5 (3-264). 3.4.6 (Recreational Activities) heading and 14-JJ some text appears to be missing.

Table 4.1-1 (4-3 to 4-6). It appears from this summary table that there no clear differences of potential environmental impacts between alternatives. If this is the case, it is critical that EPA describe in detail the process that lead to the selection of Alternative Site 5 as the Preferred Alternative in the FEIS [See comment 2.2.4 (2-32)]. 14-KK

4.2 (4-7). Specify which impacts and processes occurring at shallow water sites can be extrapolated to deep water environments. 14-LL

4.2.1.3 (4-15). Support should be provided for using 6,000 cy barge capacities in the model. It seems likely that smaller barges with less capacity would be most available in the San Francisco Bay area. 14-MM

Table 4.2-2 (4-16). The use of data from NSC Oakland only in the sediment deposition model is questionable. This kind of data is available from other sites around San Francisco Bay and should probably be used in the model as well. 14-NN

4.2.1.4 (4-45). It is interesting to note that EPA's Preferred Alternative (Site 5) is the only site that would result in dredged material being deposited on the bottom within a National Marine Sanctuary. 14-OO

4.2.2.2 (4-51). The word "significant" is used to describe mortality to benthic organisms if dredged material accumulates in thicknesses of 5-30 cm. The context in which "significant" is used should be stated (i.e., statistical significance or significant as defined by NEPA). 14-PP

4.2.2.5 (4-59). Dredged material permits issued by the Corps in accordance with Section 103 of the MPRSA would be conditioned on a case-by-case basis, if necessary. This should be clarified. 14-QQ

4.2.2.5 (4-60). The statement concerning "material that exhibits a potential for contaminant bioaccumulation will not be discharged at an ODMDS" is factually incorrect. EPA/Corps (1991) states when tissue concentrations of contaminants of concern in organisms exposed to dredged material statistically exceed those of organisms exposed to the reference material, EPA and the Corps should develop and agree upon case specific evaluative criteria for determining compliance with the bioaccumulation aspects of the benthic criteria of 40 CFR 227.13(c)(3)[Page 6-6]. 14-RR

4.2.2.8 (4-63). See comment 4.2.1.4 (4-45). EPA concludes that dredged material will accumulate on the bottom within the 14-SS

Gulf of the Farallones National Marine Sanctuary (NMS)[i.e., the dredged material footprint], which seems to inconsistent with the statement here regarding disposal within NMS's. In addition, Corps specifications for maintenance dredging of federal navigation channels allow for a 10% loss in draft (leakage) from hopper dredges, barges or dump scows while transporting dredged material to disposal sites. For 6,000 cy barges the leakage allowance would be 600 cy. The "reality" of transporting dredged material for ocean disposal should be clear in the FEIS.

4.4.2.2 (4-76). The statement "no species that are known to be unique to the area or geographically limited in distribution are found at this site (Alternative Site 3) or at Alternative Sites 4 or 5" seems inconsistent with 3.3.2.2 (3-134) which states that 5 species of megafaunal invertebrates, believed to be previously unknown to science, were collected in Study Area 5. 14-TT

4.6.1 (4-88). Information that the Corps may require permit applicants to submit will be consistent with the Corps' Regulatory Program regulations (33 CFR 320-330), NEPA regulations (33 CFR 230 and 325), and EPA's ocean dumping regulations (40 CFR 225, 227, and 228). 14-UU

4.6.1 (4-89). The San Francisco District Regulatory Branch does not prepare "draft" permits for external review. In accordance with 40 CFR 220.4(c), EPA has the authority to review, to approve or to disapprove or to propose conditions upon dredged material permits for ocean dumping of dredged material. This section should be clear regarding agency authorities. In addition, EPA Region 9 and the Corps South Pacific Division are preparing a Regional Implementation Agreement for Evaluating Dredged Material Proposed for Ocean Disposal. This Agreement will focus on dredged material sampling and testing only, and does not address permit conditions to ensure disposal within an ODMDS. 14-VV

4.6.1 (4-90). Provide a citation for EPA's authority to take enforcement actions on violations of Corps issued Section 103 dredged material permits. 33 CFR 326 provides the regulations, and cites the authority, under which the Corps takes enforcement actions for violations of authorized activities. 14-WW

4.6.2 (4-90). In accordance with 40 CFR 228.3, EPA has site management responsibility. No mention is made of the Corps for having such an authority or responsibility for sites designated by EPA in accordance with Section 102 of the MPRSA. 14-XX

5.3 (5-8). It appears that EPA went through an elaborate process to develop an Ocean Studies Plan (OSP), but ultimately 14-YY selected Study Area 5 as the Preferred Alternative based on data collected by the Navy. This section of the FEIS should have a comparable discussion of the Navy's field research plans, and an analysis of the comparability or non-comparability of these methods with those employed by EPA in their OSP.

5.3 (5-14). See comment 5.3 (5-8), and comment 3.2.5.5 (3-90), regarding the lack of data comparability and the process used by EPA to select the Preferred Alternative. (14-ZZ)

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State of California

Exhibit (15)

JAN 13 1993

ENVIRONMENTAL PROTECTION

Memorandum

To: Mr. Michael A. Kahoe
Assistant Secretary
California Environmental Protection Agency
555 Capitol Mall, Suite 235
Sacramento, California 95814

Date: January 11, 1993

From: Department of Fish and Game

Subject: Draft Environmental Impact Statement (DEIS) for San Francisco Bay Deep Water Dredged Material Disposal Site Designation

The Department of Fish and Game (DFG) has reviewed the subject DEIS, issued by the U.S. Environmental Protection Agency (EPA), proposing the designation of a deep water ocean dredged material disposal site (ODMDS). The designation is prepared under the authority of the Marine Protection, Research, and Sanctuaries Act (MPRSA), and in coordination with the regional, multiagency Long-Term Management Strategy (LTMS). The ODMDS is expected to partially fulfill the LTMS objective of providing a range of disposal options for sediments dredged from San Francisco Bay. The proposed site is designed to accept an estimated six million cubic yards of material annually, which must meet EPA and U.S. Army Corps of Engineers (COE) sediment-quality criteria, for a 50-year period.

The DEIS describes and discusses, in detail, three deep water alternative sites (No's. 3, 4, and 5), with emphasis upon the preferred alternative (No. 5), and provides information on two near-shore alternative sites (No's. 1 and 2). Alternative Site No. 5 is a former chemical munitions disposal area and is located on the continental rise (depths between 2,500 and 3,000 meters) approximately 50 nautical miles west - southwest of the Golden Gate.

The preferred alternative is characterized by relatively low infaunal diversity and abundance, moderate numbers of megafaunal invertebrates and fishes, common coastal plankton communities, and higher use by marine birds and mammals when compared to the alternative sites. Commercial and recreational fishery activities at Alternative Site No. 5 are described as very low. Identifiable potential adverse impacts to marine resources are, for the most part, identified as insignificant or mitigatable to the insignificant level. The lone exception to this overall assessment would be burial or other forms of disturbance to benthic organisms at the site of deposition. Modelling studies discussed in the DEIS predict that there will be no measurable movement of materials by either coastwide or localized currents into any of the three adjoining National Marine Sanctuaries.

The DFG commends the EPA and all contributing members of the LTMS Ocean Studies Work Group for the preparation and execution of a thorough and comprehensive study plan. In general, we view the DEIS as adequately portraying the complex and dynamic physical, chemical, biological, and socioeconomic factors influencing the study areas and the selection of an environmentally acceptable ODMDS. Additionally, we strongly support the choice of Alternative Site No. 5 as the EPA's preferred alternative. We believe that placement of approved sediments at this site will result in the least damaging impacts to marine resources and sharply reduce any potential conflicts with California's valuable commercial and recreational fisheries.

While we support selection of Alternative site No. 5, we also wish to comment on the following two aspects of the DEIS:

1. The level of detail found in the characterization of demersal fisheries resources was not as precise as the DFG feels it should have been taking into consideration that a trawl fishery database, which incorporates both logbook and landing receipt information, was made available to the EPA by the DFG. This database allows for generalized catch-block information to be evaluated in light of specific depth contours. To our knowledge, analysis or information from this database was neither presented, nor referenced, in the DEIS. The absence of this database in the DEIS, however, does not alter our conclusion that the Alternative Site No. 5 possesses the lowest fishery values and potential use conflicts of the alternatives under consideration. 16-A

2. The discussion of site management and monitoring could be improved with respect to specific actions to be taken by, or opportunities available to, the EPA and COE. For example, in the likely event that the U.S. Navy receives approval to use Alternative Site No. 5 for the disposal of approximately 1.6 million cubic yards of sediment from Naval Air Station Alameda and Naval Supply Center Oakland, under Section 103 of the MPRSA, tracking of disposal event effects could be used to validate footprint and suspended sediment transport models, as well as contribute to other study elements. However, project-specific use of this area by the Navy was discussed in depth in the DEIS only relative to cumulative impacts. Site management and monitoring are critical issues to the long-term success of any aquatic disposal site and should be a substantive part of the public review process. 16-B

These limited concerns notwithstanding, the DFG wishes to reaffirm our approval and support for the EPA's efforts in the lengthy and laborious site designation process and their on-schedule production of the DEIS as well as reiterate our concurrence with the selection of Alternative Site No. 5 as the preferred alternative for an ODMDS to receive San Francisco Bay dredged sediments. As always, DFG personnel are available to discuss our comments in greater detail. To arrange for discussion, please contact Mr. Robert N. Tasto, Environmental Specialist, California Department of Fish and Game, 411 Burgess Drive, Menlo Park, California 94025, telephone (415) 688-6360.

John L. Turner, Chief
Environmental Services Division

cc: Mr. Robert N. Tasto
Department of Fish and Game
Menlo Park, California

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Exhibit (16)

DEPARTMENT OF THE NAVY
WESTERN DIVISION
NAVAL FACILITIES ENGINEERING COMMAND
900 COMMODORE DRIVE
SAN BRUNO, CALIFORNIA 94066-2402

IN REPLY REFER TO

22 JAN 1993

Mr. Harry Seraydarian, Director
Water Management Division
Attn.: Ms. Shelley Clark
U.S. Environmental Protection Agency
75 Hawthorne Street (W-7-1)
San Francisco, California 94105

Mr. Seraydarian:

This constitutes the U.S. Navy's review comments on your December 1992 Draft Environmental Impact Statement (EIS) for designation of a deep water dredged material disposal site off San Francisco.

We concur with your conclusions that no significant adverse impacts are likely to result from selection of any of the considered alternative ocean disposal sites, and especially from the preferred site 5. As you know, the Navy recently conducted extensive field studies at the same site for our proposed disposal on up to 1.6 million cubic yards of sediments from Naval Air Station Alameda and Naval Supply Center Oakland, in support of a proposed Marine Protection, Research and Sanctuaries Act Section 103 permit, as documented in our own 1990 Final EIS and ongoing 1992 Supplemental EIS. All of our studies led to similar determinations of no significant effect at the preferred site. Of the many regulatory agencies and environmental groups who have publicly reviewed our documents, none has yet indicated different conclusions.

Designation of an ocean disposal site is urgently needed for the San Francisco Bay area. The Navy recognizes the sensitivity of the sole existing disposal site, adjacent to Alcatraz Island within the Bay. While we do not think that existing sediment disposal at that site results in significant impacts, we also acknowledge the regional conclusion that one or more alternate disposal sites are needed for large quantities of new dredge sediments. In order for the Navy to achieve its defense-related mission for the Pacific, we must maintain navigational access to our port facilities in San Francisco Bay.

Although the DEIS deals with disposal site designation, we would note based on our own studies that (16-A) typical dredge sediment from the ports around San Francisco Bay may not be as clean as that of any ocean disposal site. EPA and the other regulatory agencies may need to reevaluate the protocol criteria for determining what sediments are suitable for ocean disposal, achieving a reasonable balance between environmental protection and effective use of the disposal site by maritime dredgers.

We recommend that a dredge management and disposal plan be drafted for public review, as noted in (16-B) DEIS paragraph 4.6. page 4-87. Such a plan should indicate the types of requirements that may be placed on dredge disposal operations, what the costs would be, and who would bear those costs.

We support your DEIS document's studies and conclusions, and your expeditious designation of an ocean disposal site.

For further information, contact Mr. John H. Kennedy, Head, Environmental Planning Branch, Code 203, (415) 244-3726.

John H. Kennedy
JOHN H. KENNEDY
MANAGER, ENVIRONMENTAL PLANNING BRANCH

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Exhibit 17

State of California

Business, Transportation and Housing Agency

Memorandum

RECEIVED
JAN 27 1993
ENVIRONMENTAL PROTECTION

To: MICHAEL A. KAHOE
Assistant Secretary
California Environmental Protection Agency
555 Capitol Mall, Suite 235
Sacramento, CA 95814

Date: January 22, 1993

File No:

From: **DEPARTMENT OF TRANSPORTATION**
Director's Office

Subject: DEIS for San Francisco Bay Deep Water Dredge Material Disposal Site Designation

Caltrans appreciates the opportunity to comment on this document. The proposal creates no adverse impacts to the state transportation system. Additionally, the ability to dispose of dredge material at an environmentally sound site will permit the dredging necessary for improved waterside access to San Francisco Bay Area ports.

I would like to take this opportunity to voice Caltrans' support. Improved access to our ports will increase the operating efficiency of such facilities, generate higher employment, permit California to better compete in international trade and the global economy, and enhance the goods movement elements of the state's transportation system. These benefits are fully compatible with Caltrans' mission to improve mobility of both people and goods.

JAMES W. VAN LOBEN SELS
Director

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The Environmental Forum of Marin

Exhibit (18)

A NON-PROFIT CITIZEN GROUP DEVOTED TO EDUCATION IN MARIN COUNTY ON ENVIRONMENTAL MATTERS

January 19, 1993

Mr. Harry Seraydarian, Director
Water Management Division
U.S. Environmental Protection Agency
75 Hawthorne St. (W-7-1)
San Francisco, Ca. 94105

Dear Mr. Seraydarian;

I am writing on behalf of the Environmental Forum, an organization concerned with the environmental health of the San Francisco bay area. We have studied your EIS for proposed San Francisco Bay Deep Water Dredged Material and feel that the preferred alternative is a very inappropriate site for dredge spoils.

You prefer site 5 because of its depth and previous use as a disposal site for radioactive waste. One error should not be compounded by mingling spoils of unknown chemical content with those of nuclear waste.

Can the safety of a site be equated with its depth below the ocean? Did you consider areas further off the coast - away from the sanctuaries that envelope the bay? (18A)

By chosing site 5 closest to the Farallone Islands, you put at risk an area highly valued by scientific research for its remoteness from human disturbance and its traditional use by marine life. As stated, it is the site most frequented by threatened and endangered species. If foraging prey decreases due to water disturbances, birds, fish and mammals will follow them. We feel that frequent disturbances will occur, regardless of barge routes. (18-B)

How can you call an activity one of temporary nature when it will continue when it will continue to be done on a daily basis for fifty years, resulting in the ultimate disposal of 400 million cubic yards of dredged material. Frequency of barge trips will result in disturbances to marine life as long as the site is used. (18-C)

Any activity that increases plankton mortality will impact every animal on the food chain. It will increase stress on pelagic fish already suffering from overfishing. (18-D)

We believe that ocean dumping will affect marine life to a far greater extent than acknowledge by the EIS. The possibility of cummulative damage is not adequately addressed. Because you have no examples of successful dumping in similar circumstances, the EIS has too many uncertainties. (18-E)

The desire to find a site beyond public scrutiny may influence EPA's preference for ocean dumping. We did not know what we were doing when we pushed radioactive waste into the ocean; it appears that we still don't know enough to sanction the dumping of dredged material at site five.

Thank you for your attention.

Sincerely Yours,

Lindsay Rehm

Lindsay Rehm
Water and Bay Chair

Exhibit (19)

Golden Gate Audubon Society

A Chapter of the National Audubon Society
Serving San Francisco and Parts of Alameda and Contra Costa Counties

Monday, January 25, 1993

Harry Seraydarian, Director of Water Management Division
U.S. EPA
75 Hawthorne Street
San Francisco, CA 94105

Fax # 744-1235

re: Draft EIS for San Francisco Bay Deep Water Dredged Material Disposal Site Designation

Dear Mr. Seraydarian:

The Golden Gate Audubon Society regrets to inform you that we believe that the Draft Environmental Impact Statement (DEIS) for San Francisco Bay Deep Water Dredged Material Disposal Site Designation is a flawed document that should not be used to determine the proper alternative for ocean disposal of dredged material. The document is incomplete. To correct its flaws, a Supplemental EIS must be prepared. Our reasons are detailed below. (19-A)

The information available in the DEIS on bird and marine mammal use of the proposed sites is inadequate. The work performed by the Point Reyes Bird Observatory on avian and marine mammal use of the alternative sites was based on existing data. This data was collected for areas that do not conform exactly to the proposed alternate disposal site configurations. This lack of conformity between data and sites brings into serious question the value of such data. (19-B)

While some new avian and marine mammal data was developed for sites 3 and 4, this data is inadequate because not enough data was collected. Site 5 avian and marine mammal analysis used data developed by the Navy. This data was obtained by observations taken at times of the year different from those obtained for Sites 3 and 4. (19-C)

Clearly we are dealing with very inconsistent data. Some obtained years ago, some recently. The times of year of the observations differ, and this can be critical for the breeding colonies of the Farallones Islands. Both avian and marine mammal numbers vary dramatically over a year's seasons. The fact that different consultants were used for the differing sites also puts the results very much into question. Different consultants often come up with different numbers, especially in bird counts. There is no consistency in this EIS's data collection and interpretation and this must lead to doubt as to the scientific validity of any conclusions reached in this DEIS. (19-D)

AMERICANS COMMITTED TO CONSERVATION
2530 San Pablo Ave, Suite G Berkeley, California 94702 • (415) 843-2222

We can only conclude that more data must be compiled on all the sites: 1) by a single consulting team, 2) at similar times of the year and 3) on the specific disposal sites in question. Any other course must result in an EIS based on the most suspect of data. (19-E)

We do not agree with the selection of Site Five as the preferred alternative. It is the site closest to the Gulf of the Farallones National Marine Sanctuary and thus is most likely to impact the marine mammals and avian species inhabiting the Sanctuary. Site Five was shown to have highest bird and mammal use. We prefer site 4 because it has the least bird and mammal use and is farthest away from the Farallones Islands' breeding colonies. (19-F)

The Monitoring component of the DEIS is completely inadequate. Sediment and current meters should be in place before any dumping is allowed on the site (we have learned this from the CALTRANS Highway One monitoring fiasco). A monitoring plan should require qualified bird and mammal observers to be placed on every dredge-disposing vessel using the site. A monitoring strategy must be developed to determine the effects dredge disposal plumes have on mammal and avian species. No such provisions are in this DEIS, yet such monitoring provisions are essential to ensure that this ocean dredge disposal operation does not impact avian, marine mammal and fish species. (19-G)

We believe that the cost of the monitoring program must be borne by the dredgers. It is inappropriate for the public to bear these costs. If monitoring money is not forthcoming no dredge disposal should take place at the selected ocean site. (19-H)

Enforcement of this process is vitally important. Illegal dumping (short of the intended site) and the use of the site by those without permits must all be controlled. (19-I)

We thank you for your consideration of our views and hope that a Supplemental EIS will be prepared. We are aware of the feeling of urgency of this project but we know that you share our view that an ocean dredge disposal plan that leads to the devastation of marine species is not in the public interest. Further studies must be performed before such species are put at risk.

Sincerely yours,

Arthur Feinstein
Program Coordinator

Exhibit (20)

UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL OCEAN SERVICE
OFFICE OF OCEAN AND COASTAL RESOURCE MANAGEMENT

Gulf of the Farallones
National Marine Sanctuary
Fort Mason, Building 204
San Francisco, CA 94123
tel: 415/556-3509
fax: 415/556-1660

21 January 1993

Mr. Harry Seraydarian
Water Management Division
US EPA
75 Hawthorne Street (W-7-1)
San Francisco, CA 94105

Re: DEIS San Francisco Bay Deep Water Dredge Material Disposal Site Designation

Dear Harry:

The Sanctuary program of the Department of Commerce has assigned me the responsibility and authority to respond to the Draft Environmental Impact Statement for San Francisco Bay Deep Water Dredge Material Disposal Site Designation (DEIS) for the Cordell Bank National Marine Sanctuary (CB), Gulf of the Farallones National Marine Sanctuary (GF) and the area of the Monterey Bay National Marine Sanctuary (MB) north of Santa Cruz County. The three Sanctuaries have been established under authority of the Marine Protection, Research and Sanctuaries Act [CB (1989), GF (1981) and MB (1992)] to protect the resources of the most productive area of the continental United States. These resources include marine mammals, fish, invertebrates, plants and other living organisms and historic resources of the area. The GF is the closest Sanctuary to your prefered site number 5; however, material disposed at this site could also enter and effect the resources of CB and MB. Each Sanctuary has unique regulatory requirements to accomplish the resource protection required for the area as well as mandated protective responsibilities incorporated in the Act.

The Sanctuaries are concerned that the material disposed at site 5, could move and effect the Sanctuary resources. Mathematical models which expostulate this will not occur have not been verified or tested. Because this site has the possibility of damaging resources in three of the nations ten National Marine Sanctuaries verification of models must be accomplished as soon as possible. This opportunity may present itself prior to the establishment of the 102 site by using data which can be developed when this area is used as the 103 site, by the US Navy (USN). How this verification will be accomplished by 103 operations needs to be clearly stated in the DEIS. Therefore, the proposed monitoring plan for the USN needs to be incorporated and reviewed for comment within the scope of the 102 DEIS. (20-A)

Dumping in any of the proposed area sites (5, 3, or 4) must not occur unless an agreed upon monitoring plan is in place and operational. Environmental conditions need to be studied by independent observers onboard all vessels to determine the prevalence, deportment and avoidance of marine mammals, birds, other marine life and the general ecological conditions of the site. This data should be systematically collected by qualified observers independent of the dredge company, dredge permittee or transport operators. This effort is needed for your DEIS states the limited nature of your data in duration, systematics, repeatability, seasonality and scientific regor. Current meters and sediment movement equipment must be in place and operational during all dumping until verification of the models. (20-)

The monitoring plan in the DEIS must give a very specific route of travel for all material moved through the GF. GF has recommended to the USN that transit outbound be via the west bound US Coast Guard (USCG) separation scheme to 37° 28.5' N, thence due west (270° T) to the center of the site at 37° 28.5' N, 123° 29.5' W. This location is mentioned because you state your site (S-12-13.) is 10 nmi from the Sanctuary, but your diagrams presented show it as close as 3 nmi. Three nautical miles is too close to the GF. The DEIS's more northly location, would also increase the vessel round trip transit distance by roughly 1.3 nmi. The DEIS site also increases the likelihood that vessels will depart the USCG separation lanes early. (20-C)

GF prohibits (Sec 936.6) vessels (4) from entering within 2 nmi of the Farallon Islands. These Islands are a US Fish and Wildlife Refuge of unique ecological importance and productivity in the continental United States. The GF also has the authority (Vol 46, No. 16, Jan 26, 1981 Article 4) to regulate all vessels, except fishing vessels and vessels within a Traffic Separation Scheme. Therefore, knowledge of the exact vessel transit routes are needed for GF to determine if it needs to institute regulations. GF believes this should be unnecessary given the cooperative nature of the Long Term Management Strategy process; however, transit requirements must be available for all to discuss so interested parties may comment and provide EPA and GF a review of their concerns. (20-D)

The following is a summarization of Sanctuary concerns: (20-E)

1. Monitoring plans must be developed within the DEIS (monitoring needs are mentioned over ten times in current DEIS as important).

2. Monitoring (sediment and environmental assessment) personnel and equipment must be in place and functional during dumping. (20-F)

3. Monitoring must be conducted by qualified independent investigators. (20-G)

4. Incorporating 103 work will help verify models. (20-H)

5. Expanding characterization of site 5, is needed technically and to reduce uncertainty. (20-I)

6. Dumping site center should be no closer to the Sanctuary than 37° 28.5' N, 123° 29.5' W. (20-J)

7. Dumping should be prohibited more than four tenths of a nautical mile (.4 nmi) from the above center. (20-K)

Included as an appendix are a number of items which need clarification, bounds or definition.

The Sanctuary thanks you for the opportunity to comment on this document and appreciates the hard work and quality of this DEIS. EPA has developed a usable, accurate and informative document which is also readable. The data developed, compiled and presented within the DEIS represents an important body of knowledge for this project and the overall understanding of this complex ocean environment.

Sincerely yours,

Edward Ueber
Sanctuary Manager
Gulf of the Farallones
and Cordell Bank
National Marine Sanctuaries

EU: cmg/AP1

c: R. Lopez, SRD
T. Jackson, MBNMS

Appendix

Page	Comment	Action requested	
S-1	Limited data on planktonic communications	get more	20-L
S-5	"moderate use"	define	20-M
S-7	10 Km squared over 10 cm - over 1 cm	calculate	20-N
S-8	"minimal and temporary" "could cause some interference"	define why	20-O
S-10	"low probailities"	define #	20-P
	• mention twice "barge transit routes" this is important	where are they	20-Q
	• What is site management and monitoring program (criteria 3)	define	20-R
S-11	US Navy site 2 miles south	move prefered site	20-S
S-12	3. "at least 10 nmi"	does not	20-T
S-13 •	5. This is dependent on monitoring plan	give plan	20-U
S-14 •	8. This should be required	traffic lanes	20-V
1-12 •	What is monitoring to be	define	20-W
1-13	1.5	who and when	20-X
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1-21	GOFNMS is GFNMS	change in document	20-Z
3-19 •	3.1.4.2 - monitoring plan?	when	20-AA

• Related to monitoring.

Exhibit (21)

HELLER EHRMAN WHITE & MCAULIFFE

ATTORNEYS

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January 22, 1993

98413-0001

VIA HAND DELIVERY

Mr. Harry Seraydarian
Water Management Division
U.S. EPA
75 Hawthorne St. (W-7-1)
San Francisco, CA 94105

Deep Water Dredged Material Disposal
Site Designation Draft EIS

Dear Mr. Seraydarian:

These comments on the above-referenced Draft EIS are submitted on behalf of my clients, the Half Moon Bay Fisherman's Marketing Association (HMBFMA).

A. Introduction

HMBFMA applauds EPA's decision to designate Site 5 as the preferred alternative in the Draft Environmental Impact Statement (DEIS). Study Area 5 is an area which my clients have for the last five years been urging upon EPA as a site most likely to have the least impacts on the marine environment, if an ocean dumping site was determined to be absolutely necessary. This site is off of the Outer Continental Shelf, and as such complies with Congress' mandate to protect the Shelf and fishery resources.

The DEIS' discussion of the baseline environment is detailed and constitutes a valuable resource in understanding this marine area. It goes a long way toward filling major information gaps.

We have some concerns about certain aspects of the DEIS, primarily: (1) the absence of a monitoring plan; (2) the failure of the DEIS to adequately document the need for the projected amount of dredged material disposal in the ocean environment; (3) the DEIS' sidestepping of the availability of non-aquatic disposal alternatives; and (4) specific deficiencies in the analysis of environmental impacts. HMBFMA is also troubled by the DEIS' confusing references to the B1 site. Our detailed comments are below.

B. The DEIS Fails to Establish the Need for Deep Water Disposal of 6 mcy annually

The DEIS correctly states that EPA is required by law to demonstrate the need for the proposed deep water site. However, the DEIS fails to adequately fulfill this mandate. The DEIS proposes the dumping of 6.0 mcy annually into the ocean (out of a total 7.6 mcy/year) for a period of 50 years; a project with potentially devastating impacts for the marine environment. It is inappropriate to designate a disposal site of such magnitude without clearly demonstrating: (a) that there is an actual need to dredge this enormous amount of sediment; and (b) that there is an actual need to dump over 80% of such sediment in the ocean.

No one doubts that some amount of dredging is required to keep open various ports and channels in the Bay Area. However, the DEIS makes no attempt to **assess the quantity** of those needs. That San Francisco is an important thoroughfare for international trade does not, without further analysis, demonstrate a "need" for an ocean dump site capable of handling almost all of the Bay Area's maintenance and new work dredging over the next 50 years.

The "Need for Action" section is fundamentally flawed in three respects: (1) it fails to evaluate the quantity of sediment for both maintenance and new work "required" to be dredged over the time period of the project; (2) it dismisses viable alternatives to ocean disposal without any analysis, thus premising the "need" for a massive ocean site on the supposed "unavailability" of alternatives; and (3) it ignores EPA's own regulations which guide the determination of whether ocean dumping is "needed."

Turning to the first issue, the DEIS accepts without any discussion the Army Corps' estimate that 7.6 mcy "must" be dredged from the Bay each year over the next 50 years, for a total of roughly 400 mcy. As far as we can ascertain, the total volume figures relied upon in the DEIS were developed several years ago by the Army Corps as planning estimates, and have never 21-A been subjected to any type of independent scrutiny.[1] While we recognize that EPA is entitled to rely to a certain extent on research conducted by sister agencies, it is not entitled to abdicate its responsibility under NEPA to ascertain a reasonable range of probable dredged material disposal needs justifying the establishment of a permanent ocean site. It is critical that the DEIS for an ocean dump site spell out the basis for claims regarding the total volume of disposal capacity required.

With regard to the second issue, no source or documentation is provided in the DEIS for the assertion that over 80% of the projected dredged material (6.0 mcy) "must" be dumped into the ocean each year. The only justification offered in the DEIS is the disappointing statement that non-aquatic sites "generally have limited capacities" and the tired repetition that there are "presently" no non-aquatic sites available.[2] The DEIS fails entirely to establish a "need" for the volume of dumping proposed in the ocean by simply turning a blind eye to alternative sites. While it is generally true that no single upland site has an unlimited capacity for dredged sediment, it is patently false that upland alternatives taken as a whole do not constitute a major dredged material disposal option. EPA has prepared this DEIS expressly as part of the LTMS, and has based its assessment (21-B)

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[1] The DEIS cites to the Final Ogden Beeman "Alternative Disposal Options" Study, dated 1992, as the source for the 7.6 mcy annual/400 mcy 50-year volume figures. This Study cites to another source for these figures, the Army Corps' "LTMS Phase I Report," dated December, 1990, Table 2 (Page 33). No source or documentation for these figures are provided in the 1990 Report. Moreover, the Corps expressly recognized at that time that: **"Planning estimates of future dredging requirements from historic dredging records tend to have large standard deviations due to confounding factors** such as amount of rain fall, upstream erosion, freshwater diversions and the degree and extend of sediment resuspension." Id. at 31.

[2] There are "presently" no ocean sites available either. The absence of a site at the instant the DEIS is published is not ground for the DEIS to ignore the fact that various sites are coming on-line in the foreseeable future. Indeed, several planned sites are already well into the permitting process. Moreover, at least one port has already begun using an upland site, the Redwood Sanitary Landfill, in a limited capacity.

of the "need" for an ocean disposal site of substantial magnitude on the LTMS goals calling for the development of disposal options in three different media. It cannot then ignore other aspects of the LTMS which are dedicated to the study and development of alternatives to ocean disposal.

This leads to the third issue, that EPA has inexplicably ignored its own regulations establishing the criteria for determining the "need for ocean disposal." Among these criteria are the relative environmental risks, impacts and costs of alternatives "including but not limited to: (1) landfill; ...(4) spread of material over open ground; (5) recycling of material for reuse ..." 40 C.F.R. § 277.15(a).[3] HMBFMA recommends that the DEIS be revised to include a critical evaluation of the quantity requirements for an ocean dump site in light of the future availability of non-aquatic and reuse sites. 21-C

C. **<u>The DEIS Fails to Commit to Monitoring the Impacts of Long-Term Ocean Dumping and Therefore Fails to Provide Adequate Mitigation</u>**

The DEIS recognizes that EPA's regulations require that even after a site is chosen, its use must be discontinued if it becomes apparent that the site "does not meet the criteria set forth" in the site designation regulations. (Page 2-30). Nevertheless, EPA never commits to a monitoring plan that would determine the actual (as opposed to modeled) impacts of the proposed disposal, and the performance of dredgers. 21-D

The assurance in the DEIS that an adequate plan will be developed once the site is approved (pages 3-19, -20, 4-87) is a classic example of "piecemealing" the environmental analysis, a clear violation of NEPA. Monitoring, for NEPA purposes, is essentially a mitigation measure. Without proper monitoring, there can be no assurance that: (1) permit conditions are being 21-E

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[3] We recognize that these criteria are listed in the section nominally dealing with the issuance of permits. Nevertheless, if EPA's regulations expressly require it to consider the availability of non-aquatic alternatives in issuing permits for ocean dumping, obviously it cannot ignore the availability of such sites in establishing the "need" to designate an ocean site in the first place.

complied with; (2) dredge spoils are staying in place as expected; and (3) the environmental impacts of disposal in the ocean are not significant. Hence, monitoring is necessary to support EPA's conclusion that the proposed ocean disposal will not cause significant impacts.

However, the DEIS hedges on whether or not monitoring will actually occur. The DEIS "assumes" that equipment and vessels will be available. This is not a commitment, and indeed, rings hollow following EPA's public admission at the last LTMS meeting of the Policy Review Committee that monitoring in any given year would be subject to the vagaries of EPA's budget appropriations. What is the public to expect if the funds for equipment and vessels are not available, contrary to the DEIS' assumption? Moreover, The EIS' entire discussion of site managing and monitoring is phrased in self-consciously non-committal, equivocal terms. It is entirely unclear from reviewing Section 4.6.2 which of the various site management options, if any, will be employed. (21-F)

EPA's plan to develop a monitoring proposal for inclusion in the Final EIS cannot be sustained under NEPA. To a large extent, the question of whether a site should be designated hinges on whether potential impacts can be effectively mitigated. Monitoring is of special mitigation significance for this project since EPA's conclusions that the project will not cause significant impacts are based almost entirely on modeling studies. The only way to mitigate against inaccuracies and/or unforseen circumstances in the model predictions is to monitor dredger performance and impacts of the disposal. Therefore, the strength of the modeling program is a fundamental aspect of the project, and should be a major component in the determination of whether or not to proceed. (21-G)

The Final EIS will be released along with the final decision on the project. Any comments on this final document are therefore superfluous and irrelevant to the decision-making process which will have ended. In order to comply with NEPA it is critical that all vital project components be placed before (21-H) the public and decision makers **prior to** and not after the decision has been made to proceed.[4].

By putting off the development of a monitoring plan until after the project has been approved, EPA is essentially saying to the public and decision makers: "Trust us. The monitoring plan will be just fine." We have the greatest confidence in the integrity and sincerity of EPA in this regard. Nevertheless, NEPA demands and we must insist that the full project be placed before the public at one time. The monitoring plan is a critical aspect of the project, and project approval should not be provided unless it is absolutely clear in the EIS that monitoring of dredgers' performance and disposal impacts is part of the project being approved. 21-I

The DEIS provides no rationale for why this critical part of the project has been cut out of the EIS process. The flaws in this decision are apparent. For example, the DEIS speculates that "management action" such as limits on disposal volume or timing may be taken if monitoring indicates that negative impacts have occurred. HMBFMA would recommend that EPA implement such "management activities" prior to the occurrence of negative impacts in order to avoid them. If the monitoring plan were part of the EIS, issues like this would be exposed to the "hard look" Congress intended. HMBFMA concurs with the comments submitted by the Gulf of the Farallones National Marine Sanctuary, and incorporates them herein by reference. In particular, we agree with the recommendations of the Sanctuary Manager that: (1) independent observers must be required to study environmental conditions, and not the dredge operators; and (2) the models must be independently verified. 21-J

Without a clear and unqualified commitment to monitoring both the performance of dredgers and the environmental impacts of dredged material disposal at the proposed site, HMBFMA cannot support the project as proposed. We will urge our fellow

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[4] EPA has suggested informally that the public will be able to comment on the monitoring plan in the rulemaking process. By this time, however, the ocean site **will have already been designated.** Thus EPA is attempting to isolate the decision about the ocean site from any decision about monitoring. Our point is that without an adequate monitoring plan, **the site should not be designated at all.**

commercial and recreational fishermen, and environmentalists to adopt similar positions.

D. **Certain Aspects of the Environmental Impact Analyses Are Flawed.**

1. Modeling assumptions appear to be very limited.

In preparing the disposal plume model, EPA assumed a total annual volume of about 4.4 mcy. The DEIS makes clear, however, that the site is expected to accommodate 6.0 mcy. Thus, the actual dumping at the site will exceed the model's assumptions by over 25%. This appears to be a significant difference. Please explain: (1) why the model did not assume the full amount of dumping which is expected; and (2) to what extent an additional 25% of dumping annually would alter the results of the model if at all. It appears that the EIS should be revised to include a "most likely case" scenario, the disposal of 6.0 mcy. NEPA precludes decision-making based on only best case scenarios. 21-K

In addition, it does not appear that the model considered a worst case situation, in which an amount in excess of the estimated 6.0 mcy is dumped at the site. The EIS should be revised to include analysis of a worst case dumping scenario.

2. Fish impacts analysis fails to consider any but the "expected conditions." 21-L

The analysis of impacts to fish as a result of the proposed dumping asserts that to the extent that fish are mobile, they will simply avoid a dumping area, and thus, that impacts to these species are not significant. (Pages 4-58, -58) Impacts to habitat are given short shrift. This fails to address a situation in which the dredged material does not move exactly as anticipated by EPA's model. For example, the DEIS (and apparently the model) does not address the very likely scenario in which a lot of dumping occurs in a short period of time, due to weather constraints. This would obviously affect the length of time the plume is present in the water column.

The analysis should be expanded to address the possibility that dredged sediments will move beyond the expected footprint into a larger area than expected. Impacts to habitat should also be addressed, or the conclusion that habitat will not be significantly affected should be supported.

3. Impacts to marine sanctuaries and proposed mitigation measures are fundamentally flawed. (21-M)

The DEIS states that the accidents in the marine sanctuaries through which the dredged material must pass are "likely to be small, 6000 cy per barge." (page 4-63) The DEIS provides no support for this statement. The DEIS should be revised to include such support. Moreover, again, the DEIS fails to consider a worst case scenario for transport or short dumping incidents in the GFNMS. The DESI should be revised to include such worst case analyses.

The section is also flawed in that it fails to describe the impacts to the Sanctuary of either small or large disposal incidents. The DEIS should provide decision-makers and the public with information regarding the potential impacts to Sanctuary resources of inadvertent disposal incidents.

We agree that the impacts of inadvertent or improper disposal can be mitigated. The mitigation recommended, however, (page 4-63) is wholly inadequate. First, the DEIS does not indicate how barge transport routes should be "specified" or what agency should do so under what authority. Second, there are any number of additional mitigation measures which could protect the Sanctuary beyond designated routes, including as onboard observers, electronic monitoring, limits on barge traffic depending on weather conditions, limits on the amount of material that barges can take, etc. The DEIS should be revised to include a complete range of mitigation measures which could lessen the possibility of impacts to the Sanctuary. Third, the DEIS contains no commitment to the implementation of even the single mitigation measure proposed.

This section should be revised. There is no support in the DEIS to support the implication that specifying transport routes alone will mitigate to insignificant levels the potential for impacts to Sanctuary resources resulting from spills and short-dumping. The commitment to mitigation measures should be made an explicit part of project approval.

E. Miscellaneous Comments

1. The DEIS' characterization of B1 Area is inconsistent and confusing. (21-N)

HMBFMA objects strongly to the DEIS' characterization of the B1B site as "removed from Dungeness crab and rockfish habitat" and as supporting low abundance and diversity of commercial fish. (Page 2-13) First, the studies cited in the DEIS themselves are in conflict, some of them actually stating, to the contrary, that the B1 area supports high numbers of commercial species and crab, and is an important nursery and breeding habitat. (See Table 2.1-2). The failure of EPA to clarify this point in the text creates the impression that it has accepted the Corps' 1988 characterization of the area as unimportant from a fisheries' perspective, a view categorically rejected by my clients and other commercial fishermen.

Second, these statements in the DEIS are based on Army Corps studies which are out of date and widely disputed by commercial fishermen, as EPA has heard on numerous occasions. Third, and most important, we do not understand why EPA is citing to studies that are 10-5 years old and admittedly not comprehensive, when it has spent a fortune on recent studies of the Continental Shelf, specifically including the B1 area.[5] To the extent that EPA feels that it is appropriate to establish in this EIS that the B1 area is an unimportant area for commercial fishing and contains low abundances and diversity, we must insist that it back these statements with its own studies conducted specifically for the ocean designation process. (21-O)

In addition, HMBFMA reiterates the objections we have stated previously in Ocean Studies Group meetings, and previous written comments, regarding EPA's characterization of the B1B site as "a historical site." (Pages 2-32, 3-16) The use of this area was precluded by the California Appellate Court because the permittee failed to obtain consistency review from the Coastal Commission. Moreover, the few barge loads intended for this site were (21-P)

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[5] These studies are cited at length in other sections of the DEIS, and consistently refer to the high abundance of fish and invertebrates in the B1 area, as well as the richness and diversity of this area. This contributes even further to the confusion around EPA's characterization of the B1 area.

illegally dredged and were dumped so far off the mark that EPA itself engaged in lengthy proceedings against the port and its dredger. The dumping which did occur at this site was extremely limited, the DEIS states that it was no more than 18,000 cy. In all likelihood this limited and troubled episode would not serve as the necessary precedent to justify designating the area as the receptor for 6.0 mcy of dredge spoils annually.

Nevertheless, the repeated characterization of this site in the DEIS as "historic" implies just that: that its status as a "historic site" would make it a likely candidate for a permanent disposal site, but for only the fact that it now lies inside the Monterey bay Sanctuary. HMBFMA believes that this is inaccurate and that the EIS should be revised.

2. Zone of Siting Feasibility/Ocean Dumping Regulations

The DEIS states that the zone of siting feasibility is part of the designation process for an ocean disposal site. (Page 2-3) This characterization is misleading and unclear suggesting that the ZSF is part of EPA's site designation regulations. The fact is that the Ocean Dumping Act and EPA's ocean dumping regulations are the sole criteria for the designation of an ocean disposal site. The zone of siting feasibility analysis is an Army Corps overlay on the legally mandated process. The DEIS should be revised to correctly characterize the role of the ZSF in the siting process, and must contain cites to the regulations and/or policies authorizing the ZSF analysis' role in the ocean dump site designation process. 21-Q

Moreover, it is disturbing that the DEIS identifies various issues involved in the selection of potential ocean disposal sits, but places last among them, only one of the various criteria outlined in its own regulations. After commenting numerous times on the need for EPA to focus on its own very explicit ocean dumping criteria in selecting candidate dump sites, HMBFMA is baffled by the primacy given by EPA to the ZSF and other informal guidance documents, apparently over considerations mandated by the MPRSA and EPA's regulations. (Page 2-3)

Conclusion

HMBFMA concurs with EPA's decision that of the ocean sites studied, Site 5 is the best option. However, we are concerned by the unquestioned assumption that ocean disposal is in all cases required, and that the proposed dumping will never have any adverse impacts on the ocean environment. We urge EPA to revise the DEIS to address these issues.

Thank you for the opportunity to comment on this document. We look forward to working with EPA in the future on this issue.

Sincerely,

Cynthia L. Koehler

cc: PRC
Congressional Delegation

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Exhibit (22)

Tom Jow
1108 Beaumont Drive
San Jose, CA 95129
(408)446-5603

Mr. Allan Ota
Environmental Protection Agency
Region IX
75 Hawthorne Street
San Francisco, CA 94105-3901

January 19, 1993

Dear Allan:

Attached for your consideration are suggestions for changes in the draft EIS.

As much of the commercial fish caught in the study region are taken in trawls, I have incorporated results of analyses of the CDFG Trawler Database in the EIS as much as possible.

In reviewing my paper to make comments, I have also uncovered a number of typos. The corrected pages are attached.

Sincerely,

Tom Jow

COMMENTS ON DRAFT EIS FOR SAN fRANCISCO BAY DEEP WATER DREDGED MATERIAL DISPOSAL SITE DESIGNATION

Page 3-141

Third paragraph, first sentence: delete **pink shrimp**. Reason: According to CDFG no shrimp fishery exists in Study Area 2 or in the Study Region. 22-A

Page 3-148

First indented paragraph, next to last sentence: Change to read: Of these, all except pink surfperch and **plainfin midshipman** have important commercial value. Reason: no landings reported for midshipman in CDFG bulletins. 22-B

Page 3-161

Third paragraph, first sentence: Change to read- This section describes the commercially and recreationally important species of fishes in the study region including those collected by trawls from EPA (SAIC 1992b) and Navy studies (Calliet et al. 1992), as well as information summarized in Bence et al. 1992, and Jow (1992), unpublished California Department of Fish and Game------Battelle (1989). 22-C

Last paragraph,second sentence: Did SAIC collect Pacific halibut or were they California halibut? Table 3.3.3.3. names California halibut. See my earlier comments to Shelly Clarke (attached). 22-D

last sentence: change tunas to **albacore tuna.** Reason: Albacore is likely the only tuna taken by anglers. Its possible that an occasional bluefin, bigeye tuna or skipjack might be caught. 22-E

Page 3-162

Second paragraph, first and second sentences: **Pacific halibut**-see comment above. 22-F

Insert as third sentence: **The rank order of flatfish landed by trawlers was Pacific sanddab. Dover sole, English sole,petrale sole, and rex sole (Jow 1992).** 22-G

last paragraph, last sentence: Change to read- MMS/CDFG Commercial Fisheries Database (1992) and CDFG Trawler Database (Jow 1992) indicated rockfishes-------Study Areas 3 and 4. 22-H

Page 3-164

Table 3.3.3.3. - Replace tunas with albacore tuna. 22-I

Page 3-165

Second paragraph: Insert as line 11: The commercial trawl catch of sablefish occur in the deeper part of Study Area 2 in 110 to 183 m and in shallower parts of Study Areas 3 and 4 in 457-1372 m and 1006-1280 m, respectively (Jow 1992). (22-J)

Page 3-241

Last paragraph, second sentence: Change to read - The principal market species in this region include Dungeness crab, market squid, salmon, albacore tuna, flatfishes (Dover sole, English sole, Pacific sanddab, petrale sole, rex sole), a variety of rockfish (*Sebastes spp.*); including chilipepper, bocaccio, widow, splitnose, yellowtail, canary, and shortbelly), thornyheads (*Sebastolobus spp.*) and sablefish (MBC 1989; Tetra Tech 1987; Jow 1992). (22-K)

Third sentence: Change to read - In addition to primary market species, a number of other species including several species of sharks, albacore tuna, mackerels, anchovys and Pacific herring-----Reason: The main fishery for herring is in San Francisco and Tomales Bays where they are caught for their roe so baitfish is a misnomer. (22-L)

Page 3-246

Last paragraph, first sentence - delete **baitfishes such as** and insert **albacore** before tuna. Reason: Sentence implies that herring, salmon, etc are baitfish. Also for reason above where herring are fished for their roe so they are a foodfish rather than a baitfish. (22-M)

Page 3-247

First sentence: Add Jow **1992** to references. (22-N)

Page 3-248

First paragraph: I couldn't find any mention of tunas or mackerel in Battelle 1989. My previous suggestion on mackerel was that the domestic fishery is carried out with roundhaul nets in nearshore areas. There is an offshore element of the jack mackerel resource that is comprised of large mackerel. It has not been the target of a domestic fishery but has entered the foreign trawl catch. I do not mention mackerels in my paper. A suggestion is to delete this sentence. In the previous sentence replace tunas with **albacore tuna**. (22-O)

Page 3-251

First paragraph

Second sentence - replace baitfishes with **pelagic fish.** 22-P

Page 3-252

Second paragraph: Replace the fourth sentence with: In the study region, sablefish were caught in trawls mainly between 128 and 1097 m. The highest trawl catchs were from 366 to 823 m depths (Jow 1992). Traps and longlines are fished at depths between 384 and 1262 m. 22-Q

Page 3-253

First paragraph, line 2: Change to read: rockfishes (primarily including chilipepper, bocaccio, widow, splitnose, yellowtail, canary, shortbelly, and thornyheads), and flatfishes (Dover sole, English sole, Pacific sanddab, petrale sole, rex sole, and sand sole). Reason: Rank order of species catches from 1985-1987 in study region. 22-R

line 8: Change to read : (1992) and the CDFG Trawler Database (Jow 1992), while recreational catches are from the CDFG Recreational Fisheries Database (1992). 22-S

Second paragraph, line 3: Change to read: however, most rockfishes (*Sebastes spp.*) are caught in the study region at depths between 128 and 293 m and most thornyheads (*Sebastolobus spp.*) are caught at depths between 549 and 914 m (Jow 1992). 22-T

Page 3-254

First paragraph: Insert as last sentence - The major fishery in the study region by commercial trawlers is in 457 to 914 fm depths; a minor Dover sole fishery occurs at 73 to 91 m depths (Jow 1992). The latter depths corresponds to depths in Study Area 2 while the former depths corresponds to depths in the shallower parts of Study Areas 3 and 4. 22-U

Second paragraph, second sentence: Change to read: They are taken from depths ranging from 18 to 457 m (Miller and Lea 1972). They are caught in trawls in the study region at depths between 18 and 366 m. Most are caught between 73 and 146 m but a substantial spawning ground fishery occurs at 329-366 m (Jow 1992). 22-V

Last paragraph, first sentence: Change to read: English sole are found from the Bering Sea to southern Baja California at depths between 18 and 457 m (Miller and Lea 1972). Their distribution is centered from the Gulf of Alaska to southern California (Love 1991). Reason: 600 m depth is questionable whereas Miller and Lea (1972) depths are substantiated. 22-W

Insert before last sentence starting with SAIC: The major trawl fishery for English sole in the study region occurs between 37 and 146 m depths (Jow 1992). (22-X)

Page 3-255

Replace first sentence with: Rex sole has a depth distribution similar to Dover sole. In the study region trawl catches were recorded from depths of 18 to 914 m with most catches from 366-549 m depths (Jow 1992). (This peak abundance conflicts with the last sentence of the paragraph, but its a contrast between commercial trawls and research trawls and the last sentence could be qualified by changing it to read: In Contrast, research bottom trawls indicated------(Bence et al. 1992). (22-Y)

Page 4-64

Second paragraph, first sentence: Replace with: Analyses of the MMS/CDFG Commercial Fisheries Database (1992), the CDFG Trawler Database (Jow 1992) and the CDFG Recreational Fisheries Database (1992) indicated that the majority of commercial and recreational fisheries are located predominantly in the continental shelf region. (22-Z)

Page 7-18

Add as the third reference:

Jow, Tom. 1992. Analyses of 1985-1987 Californai department of fish and game trawler database for designation of an ocean dredged material disposal site near San Francisco. 57 pp. Report to the U.S. Environmental Protection Agency, Region IX, San Francisco Ca. (22-AA)

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J. Hashimoto

LEAGUE OF WOMEN VOTERS OF THE BAY AREA
An Inter League Organization of the San Francisco Bay Area

Exhibit (23)

January 24, 1993

Post-it™ brand fax transmittal memo 7671	# of pages ▸
To H. Seraydarian	From LWV/Bay Area
Co. EPA	Co.
Dept. Water Div.	Phone # 510-845-3637
Fax #	Fax #

1/29/93

Harry Seraydarian, Director
Water Management Division
U.S. Environmental Protection Agency
75 Hawthorne St. (W-7-1)
San Francisco, CA 94105

RE: DRAFT EIS FOR SAN FRANCISCO BAY DEEP WATER DREDGED MATERIAL DISPOSAL SITE DESIGNATION

Dear Mr. Seraydarian:

The League of Women Voters of the Bay Area (LWVBA) appreciates the opportunity to comment on the EIS for designation of an ocean disposal site for material dredged from San Francisco Bay. The LWVBA has a long-standing concern for the adverse environmental impacts of disposing of dredged material in the Bay. Our comments on the EIS are as follows:

1. Our major problem with the draft EIS is the lack of a well-defined monitoring program. An adequate monitoring program is key to ensuring that the ocean environment is not degraded. It is essential that the program be fully described and available for public review prior to adoption of an ocean disposal site. The monitoring program as described at 3.1.4.2 and 4.6.2 is vague and poorly defined. The EIS should identify the specific ecological impacts that would be monitored, as well as the methods which would be used to monitor. At a minimum, the following should be included: changes in elevation of the disposal site; changes in the pollutant levels in the sediment; impacts on all species that have used the disposal site; and compliance with permit requirements. Also, the monitoring program should be able to identify illegal ocean dumping. Use of satellites and on-board observers could be appropriate for monitoring various aspects. (23-A)

The monitoring program should include a schedule for frequent review of the monitoring results. The ability to make revisions in the disposal site is also essential should monitoring results indicate that adverse impacts on the ocean environment would occur or are occurring. Considerable and widespread damage could occur with the disposal of 400,800,000 cubic yards of dredged material over the 50-year time span. To ensure potential impacts would be avoided where possible, an ocean disposal permit should be sufficiently flexible so that revisions can be made when warranted. Aspects such as timing, disposal method and location may also need to be revised depending on monitoring data. (23-B)

2. Several areas of potential impact do not appear to have been adequately investigated. In particular, little data have been gathered on turbidity at and near the potential disposal sites, and the data on bird and mammal use of Alternative 5 do not match with data for Alternatives 3 and 4. Information gaps could make it difficult to evaluate adverse impacts of disposal events on fish, birds, and marine mammals. (23-C)

3. Ocean disposal is but one aspect of the dredging and dredged material disposal issue. There should be a comprehensive analysis of disposal alternatives including options for beneficial uses of dredged material, such as to recreate wetlands or repair levees, as well as opportunities for minimizing dredging. Addressing ocean disposal and upland disposal in isolation does not provide an opportunity to fully assess benefits and (23-D)

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disadvantages of each method or to fully evaluate how each method can be used to the benefit of aquatic resources.

Thank you for the opportunity to comment.

Sincerely,

Fran Packard
President

Exhibit (24) (W7)

f 1/27/93

LEVINE•FRICKE

January 22, 1993

LF 2393.08

Mr. Harry Seraydarian, Director
Water Management Division
U.S. Environmental Protection Agency
75 Hawthorne Street (W-7-1)
San Francisco, California 94105

Subject: Comments on the Draft Environmental Impact Statement (EIS) for San Francisco Bay Deep Water Dredged Material Disposal Site Designation, December 1992

Dear Mr. Seraydarian:

We wish to provide the following comments on the subject document.

1) Table 2.1-4 - Site Status and Feasibility for the Montezuma Wetlands Candidate Site--Please note that the project proposal for this site does include dredged sediment rehandling. Also, the site should be identified as a proposed "rehandling facility," as was done for Port Sonoma-Marin, Leonard Ranch, and Praxis/Pacheco, rather than as a "reprocessing facility." The draft EIR/EIS for the Montezuma project is expected to be available for public review in May 1993. (24-A)

2) Table 2.1-4 - Additional Remarks for Montezuma Wetlands Candidate Site--Please note that the site is immediately adjacent to an existing deep water (>18-foot depth) barge access channel and that no public funds are needed to bring the site on line. (24-B)

3) Table 2.1-4 - Project Site Capacity--Please note that the 20-million-cubic-yard figure is for habitat creation, including some disposal of sediment unsuitable for uncontained aquatic disposal (but not "designated" or "hazardous" sediment) in areas not coming into biological contact. We are currently estimating the rehandling facility annual throughput. (24-C)

2393\2393DEEP.LTR:FNC

1900 Powell Street, 12th Floor
Emeryville, California 94608
(510) 652-4500
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Other offices in Irvine, CA, Sacramento/Roseville, CA, Tallahassee FL, Honolulu HI

24-D

4) The document presents quantities of sediments planned to be dredged from the Bay, but does not indicate how much sediment would be suitable for disposal at the ODMDS. Nor does it discuss the impacts from chemical constituents in the disposed sediments that are deemed suitable by testing under the Ocean Dumping Regulations ("the Green Book"). Therefore, it would be useful to provide a discussion of the chemical characteristics of the potential dredged sediments in the context of their disposal criteria mentioned in Section 4.6.1.

Thank you for your attention to these comments. If you have any questions, please contact me, Mr. Stuart Siegel, or Ms. Kim Buchanan at (510) 652-4500.

Sincerely,

James D. Levine, P.E.
President

Exhibit (25)

Marin Audubon Society Box 599 Mill Valley, California 94942-0599

January 25, 1993

VIA FACSIMILE

Harry Seraydarian, Director
Water Management Division
U.S. Environmental Protection Agency
75 Hawthorne Street
San Francisco, CA 94105

RE: COMMENTS ON EIS FOR SAN FRANCISCO BAY DEEP WATER DREDGING MATERIAL DISPOSAL SITE DESIGNATION

Dear Mr. Seraydarian:

The Marin Audubon Society is very concerned about the potential for the disposal of dredged material in the ocean to result in significant destruction. The ocean is a precious resource. The coastal waters from Bodega to Monterey Bay are of immense biological importance providing habitat for resident and migratory sea birds and mammals rearing young and/or during long migrating routes to other habitat areas. The Farallone Islands are the largest nesting colony of sea birds on the west coast (outside of Alaska). Fish abound in the highly productive waters. It is essential that the EPA commit to ensuring that the ocean disposal does not in any way compromise biological resources. The DEIS does not make clear this would occur.

We are particularly concerned about failure to obtain adequate baseline data on bird and marine mammal use of the preferred site. The data is not adequate to support a finding that use of Site 5 would not have significant effects on seabird or marine mammal populations nor does it provide sufficient baseline data for comparison of monitoring results. Throughout the EIS, the value of 5 is minimized and conclusions are drawn that there would be no significant impacts, but data to support these conclusions are insufficient. (25-A)

Because Site 5 is the closest to the Farallones and has the highest bird and marine mammal use, we believe it should not be the preferred disposal alternative. Instead, we recommend that Site 4 be chosen. It is farthest from the Farallones and would likely have the least impact on breeding populations well as migrating bird and mammal populations. (25-B)

Furthermore, the monitoring and site management are not adequately addressed. A comprehensive monitoring and enforcement plan should have been provided in the DEIS. Since it is not, we (25-C)

A Chapter of National Audubon Society

recommend that a Supplemental EIS be prepared to address this and other deficiencies.

We have the following specific comments:

1. S.1 indicates that this DEIS has been prepared in coordination with other components of the LTMS and that an ODMDS is required to fulfill the LTMS objective of a range of disposal options for sediments dredged from SF Bay. An ODMDS is but one piece of the dredging picture. To fulfill the goals of the LTMS process and develop adequate solutions the dredging and disposal problem, the issue as a whole needs to be considered. Other disposal options that result in less environmental damage and/or that could benefit the environment, such as beneficial reuse and minimization of dredging, should be given equal consideration with ocean disposal. Considering ocean disposal sites separately from other options constitutes piecemealing. It gives greater weight to ocean disposal if only because it would be easier and available. It is also unclear whether consideration of an ocean disposal site in isolation complies with requirements of section 404 of the Clean Water Act and Title I of the Marine Protection, Research and Sanctuaries Act, as referred to in para. 2, p. 1.1. 25-D

2. The first sentence, p. S.2 states that a specific goal of this EIS is to provide an acceptable ocean disposal site which will not cause unreasonable degradation of the ocean. What level of degradation would be consider reasonable and what level unreasonable? 25-E

3. The Response to Selection Criteria 3. indicates that use of sites will be terminated if at any time it is determined that existing disposal sites do not meet the selection criteria, as soon as suitable alternate disposal sites can be designated. In order to comply with this criterion, a monitoring program that will ensure compliance with selection criteria should be developed and an alternate disposal site should be identified. Both issues should be addressed in the Supplemental EIS. and approved prior to the disposal of any material. 25-F

4. Why couldn't Study Area 3 be redefined to exclude the eastern point that extends into the MBNMS? A major problem with 3 is that it extends into the MBNMS, however, a simple redesign could avoid this impact. 25-G

5. Several international Migratory Bird Treaty Acts have been executed between the U.S. and several countries, including Mexico and Japan. Compliance of the project with these treaties should be discussed. 25-H

6. The basis upon which the LTMS Upland/Reuse Work Group ranks the Montezuma Wetlands as a highly feasible marsh restoration site (p. 2-23) should be stated. The Montezuma Wetlands is a project proposed by a private interest group about which numerous concerns have been raised and on which environmental review has 25-I

not been completed. We have serious question as to whether it is in the public interest to commit to this as a disposal option even before completion of environmental review. We recommend that it be deleted as an option.

7. It is unclear how compliance with criterion at 4-CFR 228.5(b) can be determined when there have basically been no baseline turbidity data gathered. (25-J)

8. A perceived advantage of Site 5 is that the dredged material could be used "specifically for burying waste containers" (p. 4-93). Considering that deposition in the ocean waters results in corrosion of metal, is there any danger that the containers holding radioactive materials could be broken open and spread throughout a wider area by disposal materials? Material that could pierce or crush containers would undoubtedly be illegal. However, illegal disposals have occurred at Alcatraz therefore should be considered a possibility at the ocean site. (25-K)

9. Would depositions of dredged material with concentrations of metals and other contaminants higher than on-site levels be allowed? (25-L)

10. Why were different methods with lower sensitivity allowed for sediment from Site 5 than other areas, and concentrations of n-alkane and many PAHs not analyzed in Area 5 sediments (p. 3-90)? (25-M)

11. What part, if any, did proximity to the Bay, which would make transport of dredged material less expensive, play in selecting Site 5 as the preferred alternative? (25-N)

12. The data collected for fish and particularly birds and marine mammals are disappointingly inadequate. We question how comparable surveys done in September and October at Areas 2,3 and 4 as compared to July for Study Area 5. Quite different fish, birds and mammals could use each site in these different months. Also, different sampling methods were used for sites 5 and 2 through 4, so that "quantitative comparisons...do not appear appropriate." Much of the marine bird data were gathered from surveys that covered the general vicinity not the specific sites and we understand that some censusors had to find their own way to the sites (basically find a boat to hitch a ride on). If EPA can't even provide funding for transportation to the survey sites, we have serious doubts that adequate funding for a monitoring and enforcement program would be provide. (25-O)

Consistent surveys during all seasons and using uniform methods should be undertaken prior to issuance of any disposal permit. Baseline data should included site specific surveys for species, movement/migration through the area, and responses to turbidity plumes. This information should be presented in a Supplemental (25-P)

EIS. As a result of these data, permit restrictions and monitoring parameters should be recommended.

13. We object to selection of Alternative Site 5 as the preferred alternative. The primary reasons given for its choice are depth and slightly higher seasonal abundance of midwater fish and infaunal species at Sites 3 and 4. We do not find the information demonstrates a convincing rationale for Site 5. In fact, it appears just the opposite. Bird and mammal use of 5 is higher. Site 5 is also closer to the Farallone Islands, the largest seabird nesting colony on the west coast (outside of Alaska), and has the greatest potential for significant impacts on marine mammals, seabirds and endangered species. (See further discussion of biological values below.) It appears to us that Site 4 has less potential to cause significant biological impacts and therefore recommend Site 4 as the preferred alternative. 25-Q

14. The information provided does not support a finding of no significant impact on seabirds, marine mammals and endangered species. For many species, the Farallones breeding population is a significant percentage of the world population. In addition, masses of marine birds pass through the area on route to other areas depending on productive waters to sustain them on their journey. The area is an important movement corridor for marine mammals. Disposal of dredged material will impact presence of prey and the visibility of prey items. Turbid plumes could have a significant effect on nesting sea birds, particularly during El Nino years when fish populations are down, if they have to travel further from breeding sites to forage. Populations of many species are already low due to gill netting and el Nino. The DEIS should recommend seasonal limitations to minimize adverse impacts on Farallone breeding populations. 25-R

15. The discussion of potential effects on endangered and other special status species is deficient. The first para. 3.3.6.1 p. 3-225 indicates that any critical habitat of candidate, threatened or endangered species that may be impacted by dredged material disposed within the study areas was submitted to the USFWS and other agencies as required by the Endangered Species Act.. This information should also be provided in the Supplemental EIS. 25-S

16. Statements that the number of observations of certain special status species has been minimal is misleading. If these species were observed in great numbers they would not need to have special classification. It appears that certain of the sites are important for movement of endangered, rare and special status species. However, the discussion does not provide clear or consistent data about their use. For example, Humpback whales were observed 'in the study region' from March through January with greatest concentrations mid-August through October; Blue whales occur 'in the Farallone Basin' in summer and fall, no 25-T

location. The discussion is not very clear about the location of the sightings. A figure showing the locations of sightings of rare, endangered and threatened species should be included. In addition, the DEIS should recommend seasonal restrictions to avoid impacts to endangered, rare and threatened species.

17. The potential adverse impacts of the movement of turbid plumes is a great concern. "Effects on water quality from dredged material disposal at the preferred alternative site are considered a Class III potential impacts because plumes are expected to disperse within 48 hours of discharge...changes to water quality parameters... are expected to be transient and localized within the discharge plume." (p. 4-35) Impacts of decreased light penetration reducing primary productivity is similarly minimized: on p. 4-48, the statement is made that effects would only last a few hours until plume dissipated (p. 4-48). Minimization of impacts occurs throughout the DEIS and it may be valid if there would only be rare, isolated disposal events. However, we are talking about the annual disposal of 6 million cubic yards of material, and 400,800,000 cubic yards disposed over 50-years. Vague references are made to discharges every 12 hours, there are, in fact, no restrictions recommended on timing or frequency of disposal events. 25-U

18. Considering the complexity of the currents, the inadequacy of data collected on suspended solids at disposal sites, and the lack of information on the effect of turbidity on foraging fish, birds and marine mammals, it seems that the potential for significant adverse impacts on food chain species including seabirds and mammals is very real and cannot be considered insignificant. Great plumes of clay-silt material could be transported about depending on currents at any given periods and the amount of material dumped and the frequency of dumping. Massive plumes could destroy food chain species, cause prey species to move, inhibit or prevent foraging activities, destroy prey species and eliminate large areas from foraging or migration habitats. Increased noise interference would be an additional impact on marine mammals which could have to change migration or movement course, primary productivity reduced and prey items would be reduced or destroyed. 25-V

19. Baseline data adequate to assess impacts of turbidity on the movement and foraging of fish, seabirds and marine mammals should be obtained and presented for public review in the Supplemental EIS. Seasonal restrictions to avoid migrating and breeding as well as endangered species, and timing restrictions to avoid great numbers of plumes be transported for days over large areas should be recommended. 25-W

20. The DEIS also minimizes impacts on infaunal organisms. On p. 4-54 and in other discussions, high recolonization rates within six months are predicted. However, if disposals events are 25-X

repeated and frequent there would not be opportunity for recolonization. Also, discussion p. 4-55 states that disposal "would result in most of the dredged material footprint being less than 10 cm thick." P. 4-51 para. one, indicates that as little as 5 cm coverage can result in significant mortality of the buried species." Localized impacts on taxonomic composition, density and biomass of epifauna could, therefore, be significant.

21. In addition to inadvertent discharges or overflow from barges into Marine Sanctuaries, there is potential for intentional dumping violations. This has occurred at Alcatraz and other parts of San Francisco Bay, why wouldn't it occur in the middle of ocean? Simply specifying a specific transit route as suggested would not be sufficient mitigation. (25-Y)

22. Use of sites 3 through 5 by albatross should be discussed. These are also a species of particular interest of naturalist tours focusing on birds. (25-Z)

23. A Monitoring Program should have been developed and presented for public review in this DEIS. It is essential that a thorough and effective program to monitor both biological and physical impacts be required. The monitoring discussion pp. 4-90 to 4-92 is inadequate, indicating only that the general items listed "may" be assessed. Thorough monitoring and enforcement programs should be in-place prior to the disposal of any dredged material and should be presented for review in the Supplemental EIS. At minimum, the monitoring program should be designed to: (25-AA)

- track turbidity changes and movement of turbid clouds. While it is understandable that the areas of concern are the Marine Sanctuaries, significant damage to ocean resources could occur with movement deposition of sediment at other locations. Size, persistence and movement of the plumes according to currents as they vary according to seasons must be documented.

- identify impacts on the movement and feeding patterns of fish, marine mammals and seabirds with particular attention to endangered threatened and candidate species. Impacts could disrupt migration and foraging patterns for fish, birds and marine mammals and cause significant loss of foraging area. Loss of foraging habitat close to the Farallones is a particular concern particularly during years when fish populations are low.

- determine the amount of bottom sediment deposited and the rate and amount of smothering of benthic organisms and the destruction of plankton and disruption of planktonic patterns.

- determine increases in contaminant levels of sediments at disposal site and/or other locations of sediment deposition.

- identify disposal events outside of intended site, at the chosen site and anywhere along the route to the dump site.

In addition,

- monitoring methods that are most effective should be utilized. Sediment and current meters should be in-place; on-board observer-experts in marine mammals and bird identification should be on-board disposal vessels; and other means, such as satellites if necessary, to determine the movement of turbid plumes and their effect on marine species should also be in place.

- cost of monitoring should be borne by dredgers.

- a schedule that assures regular adequate review and assessment of all monitoring results should be developed and adopted. The program should also ensure compliance with selection criteria. Review of the data at least every year or two, or on an as-needed basis should be required.

- responsibility for monitoring should be delegated to an agency with a primary interest in biological resources, such as the Gulf of the Farallones National Marine Sanctuary.

24. An enforcement plan that assures prompt action on violations should be developed and adopted. It should include speedy imposition of substantial fines that would serve as a deterrent to violations, and the ability to revise permits to remedy or avoid adverse impacts that are occurring. 25-BB

25. An advisory committee should be appointed to review monitoring results and recommend revisions to monitoring and to permits. Committee should include members of wildlife agencies, Marine Sanctuaries, and interested environmental organizations. 25-CC

26. The EIS should recommend permit restrictions to minimize or avoid adverse impacts prior to issuance of any permits. Restricting permits should not wait until there is evidence of significant adverse effects. We are particularly concerned that the frequency of disposals be restricted to minimize impacts, and that timing be limited to avoid breeding and migration seasons and to reduce the potential for transport. If there evidence after adequate monitoring that plumes are not causing adverse effects on the marine species, restrictions can be listed. 25-DD

Thank you for considering our comments.

Sincerely,

Barbara Salzman
for the Conservation Committee

7

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Exhibit (26)

THE MARINE MAMMAL CENTER

Marin Headlands

Golden Gate National Recreation Area

Sausalito, California 94965

(415) 289-SEAL

21 January, 1993

1/26/93 PM 1/33

Mr Harry Seraydarian
Director, Water Management Division,
U.S. Environmental Protection Agency,
75 Hawthorne Street (W-7-1),
San Francisco, CA 94105

Dear Mr Seraydarian,

We are responding to the call for comments on the EPA DEIS for San Francisco Bay Deep Water Dredged Material Disposal Site Designation. The Marine Mammal Center (TMMC) is a non-profit wildlife facility that rescues, rehabilitates and returns to the wild distressed marine mammals along 1000 miles of California coastline. Founded in 1975, TMMC now has over 30,000 members and donors nationwide. TMMC promotes public awareness and furthers scientific knowledge of marine mammals.

There are a number of issues requiring clarification that arise from the draft impact statement, both regarding marine mammals specifically as well as some general comments. There are several issues pertaining to potential impact on marine mammals that we would like to address. Additional detailed research into these matters would be warranted prior to initiating a dredging and dumping program.

1. Dredge barge activities may be prolonged (time to reach dump site and complete dumping) and frequent (up to twice a day, p. 3-259), causing potential disruption of foraging and other habits in the area of the dump site (section 4.2.2.6). With Alternative Site 5, this could be very intrusive for northern fur seals, a depleted species that favors the area over the continental slope and rise (pp. 3-218, 3-229), as well as many of the cetacean species. Any disturbance caused by dumping activities would contravene the regulations set out under the Marine Mammal Protection Act (MMPA). (26-A)

2. The increased turbidity of the water (section 4.2.1.3 & p.4-31) may affect foraging success as well as prey species abundance (p. 4-57). All the Alternative Sites are areas with juvenile rockfish and other prey species (section 3.3.3), which are expected to be affected by the dumping. This in turn will have effects on their pinniped and cetacean predators. In an El Niño year (such as 1991-92 and now 1993), already depleted fish stocks (26-B)

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may not withstand the regime changes brought on by dumping (particularly juvenile fish). This may also have a detrimental effect on the marine mammal populations.

3. The foraging habits of many pinnipeds and cetaceans have not been fully described. There are suggestions that adult male elephant seals feed at depth (p. 3-216) and may graze benthic communities in all the proposed sites. This may also be true for several cetacean species. The bioaccumulation of heavy metals and other substances from the dredging spoils could have serious consequences for the health and survival of marine mammal species. 26-C

4. Marine mammals may not be impacted in a manner identical to potential effects on seabirds (pp. 4-60 & 4-79-4-81). They have different foraging habits and habitat requirements, which have not been fully investigated. 26-D

In addition to our specific comments regarding marine mammals, there are also some general concerns about the proposed dumping sites.

5. Most of the modelling of the dumping effects has been derived from shallow site extrapolation (pp. 4-2 & 4-7). There is no evidence that deeper water dumping will act in the assumed ways. There should be more systematic investigation of sediment dynamics at depth (and current patterns in the specific site) prior to dumping (p. 4-37). 26-E

6. The geology of the preferred Alternative Site 5 suggests, although this has not been a major focus, the widespread presence of submarine canyons. In addition, there is strong indication of turbidity flows (section 3.2.5.1 & p. 3-114), and subsequent resuspension of fine silt and clay sediments (p. 3-31 & section 4.2.1.2). There are also old munitions deposits in the general area (as yet undisclosed - p. 2-37 - and probably shifted by currents and other activities). The erosive action of turbidity currents could be disastrous in connection with dumping of chemicals and munitions (pp. 3-8-3.13). The proposed volume of sediment could easily cause destabilization and slumping, with turbidity flows to deeper waters. In turn, this could spread dredged sediments over a much wider area than proposed. This could combine with a nepheloid layer to impact a larger site and more benthic communities than suggested (p. 4-14). In fact, there is 26-F

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insufficient discussion of the impact on the area covered by dumped sediment, which is anticipated to be significantly larger than the apparent dumping site (p. 4-45).

7. While there has been some analysis of the sediments in the Alternative Sites (section 3.2.5.4), there is no documentation regarding specific analysis of the proposed dredge sediment components (p. 3-17). As with many dredge sites, San Francisco Bay has an accumulation of heavy metals, hydrocarbons and agricultural compounds (e.g. chlorinated pesticides and PCBs) from drainage and commercial activities around the Bay. Alternative Site 5, for example, already shows a relatively higher concentration of heavy metals, such as mercury (Table 3.2-6); this is probably a result of sediment accumulation in submarine canyons, gradually working away from the coastal areas. It seems unwise to add to an already slightly elevated concentration of heavy metals and other substances (e.g. lindane) by dumping dredging spoils. 26-G

8. Alternative Site 5 is over the continental rise and in an area of frontal activity (p. 3-74) and productivity (pp. 2-34 & 2-40), hence the abundance of juvenile fishes and marine mammal predators (pp. 3-191 & 3-213). Dumping in this area would impact local productivity and could have wider effects up the food chain. 26-H

9. All of the Alternative Sites have an abundance of benthic invertebrates (section 3.3.2). The preferred site has a number of unique characteristics, including the only sponge species found in the proposed sites (p. 3-105), as well as a number of species known only for that site (p. 3-134). On page 3-114, a natural disturbance is mentioned, as well as its subsequent effect, decreasing species diversity and density. This disturbance was similar to the effect of dumping, but much smaller in impact; the dumping could have a much larger effect than anticipated on the benthic community (both in the site and nearby) (sections 4.2.2.2, 4.4.1.3. & 4.4.2). 26-I

10. El Niño conditions occur sporadically, every 2 to 8 years on average; they are found in conjunction with decreased or suspended upwelling (sections 3.2.2.1, 3.2.2.7, 3.2.2.8 & 4.2.1.2). In a severe year, this may result in some sediment moving eastward into the marine sanctuaries near all the proposed sites (p. 4-20). 26-J

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11. The potential problems with monitoring deep water sites are very important considerations (section 3.1.4.2). In particular, there are insufficient provisions made regarding this study with respect to Alternative Site 5, the deepest of the proposed sites (p. 2-36). Unless there are definite plans and methods for conducting appropriate monitoring (section 4.6.2), dumping is not advisable. Little is known about the system prior to dumping (re: biology, chemistry, geology and physics), so predictions about consequences are not necessarily accurate. With incomplete preliminary data, monitoring after dumping would be poor science and potentially disastrous. The Marine Mammal Center opposes any disturbance that cannot be appropriately monitored. 26-K

12. Why is the proposed volume of dredging increasing (section 1.2)? San Francisco Bay is very shallow on average, due to the dynamics of the system and previous human disturbances. None of the dredged sites will be sustainable without continued dredging (p. 1-6). How feasible is the continued existence of the Oakland and Sacramento ports in the face of perpetual dredging? There is surely no need to dredge new channels for recreational reasons (p. 1-6), considering the expense and potential oceanic impact of such activities. And the proposed increase in water coming into the delta (through a decrease in water allocation to agriculture) will mean an increase in the sedimentation rate in the Bay. On an economic note, this seems like a short-sighted solution to a rather monolithic problem. 26-L

13. The risk of barge accidents in the region of the Farallon Islands is a problem (pp. 2-28 & 3-259). Routing barge traffic well clear of the sensitive areas may not be practical or enforceable. 26-M

There seems to be a need for additional research on a number of these aspects of dumping. We appreciate the amount of work that has gone into the environmental impact statement to date, but this proposal has wide-ranging implications that require more study before the plan is implemented. Dumping on land does not have the potential to hold the amounts of material proposed, and the deep water Alternative Sites do not seem appropriate based upon the information thus far. We are particularly concerned with the potential biological impact of the dumping, and concur with the comments made by PRBO on this matter (1/15/93). Adequate monitoring is essential to

THE MARINE MAMMAL CENTER

this project, and plans should be fully expanded and tested for viability before any dumping takes place.

Thank you for allowing us to comment on this matter.

Sincerely,

Marin Headlands
Golden Gate National Recreation Area
Sausalito, California 94965
(415) 289-SEAL

Peigin Barrett
Executive Director

Krista Hanni
Science Director

cc: Jerry Gibbons, Chair, Board of Directors
Dr. Hilary Feldman, Marine Biologist

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PACIFIC FISHERY MANAGEMENT COUNCIL
Metro Center, Suite 420
2000 SW First Avenue
Portland, Oregon 97201
Telephone: (503) 326-6352

CHAIRMAN
Philip Anderson

Exhibit (27)

1/27/93
EXECUTIVE DIRECTOR
Lawrence D. Six

January 22, 1993

W7

Mr. Harry Seraydarian, Director
Water Management Division
U.S. Environmental Protection Agency
75 Hawthorn Street (W-7-1)
San Francisco, CA 94105

Dear Mr. Seraydarian:

The Pacific Fishery Management Council has been following the Long-Term Management Strategy (LTMS) established to select an ocean dump site for dredge spoils from San Francisco Bay. The Council considers attention to this activity an important part of its directives under the Magnuson Fishery Conservation and Management Act. The directives include development and monitoring of management plans for fisheries within 3 to 200 miles off the coasts of Washington, Oregon and California, as well as concern for fishery habitat.

The Council agrees with the selection of "Site 5" as the preferred alternative in the "Draft Environmental Impact Statement for San Francisco Bay Deep Water Dredged Material Disposal Designation" (DEIS). This site appears to be the most likely one to avoid any net loss of the productive capacity of the marine and estuarine environment which sustains commercial and recreational fisheries. However, the Council is troubled by the lack of a scientific monitoring plan in the DEIS to determine the actual impacts of dumping at the site. It is our understanding that a monitoring program will be included in the final EIS. (27-A)

The Council believes that a scientific monitoring program is necessary for the dump site and that there must be opportunity for comment on the program prior to its final adoption. Under the authority of 16 USC 1852 (i)(2), the Council requests your agency to apprise us of your intentions with regard to providing for public input into the development of a monitoring program. (16 USC 1852 (i)(2) states that: "Within 45 days after receiving a comment or recommendation under paragraph (1) from a Council, a Federal agency shall provide a detailed response, in writing, to the Council regarding the matter. . . ") (27-B)

In addition to our concern about a monitoring program for materials dumped at the site, the Council is also concerned that provision be made for monitoring and enforcing compliance with dumping materials at the site and not in other unauthorized areas. Absent such monitoring and enforcement, significant habitat damage may occur. (27-C)

Mr. Harry Seraydarian
January 22, 1993
Page 2

Thank you for this opportunity to comment on the deposition of dredged materials from San Francisco Bay. We look forward to your response to our concerns. If you have any questions with regard to our comments, please contact Mr. John Coon of the Council staff (503/326-6352).

Sincerely,

Lawrence D. Six
Executive Director

JCC:
cc: NMFS, SW Region
Boyd Gibbons
Habitat Committee

Exhibit 28

Farallon Island Station
In Cooperation with
U.S. Fish and Wildlife Service

PRBO
INTERNATIONAL BIOLOGICAL RESEARCH

Palomarin Field Station
Point Reyes Bird Observatory

October 16, 1992

Ms. Janet Y. Hashimoto, Chief
Marine Protection Section
U.S. EPA, Region IX
75 Hawthorne Street
San Francisco CA 94105-3901

Dear Janet:

Following the last meeting of the LTMS Ocean Studies Work Group, at which initial discussions were made over the design of a program to manage and monitor the dredged material dumping, we at PRBO have discussed this and have developed the following recommendations for your consideration:

In terms of management, a program should include the following:

1. It is necessary that the position of dumping events be recorded either by use of a "black box" that records position when the draft of the vessel decreases markedly (preferred) or by radar, perhaps on the Farallones (where agencies such as USGS already have recording/transmitting devices). 28-A

2. Barges, both full and empty, should be confined to the already designated traffic lanes. In the area between the end of the traffic lanes and the dump site, barges should follow prescribed routes with adequate separation between going and coming barges. Turns of the vessel after dumping, for return to the prescribed route should also be consistent. 28-B

In terms of monitoring:

1. For at least three years, one including an El Nino event (or maybe for a 5-yr period, which would likely "catch" an ENSO), the behavior of the plume resulting from disposal should be recorded or regularly "sampled" (perhaps by aerial photo or satellite image, if a color-scanning satellite is finally returned to orbit). Other procedures should be undertaken to verify various footprint and plume models. Some sort of moorings should be afixed within Marine Sanctuary boundaries to assure that impacts to Sanctuary waters (turbid plume) are not a regular event. 28-C

2. For an initial two-year period, a study should be undertaken to observe the behavior of marine birds and mammals, and their mid-water prey, in response to disposal plumes. This would likely involve aerial transects (bird/mammal censuses; photo of plume) before, during and following a series of disposal events taking into account the 28-D

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4990 SHORELINE HIGHWAY, STINSON BEACH, CA 94970-9701 TEL. (415) 868-1221 FAX (415) 868-1946

seasonality of occurrence and the ecological needs of various organisms. In terms of mid-water prey, some sort of mooring, with upward looking hydroacoustic and turbidity monitoring capabilities would be in order. If marked responses by organisms are shown this might necessitate certain monitoring programs be instituted (e.g. if a change in seabird diet becomes a possibility, due to change in prey behavior, then perhaps diet monitoring).

3. Samples should be collected regularly from the Farallones to monitor bioaccumulation of contaminants (heavy metals, pesticides and organochlorines). Samples would include mussels (Mytilus) and bird eggs from several species (Western Gull, Cassin's Auklet, Rhino Auklet & perhaps Common Murre and Ashy Storm-Petrel, if enough eggs can be found). Analyses should be run regularly by EPA and other labs; collaboration with NOAA's "Status and Trends" program, in which contaminants in the marine system are monitored (though not near the Farallones), may be fruitful. If contaminants are found this program should be expanded to include more intensive studies of the food web. Perhaps some benthic organisms, as well, should be sampled from the disposal site (e.g. sole). 28-E

4. Finally, a naturalist should be assigned to the barges at regular intervals in order to record responses to disposal events and to chronicle any changes in bird/mammal use of the area (indicators of changes in mid-water organisms as well; changes in abundance of benthic organisms would be indicated by changes in elephant seal use of the area). Trends, rather than a baseline "snapshot" (much more expensive over the long run), would be more sensitive and would better reveal alterations in habitat use/occurrence patterns of birds/mammals. 28-F

We look forward to working with you more as the management and monitoring programs begin to take shape.

Sincerely yours,

David G. Ainley PhD
Director, Marine Studies
LTMS Study Group Member

Farallon Island Station
In Cooperation with
U.S. Fish and Wildlife Service

PRBO
INTERNATIONAL BIOLOGICAL RESEARCH

Palomarin Field Station
Point Reyes Bird Observatory

JH 1/21/93

January 15, 1993

Mr. Harry Seraydarian, Director
Water Management Division
U.S. EPA
75 Hawthorne Street (W-7-1)
San Francisco CA 94105

RE: Comments regarding the EPA DEIS for deep water dredge material disposal - recommendations for a marine monitoring program to include the principal vertebrates of the area, including seabirds, pinnipeds, and cetaceans.

Dear Mr. Seraydarian:

We are responding to your call for comments on the DEIS for San Francisco Bay Deep Water Dredged Material Disposal Site Designation. We made extensive comments on a preliminary version of the Draft. Many of our criticisms were addressed. We appreciate that, in large part, our comments were taken seriously.

28-G

The DEIS continues to view the importance of endangered, threatened and depleted bird and pinniped species relative to their PRESENT abundance. That is, the tone of the DEIS dismisses any potential impacts on them because these species are presently rare. The DEIS does not qualify its statements regarding efforts to detect these species' use of the disposal sites; the EPA-funded preliminary studies were, at best, minimal. Thus, the DEIS tone disregards the historical population size of these species and the recovery plans that have been devised for each.

Considering the high natural productivity and biological significance of the proposed dump site, which led to the creation of the Gulf of the Farallones National Marine Sanctuary immediately to the east, the potential impact on the diverse vertebrate animals found in the area should be considered. It is our recommendation that a regular monitoring program be established to determine the impact of the proposed dumping and to better understand the movements and feeding strategies of seabird, cetaceans, and pinnipeds in the area. The dumping of dredged materials will potentially have a major impact on water quality in the area, principally water clarity, which could affect the prey species of the vertebrate marine organisms in the area, or potentially affect the predators' ability to capture their usual prey if visibility is reduced. 28-H

Arctic Alaska Antarctic Eastern Pacific Ocean All Western States Mexico Mono Lake

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Our specific recommendation is that EPA should require the development and initiation of a monitoring program PRIOR to the actual dumping of dredged materials to evaluate the ecological impacts and consequences of dredged material disposal at sea. This is especially important considering the sensitive nature of the marine environment, and the many seabirds, cetaceans, and pinnipeds that depend upon the waters of the entire region. The elements of the disposal site monitoring program should evaluate all the aspects indicated on pages 3-19 and 20 of the DEIS, and should also include vertebrate species in the area as well. 28-I

Many of the marine vertebrates potentially affected by the proposed at-sea dumping of dredge materials are currently at historical lows in their populations due to a variety of unnatural disturbances. At-sea dumping adds one more factor to the environment that these species must cope with. The long term protection of our marine mammals and seabirds requires constant vigilance to insure the increase of these already decimated populations. Therefore, the least that should be done is establish a regular monitoring of the species in the area, throughout the year, to assure that no adverse impacts occur. This is especially important since the size and nature of the plume, slated to last 50 years, in still unknown. 28-J

This issue was addressed in a previous letter to J. Y. Hashimoto, Chief of the Maine Protection Section. I am enclosing a copy of that letter for your information. I hope these comments will be adequately addressed in the final Environmental Impact Statement and that the recommendations will be adopted as a condition for at-sea dumping of dredge spoils.

Sincerely,

Daniel Evans, Ph.D.
Executive Director

cc: J.R. Raives, California Coastal Commission

Exhibit (29)

PORT OF OAKLAND

January 25, 1993

1/29/93 pm 1:27

Mr. Harry Seraydarian, Director
Water Management Division
U.S. Environmental Protection Agency
75 Hawthorne Street (W-7-1)
San Francisco, CA 94105

SUBJECT: COMMENTS ON THE DEIS FOR SAN FRANCISCO BAY DEEP WATER DREDGED MATERIAL DISPOSAL SITE DESIGNATION

Dear Mr. Seraydarian:

Thank you for the opportunity to comment on the Draft Environmental Impact Statement for San Francisco Bay Deep Water Dredged Material Disposal Site Designation. We applaud the quality of the scientific work that supports this study and its conclusions. We appreciate and support EPA's very thorough and timely effort to develop an ocean disposal site for dredged material.

The maritime industry plays an important role in the Bay Area economy. It directly generates 100,000 jobs and generates $5.4 billion in annual economic benefits. The development of an array of environmentally sound and affordable disposal options is critical to maintaining the competitiveness of the Bay area's maritime industry. The designation of an ocean disposal site is a crucial step in development of the long term management strategy for dredged material disposal.

The draft document states that a monitoring program will be developed to monitor disposal at the site and its impacts. We concur that monitoring is appropriate, and recommend that the monitoring program include transport of material to the disposal site. The program to be developed should also indicate how the monitoring program will be funded and implemented. The monitoring program should be made available for public review and comment, perhaps through the Final EIS. (29-A)

Thank you for the opportunity to comment.

Sincerely,

James McGrath

James McGrath
Environmental Manager

JM/JZ

c:\wp51\files\ltms\ocean.eis

530 Water Street ■ Jack London's Waterfront ■ P.O. Box 2064 ■ Oakland, California 94604-2064
Telephone (510) 272-1100 ■ Fax (510) 272-1172 ■ Cable address, PORTOFOAK, Oakland

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Exhibit (30)

PORT OF SAN FRANCISCO

MICHAEL P HUERTA
Executive Director

Ferry Building
San Francisco, CA 94111
Telephone 415 274 0401
Telex 275940 PSF UR
Fax 415 274 0528

January 22, 1993

Mr. Harry Seraydarian
Director
Water Management Division
U. S. Environmental Protection Agency
75 Hawthorne Street (W-71-1)
San Francisco, CA 94105

Re: DEIS For San Francisco Bay Deep Water Dredged Material Disposal Site Designation

Dear Mr. Seraydarian:

Your office is commended for the comprehensive technical analysis in the Draft EIS on the deep water dredge disposal site designation for San Francisco Bay. The range of alternatives and the completeness of the environmental analysis will allow selection of an environmentally sound alternative.

The Port of San Francisco, as a member of the Long Term Management Strategy (LTMS) Implementation Committee, is concerned that discussions of feasibility of an ocean disposal site have not included analyses of a monitoring program and associated costs. The feasibility of use of the ocean disposal site will ultimately depend on cost. The outcome of the LTMS and ability of users to access the alterative disposal sites (upland, ocean, in-bay) could be directly impacted by decisions made as a result of this EIS. (30-A)

Mr. Harry Seraydarian
January 22, 1993
page 2

The implementation of a monitoring program for use of the disposal site should be addressed in the Final Environmental Impact Statement (FEIS). Implementing the feasibility of a monitoring program will depend on the costs of the monitoring and on the availability of funds to conduct the monitoring. In addition, development of a monitoring program itself will also have associated costs. If the EPA is unprepared to absorb these development costs the Port of San Francisco offers support in seeking the necessary funding authority to develop the ocean disposal monitoring program for the selected site. (30-B)

The FEIS should discuss in greater detail the required elements of a monitoring program and present an overview of mechanisms to implement the monitoring program. Further decisions on a monitoring program should take place in the context of the LTMS implementation discussion currently underway. Using the LTMS process will help to resolve questions regarding the choice of implementation mechanisms for an ocean disposal monitoring program. These discussions and decisions are too far-reaching and complex to take place in the forum provided in the review of this DEIS. (30-C)

The Port of San Francisco looks forward to the completion of the FEIS for the ocean disposal site designation and the discussions to follow in the LTMS process.

Sincerely,

Michael P. Huerta
Executive Director

MPH/TJ/I-KARENP4

Exhibit (31)

STATE OF CALIFORNIA PETE WILSON Governor

SAN FRANCISCO BAY CONSERVATION AND DEVELOPMENT COMMISSION
THIRTY VAN NESS AVENUE, SUITE 2011
SAN FRANCISCO, CALIFORNIA 94102-6080
PHONE: (415) 557-3686

January 15, 1993

Mr. Harry Seraydarian, Director
Water Management Division
U.S. Environmental Protection Agency
75 Hawthorne Street (W-7-1)
San Francisco, California 94105

SUBJECT: Draft Environmental Impact Statement for San Francisco Bay Deep Water Dredged Material Disposal Site Designation (December, 1992) Inquiry File Nos. MC.MC.7415.20 & MC.MC.7402.306; Planning File: LTMS, Ocean Studies

Dear Mr. Seraydarian:

I am writing in regards to the *Draft Environmental Impact Statement (DEIS) for San Francisco Bay Deep Water Dredged Material Disposal Site Designation*, published December, 1992, and issued by the U.S. Environmental Protection Agency Region IX (USEPA). The subject *DEIS* analyzes potential impacts associated with several options for an Ocean Dredged Material Disposal Site (ODMDS) to receive material dredged from San Francisco Bay, including a "No-Action" alternative, and identifies Alternative Site 5, located in deep water 57 statute miles off the coast, as the preferred alternative. The staff of the San Francisco Conservation and Development Commission (Commission) has reviewed the subject *DEIS*, and is submitting comments regarding the document, based on the federal Coastal Zone Management Act (CZMA), McAteer-Petris Act and the Commission's *San Francisco Bay Plan*.

Although the ODMDS alternatives under consideration are located outside of the Commission's permit jurisdiction, I am commenting on the *DEIS* because the development and designation of alternatives to existing disposal sites for material dredged from the San Francisco Bay is of tremendous importance to the Commission and the region. The Commission staff commends USEPA's efforts to evaluate the possible designation of an acceptable ocean disposal site. We find the *DEIS* to be a thorough and well written document that should serve as a sound basis for the designation of an environmentally acceptable ocean site for disposal of Bay material.

Jurisdiction

Under the McAteer-Petris Act, the Commission's area of jurisdiction includes all parts of the Bay subject to tidal action. Commission permits are required for projects proposed within its area of jurisdiction including dredging and disposal activities; the issuance of such permits occurs if the Commission finds activities to be consistent with the McAteer-Petris Act and the policies and findings of the *San Francisco Bay Plan*. In addition to any needed permits, federal activities that affect the Commission's jurisdiction are subject to consistency review by the Commission, pursuant to the federal CZMA, for their consistency with the Commission's federally-approved coastal management program, including the McAteer-Petris Act and the policies and findings of the *San Francisco Bay Plan*. The proposed ODMDS are well outside the Commission's jurisdiction and thus will not require Commission permit and/or consistency review or certification. The *DEIS* correctly states that the California Coastal Commission would review any necessary consistency determinations for ocean disposal.

However, dredging projects in the Bay, for which an ODMDS would be proposed for use as a dredged material disposal site, *would* require permit and/or federal consistency review by the Commission. Section 2.1.3.1 of the *DEIS* addresses San Francisco Bay disposal alternatives and discusses regulation of such projects, but does not mention the Commission. We request that the *DEIS* be amended to note the Commission's regulation of the siting and use of in-Bay sites for the disposal of dredged material. We further request that the *DEIS* briefly state the preference in the Commission's *Bay Plan* dredging policies (see attached copy) for ocean or upland disposal and reuse of dredged material, as discussed below, and note that the Commission has also adopted the volume targets for in-Bay disposal. 31-A

Commission Dredging Policy

As stated in the Dredging Findings and Policies of the *San Francisco Bay Plan* (attached), regular dredging of San Francisco Bay is essential to the economic and social welfare of the San Francisco Bay region, but the capacity of existing dredged material disposal sites is limited and in-Bay disposal activities may have adverse impacts on the Bay's natural resources. Therefore, in regulating these activities, the Commission shall take particular steps to ensure that these are managed in an economically- and environmentally-sound manner.

The *Bay Plan's* Dredging Policies No. 2, 4, and 5 state the Commission's preference for disposal of material from dredging projects at non-tidal sites (preferably for beneficial uses) or ocean sites. As discussed in the *DEIS*, non-tidal and ocean disposal sites are presently scarce or non-existent, and the designation of an ODMDS will help provide environmentally and economically sound alternatives to in-Bay disposal, thus increasing the Commission's ability to carry out its regulatory responsibilities under its law and policies. Designation of an appropriate ocean disposal site is consistent with *Bay Plan* Dredging Policy No. 4 which states:

> To ensure adequate capacity for necessary Bay dredging projects and to protect Bay natural resources, acceptable non-tidal disposal sites should be secured and ocean disposal sites designated. Further, disposal

projects should maximize use of dredged material as a resource, such as creating, enhancing, or restoring tidal and managed wetlands, creating and maintaining levees and dikes, providing cover and sealing material for sanitary landfills, and filling at approved construction projects. (emphasis added)

We recognize that ocean resources are of major importance to the state and nation. Thus any ocean disposal should not unduly jeopardize those resources. The analysis of Alternative Site 5 indicates that ocean resources would not be unduly impacted if the site is designated, used prudently, and monitored effectively. Therefore, Alternative Site 5 appears to be an appropriate ocean disposal site, but its use will likely need to be subject to a number of requirements. Therefore, the staff supports the designation of an ODMDS, as discussed and analyzed in the subject *DEIS*. (31-B)

Non-tidal Disposal and Reuse of Dredged Material

Support for the designation of an acceptable ocean disposal site should not be taken to diminish the Commission's strong preference for disposal options that use dredged material as a resource rather than a waste. We appreciate the USEPA's support for the reuse of dredged material and your agency's strong efforts to further beneficial use of dredged material. The Commission staff will continue its management of the LTMS Reuse/Upland Studies along with the USEPA and its other LTMS partners. (31-C)

In addition to expressing its support for the designation of the ODMDS, the staff would like to take this opportunity to suggest minor corrections and provide updated information relating to studies currently underway as part of the LTMS Upland Work Group Studies. On page 2-22 through 2-23, the document states that, "[o]f 65 potential sites originally identified, nine sites have been characterized as "highly feasible sites"." On page 2-23, it states, "The LTMS selected three of these [highly feasible sites] sites—Cullinan Ranch, Cargill Salt Div.-1 (East), and Cargill Salt Div.-1 (West)—for preliminary engineering feasibility assessments. The assessments are scheduled for completion in June 1994." The text should be corrected to reflect the following information. Seventy-eight, rather than 65 potential upland/non-aquatic sites were originally identified and evaluated for disposal and beneficial reuse of dredged material. Of the 78 sites, 11 have been characterized as "highly feasible sites." (Although, Table 2.1-4 on page 2-24 of *DEIS* lists only nine discrete sites, the Redwood Sanitary Landfill is considered a separate site, and the Cargill site is considered as two separate sites). In addition, the three sites for which preliminary engineering feasibility assessments are currently being prepared are Skaggs Island, *rather than Cullinan Ranch,* and the Cargill Salt Div.-1 (East), and Cargill Salt Div.-1 (West). The preliminary engineering feasibility assessments for these sites will be ready, in draft form, for public review and comment in early, 1993. (31-D)

In addition, it should be mentioned that preliminary engineering feasibility assessments have also been prepared for the Leonard Ranch, Praxis/Pacheco, and Cargill Salt Div.-1 (east) sites, which were identified as "highly feasible" for the (31-E) development of dredged material rehandling facilities, and are currently available for public review and comment.

Future USEPA Rulemaking

At the time USEPA proposes regulations to designate an ocean disposal site, the Commission may have further comments.

During the time that designation language is drafted, we encourage you to consider requirements for the use of any designated ocean site that addresses the following objectives: (1) protection of ocean resources; (2) assurance that adequate monitoring of the use of ocean sites occurs, including providing an estimate of such costs and an indication as to whether the user will bear those costs; and (3) encourages non-aquatic, beneficial use alternatives when those alternatives are feasible. 31-F

Assuming that aquatic disposal in the Bay and in the ocean and non-aquatic disposal, including beneficial use of dredged material, become available options, we would like, in the context of the LTMS, to work with you to describe how the dredging community should analyze and balance: (a) aquatic disposal in the ocean; (b) aquatic disposal in the Bay; (c) non-aquatic disposal; and (d) non-tidal beneficial use disposal. If all four options are available, the regulating agencies should also develop guidance to the dredging community on the factors they will use in deciding which site or sites are appropriate. 31-G

I would like to thank you for giving the staff the opportunity to comment on the *DEIS*. We look forward to reviewing the final EIS/EIR and proposed rulemaking. In the interim, please keep us informed of any other issues regarding the project. If you have any questions, please feel free to contact me or Steve Goldbeck of my staff.

Sincerely,

ALAN R. PENDLETON
Executive Director

Attachment

SG/JM/gg

cc: Lt. Col. Leonard Cardoza
Commissioner Will Shafroth
Mr. Michael Kahoe
Mr. Steve Ritchie
Mr. Peter Douglas

Exhibit (32)

SIERRA CLUB
SAN FRANCISCO BAY CHAPTER

5237 COLLEGE AVENUE • OAKLAND, CALIFORNIA 94618-1414
TELEPHONE 510-653-6127

ALAMEDA COUNTY • CONTRA COSTA • MARIN • SAN FRANCISCO

January 25, 1993

1/29/93 hand-delivered by Royce

United States Environmental Protection Agency
75 Hawthorne Street
San Francisco, California 94105

ATTENTION: Mr. Harry Seraydarian, Director

RE: **DRAFT** Environmental Impact Statement (EIS) for San Francisco Bay Deep Water Dredged Material Disposal Site Designation

Dear Mr. Seraydarian:

The Sierra Club appreciates the opportunity to present comments to the above referenced draft. We intend to cooperate with and work toward developing a beneficial solution to the continuing issue of how to utilize dredge material.

Our comments are prepared in a spirit of constructive criticism and we look forward to your response.

* * * * * * * * * *

INTRODUCTION

It continues to be the policy of the San Francisco Bay Chapter of The Sierra Club to support a closely monitored program to maintain shipping channels in San Francisco Bay. Among the issues we regularly discuss with the EPA, the U.S. Army Corps of Engineers and the Port of Oakland are how and where the dredge material is utilized.

We applaud the approach being developed by the LTMS toward developing beneficial uses for dredged material such as wetland restoration, upland habitat creation and fisheries development.

Our goal is to eliminate dredged material disposal in the Bay. Several hundred million cubic meters of dredged material are being dredged annually worldwide. This dredged material is a potentially valuable resource (PIANC, 1992). We are actively working to develop alternative environmentally sound strategies that are beneficial to the Bay instead of continuing the present practice of dumping the material off Alcatraz with questionable regard for the consequences.

The DEIS presents a strategy that we view as a better alternative than disposal in the Bay. We accept that deep water site five is the best choice contained in this DEIS and we urge that dumping in the Bay be stopped. 32-A

* * * * * * * * * *

<u>ISSUES OF SPECIFIC CONCERN</u>

Issues raised in the DEIS that are of particular concern to us relate to:

A) Monitoring, surveillance and enforcement at the proposed dump site to assure compliance with regulations and procedures;

B) Monitoring, surveillance and scientific observation at the proposed dump site to analyze the effects of dumping on resident benthic and pelagic species.

C) The lack of development of a plan to monitor, survey and observe the impact of long term ocean dumping;

D) The failure of the DEIS to state a preference for reusing dredged material, and;

E) The monitoring, mitigation and description of environmental impacts on proximate marine sanctuaries;

* * * * * * * * * *

A) Monitoring, surveillance and enforcement at the proposed dump site to assure compliance with regulations and procedures.

Does the EPA have the budget, equipment, personnel and available expertise to monitor the dredging and disposal of six million cubic yards per year of material? The DEIS inadequately addresses these most important issues. The two sections of the DEIS dealing with monitoring, sections 3.1.4 (Feasibility of Surveillance and Monitoring) and 4.6.2 (Site Management and Monitoring) tell us that site management is the joint responsibility of the EPA and COE. Page 4-90 goes on to state that the United States Coast Guard, EPA and the COE are responsible for surveillance and enforcement of ocean disposal activities. 32-B

The DEIS does not explain how this monitoring, surveillance and enforcement is to occur. Will one agency be in charge of enforcement, a second in charge of surveillance and a third in charge of monitoring? 32-C

Monitoring, surveillance and enforcement should be guaranteed by the presence of a full-time EPA, COE or Coast Guard representative on board the barge containing the dredged material. 32-D

A quick analysis of the time and energy spent in the DEIS on these issues can be gleaned from the table of contents. Page ix 32-E

A quick analysis of the time and energy spent in the DEIS on these issues can be gleaned from the table of contents. Page ix shows that page 3-19 is spent on both surveillance and monitoring. On page xii of the table of contents are the words "Site Management and Monitoring," but only two pages are devoted to the subjects (pages 4-90 and 4-91).

A thorough exploration of these issues can only be accomplished in a supplemental EIS. We call for the EPA to prepare this document so that these subjects receive treatment they require. 32-F

* * * * * * * * * *

B) Monitoring, surveillance and scientific observation at the proposed dump site to analyze the effects of dumping on resident benthic and pelagic species.

It would be appropriate for the DEIS to expand its discussion of the site monitoring plan and the management options to be developed. The present discussion is brief and inadequate. 32-G

The DEIS explains how difficult it will be to monitor benthic and pelagic impacts at greater depths but says nothing about how to mitigate this problem. It states only that a site monitoring plan to detect and minimize adverse impacts through appropriate management options will be developed. 32-H

The EPA must conduct a thorough, publishable and scientifically peer-reviewed study of the effects of dumping six million cubic yards of dredge material in an area where during any particular month, the flow pattern may differ significantly from seasonal mean conditions (section 3.2.2.1, page 3-28). 32-I

Many studies cited in the section on the consequences of dumping dredge material on the biological environment at site five (4.2.2, page 4-47 to 4-63) have little to do with the actual site five environment. Hirota's 1985 study of the effects of deep-sea mineral mining on macrozooplankton is cited, Paffenhofer's 1972 study of the effects of fine-grained red bauxite muds on the survival, growth rates and body weight of a copepod is mentioned; we learned that few plankton appreciate bauxite muds. 32-J

There is no bauxite mud at site five, so why cite Paffenhofer? Hirota's concern with deep-sea mineral mining has little or nothing to do with deep sea dumping of dredge spoils (see section 4.2.2.1, page 4-47). 32-K

The DEIS states that benthic species in general do not survive rapid burial. Total mortality is inferred (See page 4-50, section 4.2.2.2). Also, the DEIS does not call for mitigation of the loss of these benthic species. 32-L

32-M

Based on minimal data, the DEIS concludes that the impacts of dredged material disposal on pelagic fishes will be insignificant. This conclusion is reached by logic presented in the DEIS as summarized below (see section 4.2.2.4, page 4-57):

1) Near-surface pelagic species (rockfishes, salmon, tunas, mackerels) become blinded in a disposal plume because of the increase in turbidity.

2) *"Deep-water mesopelagic and bathypelagic species such as deep-sea smelts and lanternfishes characteristic of the region also should be able to avoid the disposal plums, although there are no specific studies on avoidance behavior in these fishes. Therefore, it is estimated that potential impacts of dredged material disposal on pelagic fishes will be insignificant, and classified as Class III."*

There is no basis to draw a conclusion that deep-sea smelts and lanternfishes should be able to avoid the disposal plum. No study or evidence is cited. 32-N

The DEIS is fatally flawed in its attempt to analyze the effects of dumping on resident benthic and pelagic species.

* * * * * * * * * *

C) The lack of development of a plan to monitor, survey and observe the impact of long term ocean dumping.

By reference we incorporate comments made by Heller, Ehrman, White & McAuliffe on behalf of their clients, the Half Moon Bay Fisherman's Marketing Association (HMBFMA 1993) in this document. We agree that not committing to a monitoring plan fatally flaws the DEIS. 32-O

On pages 4, 5, and 6 of the HMBFMA response they thoroughly analyze the inadequacy of EPA's commitment to a monitoring plan. By leaving out this important issue the EPA shows a lack of concern for the long term effects of this proposed dumping on the environment of the area.

We repeat that The Sierra Club cannot support this DEIS until a supplemental EIS is prepared, hopefully in consultation with the LTMS, to address these concerns. Otherwise the present document fails to address a these key issues.

* * * * * * * * * *

D) The failure of the DEIS to state a preference for reusing dredged material;

Developing environmentally and economically sound alternatives to in-Bay disposal is a continuing goal of the LTMS. 32-P

We urge the EPA to support agencies within the LTMS who are working toward development of the reuse of dredged material.

The beneficial use of dredged material is an available option that is being currently developed by the LTMS. We feel that the DEIS prematurely proposes long-term use of site five without taking the work of the LTMS into consideration.

The DEIS ignores the dredging findings and policies of the San Francisco Bay Plan. The Bay Plan's dredging policies No. 2, 4, and 5 state the preference for disposal of material from dredging 32-Q projects at non-tidal (preferably for beneficial uses) or ocean sites. A more thorough discussion of these non-tidal sites for beneficial uses should be made a part of the DEIS. A discussion of both ocean dumping and beneficial uses of dredged material as a resource could lead to a balanced dredging policy.

* * * * * * * * * *

E) The monitoring, mitigation and description of environmental impacts on proximate marine sanctuaries.

Page 4-63 of the DEIS, last paragraph classifies potential 32-R disposal impacts as Class II (significant adverse impacts that can be mitigated to insignificant levels). No data is given to support this conclusion.

The DEIS states that the volume of material to be released by a 32-S single incident (accident?) would be 6,000 cubic yards for a single barge load. No data is given to support this conclusion (page 4-63, 3rd paragraph).

The DEIS fails to include in its limited description of "inci- 32-T dents" scenarios exploring the probability of bilge material or bunker fuel discharge into a marine sanctuary. The impact of such an "incident" on the Farallon Islands, which lies on the direct route of barges in transit from San Francisco Bay to preferred alternative site five, would be at least a Class I adverse impact that would be nearly impossible to mitigate.

Page 2-38 of the DEIS (Alternative Site 5) states as follows:

"Dredge barge transit could cause some interference with recreational and scientific boat traffic, particularly near the Farallon Islands. Under normal conditions, no interference with areas of special importance is expected; however, accidents resulting in releases of material near the Farallones may be a concern. A requirement for barges to avoid the Farallones vicinity could minimize potential impacts."

We appreciate the above acknowledgement by the DEIS of the possibility of accidents resulting in the release of material near the Farallones. Many types of material could be released including bunker fuel, bilge material, accumulated sewage, and untreated contaminated dredge spoils.

This concerns us because for many species, the Farallon Islands breeding population is a significant percentage of the world population. In addition, the masses of marine birds that pass through the area on route to other areas depend upon productive waters to sustain them during their journey (Marine Audubon Society 1993).

Given these facts we conclude that a more thorough discussion of 32-U the impacts to marine sanctuaries, especially the Farallon Islands, is required.

CONCLUSION

The Sierra Club cannot support this DEIS unless a supplemental EIS is prepared, hopefully in consultation with the LTMS. The DEIS fails to address key issues surrounding the proposed project and is fatally flawed in many areas.

The Sierra Club would be happy to cooperate with the EPA in developing such a document.

There are many ways dredge material can be used as a beneficial resource rather than as a waste to be dumped. With proper planning and coordination between all parties environmentally beneficial solutions will emerge.

Sincerely,

James P. Royce
Conservation Advocate
San Francisco Bay Chapter

JPR:cl

REFERENCES

HMBFMA 1993: Response by Heller, Ehrman, White & McAuliffe on behalf of the Half Moon Bay Fisherman's Marketing Association (HMBMFA) dated January 22, 1993 reading as follows:

> ***C. The DEIS Fails to Commit to Monitoring the Impacts of Long-Term Ocean Dumping and Therefore Fails to Provide Adequate Mitigation***
>
> *The DEIS recognizes that EPA's regulations require that even after a site is chosen, its use must be discontinued if it becomes apparent that the site "does not meet the criteria set forth" in the site designation regulations (Page 2-30). Nevertheless, EPA never commits to a monitoring plan that would determine the actual (as opposed to modeled) impacts of the proposed disposal, and the performance of dredgers.*
>
> *The assurance in the DEIS that an adequate plan will be developed once the site is approved (pages 3-19, -20, 4-87) is a classic example of "piecemealing" the environmental analysis, a clear violation of NEPA. Monitoring, for NEPA purposes, is essentially a mitigation measure. Without proper monitoring, there can be no assurance that: (1) permit conditions are being complied with; (2) dredge spoils are staying in place as expected; and (3) the environmental impacts of disposal in the ocean are not significant. Hence, monitoring is necessary to support EPA's conclusion that the proposed ocean disposal will not cause significant impacts.*

would be subject to the vagaries of EPA's budget appropriations. What is the public to expect if the funds for equipment and vessels are not available, contrary to the DEIS' assumption? Moreover, the EIS' entire discussion of site managing and monitoring is phrased in self-consciously non-committal, equivocal terms. It is entirely unclear from reviewing Section 4.6.2 which of the various site management options, if any, will be employed.

EPA's plan to develop a monitoring proposal for inclusion in the Final EIS cannot be sustained under NEPA. To a large extent, the question of whether a site should be designated hinges on whether potential impacts can be effectively mitigated. Monitoring is of special mitigation significance for this project since EPA's conclusions that the project will not cause significant impacts are based almost entirely on modeling studies. The only way to mitigate against inaccuracies and/or unforeseen circumstances in the model predictions is to monitor dredger performance and impacts of the disposal. Therefore, the strength of the modeling program is a fundamental aspect of the project, and should be a major component in the determination of whether or not to proceed.

The Final EIS will be released along with the final decision on the project. Any comments on this final document are therefore superfluous and irrelevant to the decision-making process which will have ended. In order to comply with NEPA it is critical that all vital project components be placed before the public and decision makers prior to and not after the decision has been made to proceed.[4]

By putting of the development of a monitoring plan until after the project has been approved, EPA is essentially saying to the public and decision makers; "Trust us. The monitoring plan will be just fine." We have the greatest confidence in the integrity and sincerity of EPA in this regard. Nevertheless, NEPA demands and we must insist that the full project be placed before the public at one time. The monitoring plan is a critical aspect of the project, and project approval should not be provided unless it is absolutely clear in the EIS that monitoring of dredgers' performance and disposal impacts is part of the project being approved.

The DEIS provides no rationale for why this critical part of the project has been cut out of the EIS process. The flaws in this decision are apparent. For example, the DEIS speculates that "management action" such as limits on disposal volume or timing may be taken if monitoring indicates that negative impacts have occurred. HMBFMA would recommend that EPA implement such "management activities" prior to the occurrence of negative impacts in order to avoid them. If the monitoring plan were part of the EIS, issues like this would be exposed to the "hard look" Congress intended. HMBFMA concurs with the comments submitted by the Gulf of the Farallones National Marine Sanctuary, and incorporates them herein by reference. In particular, we agree with the recommendations of the Sanctuary Manager that: (1) independent observers must be required to study environmental conditions, and not the dredge operators; and (2) the models must be independently verified.

---

4. EPA has suggested informally that the public will be able to comment on the monitoring plan in the rulemaking process. By this time, however, the ocean site will have already been designated. Thus EPA is attempting to isolate the decision about the ocean site from any decision about monitoring. Our point is that without an adequate monitoring plan, the site should not be designated at all.

Without a clear and unqualified commitment to monitoring both the performance of dredgers and the environmental impacts of dredged material disposal at the proposed site, HMBFMA cannot support the project as proposed. We will urge our fellow commercial and recreational fishermen, and environmentalists to adopt similar positions.

Marine Audubon Society 1993: Response by Marine Audubon Society dated January 25, 1993 reading as follows:

The information provided does not support a finding of no significant impact on seabirds, marine mammals and endangered species. For many species, the Farallones breeding population is a significant percentage of the world population. In addition, masses of marine birds pass through the area on route to other areas depending on productive waters to sustain them on their journey. The area is an important movement corridor for marine mammals. Disposal of dredged material will impact presence of prey and the visibility of prey items. Turbid plumes could have a significant effect on nesting sea birds, particularly during El Nino years when fish populations are down, if they have to travel further from breeding sites to forage. Populations of many species are already low due to gill netting and El Nino. The DEIS should recommend seasonal limitation to minimize adverse impacts on Farallone breeding populations.

PIANC 1992

Permanent International Association of Navigation Congresses (PIANC), General Secretariat, Brussels, Belgium, *Beneficial Uses of Dredged Material, A Practical Guide*, Page 9.

Exhibit (33)

STATE OF CALIFORNIA PETE WILSON, Governor

STATE LANDS COMMISSION

LEO T. McCARTHY, Lieutenant Governor
GRAY DAVIS, Controller
THOMAS W. HAYES, Director of Finance

EXECUTIVE OFFICE
1807 - 13th Street
Sacramento, CA 95814-71

CHARLES WARREN
Executive Officer

January 20, 1993

Mr. Mike Kahoe
Assistant Secretary
California Environmental
Protection Agency
555 Capitol Mall, Suite 235
Sacramento, CA 95814

Dear Mr. Kahoe:

The staff of the State Lands Commission has reviewed the Draft Environmental Impact Statement (EIS) for San Francisco Bay Deep Water Dredged Material Disposal Site Designation, December, 1992, and submits these comments for your consideration.

Specific Comments

1. Page 1-13, ¶ 1.5: It would be helpful if the criteria by which these matters would be resolved prior to the FEIS were listed and briefly discussed. What procedure would be used if the preferred site for the ocean dredged material disposal site (ODMDS) did not meet such criteria or if these matters could not be successfully resolved? (33-A)

2. Page 3-17, 1st ¶: Upon what data or information is the "expected" characterization of "prevalent sediment composites" based? What is the extent of sediment analyses for historic dredging activities within the LTMS study area? (33-B)

3. Page 3-17, 2nd ¶: What would be the seasonal restrictions on dredging within the Bay and at the preferred site for the winter-run chinook salmon? If all of the restrictions within this paragraph are charted, the only time at which allowed dredging activities in the Bay and the availability of the ODMDS coincide appears to be during the months of September through November, three months of the year. The information at page 3-259 indicates that a barge every 12 hours could be traveling from dredge sites to the proposed ODMDS on an annual basis. What would be the impact of 730 additional vessel transits within 90 days - 8 per day? (33-C)

4. Page 3-19, ¶ 3.1.4: The issue and preparation of a surveillance and monitoring plan has been deferred until the preparation of the final EIS. The final designation and continuing operation of the ODMDS depends on the feasibility of such surveillance and monitoring in that the impacts of disposal at the site are based exclusively on modeling and information gathered at shallow disposal sites, see page 4-7, 1st ¶. Also, at page 3-18, 2nd ¶, "With the exception of a brief qualitative study of the COE experimental site following a small test discharge of approximately 4,000 yd^3 of dredged material (COE), no studies of the environmental impacts of dredged material disposal have been (33-D)

conducted at any of the offshore sites" and at page 3-20, 2nd ¶, "Impacts to benthic communities at deeper sites may be more difficult to assess because less information about benthic structure and disturbance response is available."

5. Pages 3-85, Table and 3-90, Study Area 5: Information comparable to that contained in Table 3.2-8 for Study Areas 2-4 and Pioneer Canyon should also be obtained for the preferred site, Study Area 5. How can the "contaminant background" of the preferred site be established without such information? Without the site's contaminant background, on what basis will decisions as to the allowable contaminant constituency of dredge spoils to be deposited at the ODMDS be made? For example, according to the chart on pages 3-77 and 3-78, mercury from sites within San Francisco Bay is present at levels six times higher than the average for proposed sites 3 and 4, and double the level of the proposed site. Would these spoils be deemed suitable for disposal at the ODMDS? 33-E

6. Page 3-226, Table 3.3.6-1: Could this information be further broken down to indicate in which specific study areas the listed species are found, especially the preferred site? 33-F

7. Page 4-9, Section 4.2.1.1: The conclusion of this Section states that "..effects from barge tug emissions on air quality within the general LTMS study region are considered negligible..." The statement is not clear as to whether it applies to the barge traffic in isolation or in combination with existing marine traffic in the LTMS study region. Specifically, do the barges alone represent a Class III impact, but cumulatively with existing marine traffic represent a different class of impact? 33-G

8. Page 4-12, Section 4.2.1.3: How did the modeling described herein consider the following statements - "This difference may promote resuspension and transport of larger grain sized sediment than would otherwise occur in the absence of 'bottom trapping'. Enhancement of tides by topographic features also can result in unusually strong mean flows which can result in unidirectional sediment transport. This may occur at Station E, where steady up-canyon flow was observed.", page 3-41, and "Because wave-induced currents generated during winter storms can reach depths of 100 m or more, fine grained material likely will be resuspended over most areas of the shelf (Noble and Ramp 1992)", page 3-42? 33-H

9. Page 4-35, 1st full ¶: The document states, "Disposal operations should have insignificant effects on concentrations of contaminants in the water column, given that only dredged material of suitable quality will be permitted for disposal." What are the specifications for "suitable" spoils? Would any spoils with contaminants over the existing background of the preferred site be a long term problem? 33-I

10. Page 4-62, last ¶: What types of potential impacts to threatened or endangered species are expected at the preferred site and what species could be affected? 33-J

Thank you for this opportunity to comment. Should you or your staff have any questions or desire clarification, please contact me at 322-7827. We look forward to the successful conclusion of this component of the LTMS.

Sincerely,

Dwight E. Sanders
Chief, Division of Environmental
Planning and Management

cc: Charles Warren
James F. Trout
Jane Sekelsky
Elizabeth Patterson
Linda Martinez

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Exhibit (34)

SURFRIDER FOUNDATION
Legal Counsel
1642 Great Highway
San Francisco, CA 94122
#415-665-7008
Fax #415-665-9008

1/27/93 pm ?

January 19, 1993

Mr. Harry Seraydarian, Director
Water Management Division
United States Environmental Protection Agency
Region IX
75 Hawthorne Street (W-7-1)
San Francisco, California 94105

Re: Proposed Ocean Dumping of Bay Dredge Spoils
Comments on DEIS

Dear EPA:

The undersigned represents Surfrider Foundation, an international nonprofit organization engaged in the protection and enhancement of coastal environments. Surfrider currently enjoys the support of over 25,000 members world-wide and at least nine California Chapters. Surfrider Foundation Chapters may participate separately in these proceedings.

Surfrider Foundation is adamantly opposed to dumping Bay dredge spoils in the Pacific Ocean. When the Clean Water Act was enacted a mere twenty years ago its primary goal was to eliminate use of the world's oceans as a dumping ground for unwanted waste. The Coastal Zone Management Act has similar goals. This proposal is nothing more than a proposal to dump unwanted waste into the ocean. (34-A)

The proposed project may involve dumping of toxic dredge materials into prime fishing grounds. Nearshore waters may also be affected as sand is deposited at Ocean Beach and other nearby beaches. Ocean Beach is a heavily used recreational area, where often more than one hundred individuals may be found swimming, diving, surfing and windsurfing. Boat and barge traffic in and out of the Bay, and the dumping of dangerous dredge spoils may interfere with legitimate recreational pursuits. (34-B)

Further, dumping dredge spoils may interfere with the biological integrity of both the Bay <u>and</u> the areas used as the dumping ground. (34-C)

Surfrider Foundation implores EPA to evaluate alternatives to dredging the Bay. EPA is required to investigate on land disposal alternatives but little progress appears to have been made in that area. EPA should promptly investigate the prevention of siltation, rerouting shipping lanes, restrictions on shipping etc- measures which lessen the need to dredge. Further, if dredging is unavoidable, on land dumping is a far preferable alternative with much less environmental impacts than ocean dumping. Regardless, <u>no ocean dumping should be permitted until all on land disposal alternatives are thoroughly investigated</u>. (34-D)

Thank you for this opportunity to comment. If you have any questions, please contact the undersigned.

Sincerely,

Mark A. Massara

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JAN 21 1993
ENVIRONMENTAL PROTECTION

Exhibit (35)

State of California | Trade and Commerce Agency

Memorandum

To : Michael A. Kahoe
Assistant Secretary,
Cal/EPA

Date: January 20, 1993

From : Julie Meier Wright
Secretary
Prepared by: Wes Ervin

Subject: DRAFT ENVIRONMENTAL IMPACT STATEMENT (DEIS) FOR SAN FRANCISCO BAY DEEP WATER DREDGED MATERIAL DISPOSAL SITE DESIGNATION

The Trade and Commerce Agency has reviewed the subject document and has no specific comments on the document at this time. We note that the preferred site, Alternative Site 5, appears to be the best alternative from both environmental and compatible use perspectives, and has adequate capacity. Unless overriding objections to this site arise, we urge you to proceed quickly to guarantee its availability.

We strongly support the need for having an adequate ocean disposal site designated and ready in a timely manner, which complements the efforts underway for in-bay and upland disposal sites. Our key interest is in enabling the dredging necessary to support continued and expanded port activities and its attendant economic benefits in the San Francisco Bay region. Tens of thousands of jobs, and a major portion of the region's economy are dependent on a thriving port-related industry.

Thank you for the opportunity to comment. We will continue to work with you and the LTMS team to ensure a coordinated, effective dredging strategy.

cc: Tina Frank, Trade and Commerce

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NOTE: **Acronyms and abbreviations are defined at their first usage, but are also listed in the Glossary of Abbreviations, Acronyms, and Conversions.**

Exhibit 1

Response: The Environmental Protection Agency (EPA) appreciates your review of the draft Environmental Impact Statement (DEIS).

Exhibit 2

2-A: The Ocean Studies Work Group (OSWG) is responsible for developing a Site Management and Monitoring Plan (SMMP) as part of the Environmental Impact Statement (EIS) process. Site-use limitations and requirements aimed at reducing the possibility of accidental spills and disposal of material outside the boundaries of the site, especially within protected areas such as Gulf of the Farallones National Marine Sanctuary (GOFNMS), are addressed in the SMMP. These provisions also have been summarized in the final Environmental Impact Statement (FEIS). The OSWG is composed of a diverse assemblage of members representing industry, the environmental and academic communities, and State and Federal regulatory agencies. Environmental protection, scientific validity, and cost are key factors determining the components of the SMMP.

Exhibit 3

3-A: The Zone of Siting Feasibility (ZSF) study performed by the U.S. Army Corps of Engineers (COE 1992) concluded that all of the alternative sites are located within an area of economic acceptability relative to site use. Costs of using the site were not considered in the DEIS as a site-selection criterion. However, the costs are being addressed by the Long-Term Management Strategy (LTMS) OSWG as a critical component of the SMMP. Implementation issues, including long-term costs of site use, are being evaluated by the LTMS Implementation Work Group.

Exhibit 4

4-A: EPA will prepare a Coastal Consistency Determination (CCD) after the FEIS is published and before site designation is published in the Final Rule.

4-B: All dredged materials proposed for ocean disposal must be evaluated for suitability based on Green Book (EPA/COE 1991) criteria. EPA agrees that threatened and endangered species, including those frequenting nearshore coastal areas such as winter-run chinook salmon, California brown pelicans, marbled murrelets, and northern sea lions, are important resources and they will be considered in the CCD. (Note: Gray whales have been de-listed from their Federally endangered status and northern fur seals are not listed as endangered or threatened by Federal or State agencies, but are considered depleted by the Marine Mammal Commission.)

4-C: The statement on page 3-17 of the DEIS was an estimate by the COE of the frequency of site use based solely on considerations of suitable sea conditions. The suitability of sea conditions encountered during transit to the ocean dredged material disposal site (ODMDS) ultimately is up to the judgment of each vessel captain, who is responsible for the safety of his/her crew and vessel. Compliance with these measures will be evaluated by an independent inspector and by reviews of documentation as part of site-use permits.

The SMMP specifies site-use conditions which include restrictions during certain weather conditions. Specifically, dredged material barges will not leave San Francisco Bay when wave heights along the transit route are predicted to exceed 18 feet. Further, when wave heights exceed 10 feet and wave periods reach 9 seconds or less, additional precautions must be taken to prevent spillage or loss of dredged material during transit to the ODMDS. These precautions include reducing barge load capacities by a minimum of 15%, in addition to any other precautions deemed necessary by individual tugboat captains. These site-use conditions were determined based on input from industry (i.e., dredgers and barge operators) and the responsible agencies.

4-D: Weather restrictions are imposed as part of the SMMP (see response to Comment 4-C) and/or site-use conditions contained in the permit. Specific restrictions or conditions can be modified based on experience [e.g., use of the Navy Ocean Disposal Site (NODS) under a Section 103 permit effective through December 1, 1994].

4-E: At present, information concerning the frequency and amounts of dredged material spilled under different sea conditions in the project region is not available and probably anecdotal. However, the SMMP specifies that no dredged material is permitted to leak from the barges during transit to the ODMDS. Barge volumes (which include both sediment and water) are rough estimates. The initial mass of sediment loaded in each barge is not constant and the amount of sediment removed from an area is based on a final site bathymetric survey. Thus, determinations of differences in the volumes or masses of materials loaded into the barge versus that of material released at the ODMDS could not be used practically as a measure of losses during transit. Other methods, such as draft sensors, may be available for detecting leakage.

4-F: The SMMP specifies requirements for site use, including transit paths for dredge barges, navigational accuracy, and compliance documentation.

Exhibit 5

5-A: All dredged materials proposed for ocean disposal must be evaluated for suitability based on Green Book (EPA/COE 1991) criteria. EPA agrees that threatened and endangered species, including those frequenting nearshore coastal areas such as winter-run chinook salmon, California brown pelicans, marbled murrelets, and northern sea lions, are important resources and they will be considered in the CCD. (Note: Gray whales have been de-listed from their Federally endangered status and northern fur seals are not listed as endangered or threatened by Federal or State agencies, but are considered depleted by the Marine Mammal Commission.)

5-B: Site-use limitations and requirements aimed at reducing the possibility of accidental spills and disposal of material outside the boundaries of the site are addressed in the SMMP. These requirements will be incorporated as special conditions to all disposal permits issued for the site.

5-C: The role of San Francisco Bay Conservation and Development Commission (BCDC) in permitting and regulating use of disposal sites within the Bay has been acknowledged in the FEIS. However, as mentioned, the purpose of the EIS is to consider designation of an ocean dredged material disposal site. Other disposal alternatives are discussed briefly in the EIS to describe the range of possible options for disposal and beneficial reuse of dredged material from the Bay. Regulation, use, and management of sites other than those in the ocean, are beyond the scope of the EIS.

5-D: An SMMP is being developed by the LTMS OSWG. A draft version of the SMMP was reviewed through the LTMS process by member agencies and organizations following an OSWG meeting in May. Regardless, the provisions of the SMMP have been incorporated into the FEIS. The final SMMP will be completed in concert with the Final Rule.

Exhibit 6

Response: EPA appreciates your review of the DEIS.

Exhibit 7

7-A: As noted, this EIS addresses designation of an ODMDS. It is not the intent of this EIS to evaluate use of non-aquatic/reuse sites for disposal of dredged material. Eventually, several options will be available for dredged material disposal. The appropriateness of any one option will be evaluated on a case-by-case basis using guidelines and protocols presently being developed by the Implementation Work Group of the LTMS. For individual projects, the responsible agency and applicable regulations will depend on the specific disposal/reuse option selected.

7-B: Discussion of the requirements for use of dredged material as landfill cover is beyond the scope of this EIS. The BCDC is leading LTMS efforts to develop non-aquatic and reuse options for dredged material disposal. A copy of this comment letter has been forwarded to BCDC for their reference.

7-C: See response to Comment 7-B.

7-D: See response to Comment 7-B.

7-E: See response to Comment 7-B.

7-F: See response to Comment 7-B.

Exhibit 8

8-A: LTMS expects to complete designation of an ODMDS by January 1994. Designation of an ODMDS does not imply that utilization of the site for dredged material disposal also will be initiated in January 1994. As stated in the EIS, EPA and the LTMS expect that all available disposal options will be evaluated for each proposed dredging project according to guidelines and protocols that will be established and promulgated by the Implementation Work Group. The decision framework probably will not be in place by January 1994. Consequently, the LTMS may develop an interim policy on use of the ODMDS until the Implementation Work Group completes the decision framework. The ODMDS will be available only for projects where the need for ocean disposal and the quality [as defined by Green Book (EPA/COE 1991) testing protocols] have been established. This may require an individual EIS for the project. Thus, decisions regarding the use and timing of the

ODMDS for specific projects will be affected by the material testing and permit application review process.

8-B: EPA will continue to consult with representatives from the National Marine Sanctuaries (NMS), as well as with other State resource management agencies through the LTMS OSWG, on the use, management, and monitoring of the proposed ODMDS. EPA regulations require special consideration of NMS resources (40 CFR 228.5 and 228.6). Conclusions from information presented in the EIS indicate that no significant impacts to sanctuary resources are expected from the proposed action. Monitoring of the site, as specified in the SMMP, will be performed to confirm these conclusions.

8-C: Monitoring will be an integral part of the SMMP being prepared by the OSWG. The provisions of the Plan have been incorporated into the FEIS. The SMMP provides a framework for site management and monitoring, but the specific requirements will be imposed and enforced through special conditions on the permit.

8-D: The SMMP addresses potential impacts to sanctuary resources and the marine environment. The SMMP also contains requirements for site use and surveillance, and possible management actions if monitoring results indicate that significant adverse impacts are occurring.

8-E: The monitoring component of the SMMP has been designed to verify that predictions of impacts described in the EIS are accurate and that the extent and magnitude of changes do not result in unacceptable adverse effects to the marine environment.

8-F: See response to Comments 8-B and 8-D. The monitoring program in the SMMP uses a tiered approach which provides a structured framework for hypotheses and observations, management action thresholds or "triggers," and guidance for evaluating appropriate management actions. Specific monitoring tasks will be performed to provide data for addressing management questions concerning transport of material out of the disposal site and, potentially, into adjacent national marine sanctuaries.

8-G: See response to Comment 8-F. The specific monitoring requirements contained in the SMMP will address nearfield effects first and then progress to farfield investigations (e.g., NMS) if warranted. Additionally, monitoring requirements will be reviewed and revised, as appropriate, at regular intervals. Model verification of sediment footprint and plume dispersion will be performed as part of planned SMMP studies.

8-H: The monitoring program contained in the SMMP uses a tiered approach to monitoring physical, chemical, and biological processes. The structure of the program is designed to provide answers to specific management questions and determine whether disposal operations are carried out in compliance with permitting requirements and environmental regulations.

8-I: EPA will use appropriate verifiable models to predict the effects of dredged material disposal at the ODMDS.

8-J: See response to Comment 4-C. Disposal techniques and documentation, including barge capacities, transit routes, navigational accuracy, and surveillance/inspections are specified in the SMMP. These conditions, which are based on site-use restrictions contained in the Section 103 permit for the NODS, can be revised if deemed appropriate by EPA, COE, and the OSWG.

8-K: See response to Comments 4-C and 8-J. The Management Plan portion of the SMMP specifies minimum distances from the Farallon Islands allowable during transit to the ODMDS, barge loading limits, and site-use restrictions during certain sea conditions.

8-L: The monitoring program in the SMMP uses a tiered approach to address cumulative effects. In particular, the monitoring program will evaluate any detectable cumulative effects of disposal on sediment contaminant concentrations and benthic communities within and outside of the ODMDS relative to baseline or reference data.

8-M: Dredged material proposed for disposal at the ODMDS will be tested for suitability according to procedures described in the Green Book (EPA/COE 1991). Material that is contaminated, according to Green Book procedures, is considered unsuitable for ocean disposal. If monitoring determines that unforeseen impacts are occurring due to the presence or accumulation of contaminants, appropriate modifications to site management and use will be made.

8-N: The suitability of dredged material for ocean disposal is not based on bulk chemical characteristics. Therefore, it is not appropriate to define acceptable contaminant levels in terms of concentrations of individual chemicals. The Green Book (EPA/COE 1991) provides the national policy for testing, and EPA Region IX has developed general requirements for sediment testing of dredged material proposed for disposal operations within the region. The suitability of sediments proposed for discharge at the ODMDS is evaluated from results of testing described in these documents.

8-O: Possible management actions in response to evidence of impacts associated with dredged material disposal activities are described as part of the SMMP. Actions could include revising the size or location of the disposal zone, seasonal restrictions, or, in extreme cases, de-designation of the site.

Exhibit 9

9-A: Requirements for site monitoring and site management, including surveillance, inspection, and documentation, will be described in the SMMP. Provisions of the SMMP have been incorporated in the FEIS.

Exhibit 10

10-A: The modeling section has been revised to make it more understandable to the informed lay reader.

10-B: If a significant adverse impact(s) resulted from use of the preferred alternative site, the other alternatives addressed by the EIS could be considered as part of a new site evaluation process coordinated by EPA. However, supplemental studies may be necessary before these alternative sites or any new site received designation under the Marine Protection, Research, and Sanctuaries Act (MPRSA) Section 102.

10-C: Compliance with site-use conditions and other permit requirements, and possible management actions associated with non-compliance events, are discussed in the SMMP. The provisions of the SMMP are included in the FEIS.

10-D: Monitoring and surveillance are addressed in the SMMP. Possible strategies for funding are being developed as part of the LTMS process by the Implementation Work Group. Since this effort involves issues beyond the scope of the EIS, ODMDS funding for monitoring may not be finalized by the time the FEIS is published. However, commitments for site monitoring will be obtained before site use is authorized.

10-E: The DEIS addresses only ocean disposal alternatives and the No Action Alternative. The purpose of designating an ocean disposal site is to provide an option for disposal of suitable material. This is based on chemical and physical characteristics and testing (e.g., Green Book) results that demonstrate the material is not toxic and does not contain constituents that are biologically available.

Designation of an ODMDS does not imply that any or all dredged material from San Francisco Bay would be disposed in the ocean. Rather, decisions regarding specific projects will be made through their individual EISs, National Environmental Policy Act/California Environmental Quality Act (NEPA/CEQA) documents, and/or dredging permitting process. In order to use the ODMDS for a specific project, the need for ocean disposal must be demonstrated.

Work Groups associated with the LTMS are evaluating the full range of disposal options, and the specific conditions or limitations that would apply to each of the disposal options. Further, the LTMS Implementation Work Group will be developing guidelines that will be used to evaluate all proposed dredging projects and determine which of the disposal or beneficial reuse options would be most appropriate. The array of disposal options eventually identified by LTMS is considered adequate to meet predictable future needs (at least for the next 50 years) for dredged material disposal.

10-F: The statement on page 2-17 of the DEIS was made in reference to management of the Alcatraz disposal site. Mounding, with potential obstructions to navigation, is not a concern at the proposed deep-water ODMDS because of the great water depths. In contrast, dredged material disposal at the relatively shallow Alcatraz site has resulted in mounding to the point that it has become a navigational hazard. As a result, it has been necessary to impose requirements to slurry dredged material prior to discharge at this site to increase dispersiveness. The capacity of the Alcatraz site is unknown because parameters affecting dispersal (e.g., grain size, sorting, shear strength, water content of each barge load, current speed and direction at the time of disposal, etc.) are largely unknown. Thus, it is impossible to predict exactly how much more material could be disposed at this location within the Bay.

10-G: To date, the Bay Farm Borrow Area has not been approved as a dredged material disposal site. This site is being considered as part of the LTMS In-Bay studies.

10-H: Alternative Site 5 is located approximately 50 nautical miles from shore and in 2,500 to 3,000 meters of water. It was selected as the preferred alternative site primarily because it is in an area that has been used historically for disposal of low-level radioactive waste and chemical conventional munitions and because it is located in deep water away from productive fishery areas. While the proposed ODMDS is located a greater distance from shore and generally has fewer resources to monitor than the other alternative sites, monitoring the site may be more difficult. Also, the area has been used historically for waste disposal and, therefore, may be degraded. These conditions also may contribute to more hazards during sampling. EPA recognizes that there are advantages and disadvantages associated with the site, but feels that overall it is the best choice.

10-I: The SMMP addresses in detail all tasks associated with site monitoring and oversight. The major provisions of the SMMP have been incorporated into the FEIS. See response to Comment 10-H.

10-J: The National Oceanic and Atmospheric Administration (NOAA) presently is evaluating the potential environmental and human health risks associated with the presence of low-level radioactive waste materials disposed historically in the Gulf of the Farallones. If this evaluation concludes that these wastes represent a significant risk or hazard, then some remediation may be warranted. The scheduled completion date for this evaluation is unknown. Conclusions from the multiple studies performed over the past thirty years concerning the magnitude of potential environmental and/or human health problems associated with the presence of waste material are inconclusive and are considered controversial. The NOAA study will attempt to resolve some of these concerns.

10-K: A discussion of potential dredged material disposal impacts on marine mammals (e.g., temporary impairment of foraging activities and response to vessel noise) is included in Section 4.4.2.6. Based on these discussions and survey results for Study Area 5, EPA has concluded that impacts from dredged material disposal to marine mammals (including whales) are expected to be insignificant.

10-L: The statements on page 4-7 of the DEIS were intended to qualify the limits of present knowledge regarding possible effects of dredged material disposal at the alternative sites. The effects of dredged material disposal in water depths of 2,500 to 3,000 meters have not been studied. Therefore, impact assessments must rely on characterization data and studies conducted at other ODMDSs which are shallower than the alternative sites. Thus, because direct comparisons are limited, EPA chose to rely heavily on site specific data that were collected in the study region to evaluate potential impacts.

10-M: The numerical model of dredged material transport requires quantitative information on a wide variety of topics (input conditions) such as disposal operations, dredged material characteristics and settling rates, water column density, the speed and direction of ocean currents at a range of depths in the region, the rate of horizontal dispersion of particles at all depth levels, etc. While some of these input conditions can be accurately determined (e.g., the time, location, and volume of dredged material to be disposed), other parameters cannot be easily predicted (e.g., settling rates of clumped sediments in deep water; and currents associated with non-periodic phenomena). Other parameters, such as the rate of oceanic turbulence and diffusion, cannot be measured and must be estimated from oceanographic theory.

The statement "limits of present knowledge" is another way of saying that the model has been driven using "the best available information." For some parameters, actual data are available; for others, input conditions must be approximated using knowledge gained from the oceanographic literature and/or oceanographic theory.

With regard to the comment that the DEIS text and figures describing the results of the dredged material transport model were incomprehensible to the lay reader, note that FEIS Sections 4.2.1.3 and 4.2.1.4 have been rewritten to clarify and simplify the results.

10-N: As discussed in section 3.1.1.2, it is difficult to document the exact position of many of the historic low-level radioactive waste disposal sites due to security classifications imposed by military agencies, generally poor record-keeping for many disposal activities, and the limitations of navigation equipment during the disposal period. In addition, the movement of radioactive waste barrels through the water column following disposal, downslope movement of barrels, and the extent of container burial are unknown. These factors contribute to the uncertainty of determining the present location of the wastes.

Exhibit 11

11-A: Requirements for monitoring effects from dredged material disposal activities at the ODMDS, as well as management and site-use conditions, including transit routes and minimum allowable distances from the Farallon Islands, are contained in the SMMP. Provisions of the SMMP have been incorporated into the FEIS.

Exhibit 12

12-A: Requirements for site monitoring and management, including surveillance and documentation of transit routes and discharge locations, are contained in the SMMP. Provisions of the SMMP have been incorporated in the FEIS.

Exhibit 13

13-A: The Science Applications International Corporation (SAIC) model of dredged material transport used approximately one year of actual current measurement data, from a variety of locations and depths in the vicinity of the alternative sites, to predict the two-dimensional transport of disposed dredged material. These data were representative of all oceanographic processes that will be encountered in this region, including tides, density-driven flows, wind-driven currents, ocean eddies, and low-frequency coastal currents. The actual time-series measurements from each current meter were input to the model. These measurements from specific locations and depths in the water column were used to construct a detailed, three-dimensional, time-varying representation of the currents throughout the study region. Simple, averaged estimates of currents were not used to drive the model. However, EPA acknowledges that there may be extreme conditions or events that could occur which were not measured during the one-year study.

Many environmental/dynamical factors would limit or prevent resuspension and transport of disposed dredged material or other wastes lying on the sea floor at the alternative sites onto the San Mateo coast. The primary factor inhibiting transport of wastes is related to physical limitations in moving very cold, dense water (and relatively non-buoyant suspended particulate matter) from deep regions in the ocean (such as the 1,400 to 3,000 meter depths of the alternative sites) to shallow levels. The water at the sea floor in these locations is roughly 2°C and, consequently, its density prohibits it from rising to any appreciable level in the water column even when affected by tidal currents and other dynamical forces that are encountered in the deep ocean. Thus, there should be no impacts to shallow continental shelf areas or to the beaches of San Mateo County.

13-B: Dredged material proposed for disposal at the ODMDS will be tested for suitability according to procedures described in the Green Book (EPA/COE 1991). No contaminated material will be permitted for disposal at the ODMDS.

Exhibit 14

14-A: The ZSF study performed by the COE (COE 1992c) concluded that all of the alternative sites could be used economically. Further considerations of cost differences for individual alternative sites were not considered as criterion for site selection. Section 3.4 of the EIS presents available information on the fisheries resource values of the alternative sites.

14-B: The EIS has been revised to reflect the present status of the dredged material disposal operations at the NODS.

14-C: EPA and COE are the primary agencies responsible for site management. Transit routes and other site-use conditions are specified in the SMMP and in the Public Notice for permits.

14-D: EPA believes that information concerning regulatory authorities contained in this section of the EIS is correct. Although EPA does not have regulatory authority to write permits for dredged material disposal, no dredged material permit can be issued without EPA concurrence.

14-E: The projected dredged material volumes shown in Table 1.2-1 were taken from an LTMS document (Alternative Disposal Options, San Francisco Bay Region, Final Report, U.S. Army Corps, 1992). EPA consistently has relied upon the COE to provide volume estimates for the LTMS and believes that the volumes in the report represent the best available information. Annual disposal volumes at the three sites within the Bay listed in Chapter 2 of the EIS have been revised according to the data provided in Comment 14-L. Note that the volumes listed in Comment 14-E for 1991 do not agree with volumes listed in Comment 14-L.

14-F: This statement explains the authority of the State Water Resources Control Board (SWRCB) to halt disposal within San Francisco Bay (Resolution 90-37). The SWRCB may elect to not exercise this authority with the availability of other disposal options. However, EPA does not believe that this EIS is the appropriate forum for interpretation of SWRCB policy.

14-G: Section 1.6.2.3 of the FEIS has been revised to reflect the suggested changes.

14-H: The COE has been cited in EPA's FEIS as a cooperating agency for the Navy's MPRSA Section 103 site designation final supplemental Environmental Impact Statement (FSEIS).

14-I: Appropriate citations have been referenced in the FEIS.

14-J: The statement regarding comparability of data (Section 3.2.5.5) refers specifically to analytical protocols used to quantify concentrations of selected chemical parameters in sediment samples. Differences between protocols relate to the method-specified lists of target analytes and analytical sensitivities for individual analytes. These differences do not invalidate the data used to characterize the chemical composition of the sediments at the different study areas.

14-K: See response to Comment 14-B. The status of the Navy's Section 103 disposal operations at NODS had been updated as appropriate in the FEIS.

14-L: The dredged material disposal volumes at existing sites within the Bay listed in Chapter 1 were revised according to the data provided by the COE in this comment. The discussion of regulatory responsibilities for sites within the Bay has been clarified.

14-M: See response to Comment 14-D. Although the COE writes the permits for dredged material disposal projects, EPA must concur before the permit can be issued.

14-N: At the time EPA's DEIS went to press, the FSEIS had not been released. This FEIS will now cite the Navy's FSEIS.

14-O: See response to Comment 14-C.

14-P: This reference is corrected in the FEIS.

14-Q: As discussed in the EIS, the process used to select the preferred alternative site involved comparisons of the alternative sites to the 11 specific criteria for site selection listed at 40 CFR 228.6. Alternative Site 5 is located approximately 50 nautical miles from shore and in 2,500 to 3,000 meters of water. It was selected as the preferred alternative site primarily because it is located in an area that has been used historically for disposal of low-level radioactive waste and chemical conventional munitions and because it is located in deep water away from productive fishery areas. Differences in field sampling methods used for individual study areas are considered minor and do not significantly affect this evaluation.

14-R: This statement has been clarified.

14-S: See response to Comment 14-K.

14-T: Provisions of the SMMP have been incorporated into the FEIS.

14-U: Due to the high natural spatial and temporal variability in total suspended solids (TSS) concentrations, it was believed that any discrete TSS samples collected would not be representative of the range of conditions possible for suspended solids. Further, EPA believes that existing information is adequate for characterizing the physical environment of the study areas.

14-V: Nutrient concentrations were not measured during the EPA surveys because the existing information was considered adequate for characterizing nutrient concentrations within the study areas. Additionally, studies conducted for the COE's Dredged Material Research Program (DMRP) concluded that effects to nutrient concentrations from dredged material disposal operations were transient and caused only minor, short-term impacts to water quality.

14-W: Trace metal concentrations were not measured during the EPA surveys because the existing information from the study region was considered adequate.

14-X: See responses to Comments 14-J and 14-Q. As mentioned, differences in methodologies used for characterizing the environments of the study areas are considered minor; these differences do not hinder the site-selection process.

14-Y: This statement has been clarified in the FEIS.

14-Z: See responses to Comments 14-J, 14-Q, and 14-X.

14-AA: Trawling methods to collect bottom fishes and invertebrates were different between the EPA and Navy surveys, However, based on the observed similarities among communities, particularly for fish species from the alternative sites, these differences were not considered to be a significant hindrance to the site-selection process.

14-BB: See responses to comments 14-J, 14-Q, and 14-X discussing data comparability.

14-CC: See responses to comments 14-J, 14-Q, and 14-X discussing data comparability.

14-DD: See responses to comments 14-J, 14-Q, and 14-X discussing data comparability.

14-EE: The definition of legal status has been clarified in the FEIS. Those species that are Federally and/or State endangered, threatened, or which have special status, are cited accordingly in tables appearing at the beginning of Sections 3.3.4 (Marine Birds), 3.3.5 (Marine Mammals), and 3.3.6 (Threatened, Endangered, and Special Status Species).

14-FF: According to Ainley and Boekelheide (1990), approximately 122 species of breeding, migrating, and visiting marine birds are found in the study region. Under advisement from experts at the Point Reyes Bird Observatory (PRBO), ten representative species were selected that were determined to be characteristic of the resident marine bird community.

14-GG: The consultation with the California Department of Fish and Game (CDFG) was voluntary and was pursued in the spirit of project coordination associated with the State Coastal Zone Management Act. This has been clarified in the FEIS.

14-HH: Although none of the study areas are located within State waters (waters extending 3 nautical miles from the coastline), dredged material barges will pass through State waters in transit to the ODMDS.

The CDFG has jurisdiction over State waters and is concerned with any activities which may affect State endangered and threatened species. The responsibilities of CDFG have been clarified in the FEIS.

14-II: The American osprey currently is not listed Federally or by the State as a threatened or endangered species; the marbled murrelet is listed Federally as threatened and is considered endangered by the State of California. The status of these species has been updated in the FEIS.

14-JJ: This was corrected in the FEIS.

14-KK: Large differences between alternative sites in potential impacts associated with dredged material disposal were not indicated, as summarized in Table 4.1-1. Nevertheless, reasons for selecting Alternative Site 5 as the preferred alternative, discussed in Section 2.2.4, include considerations of potential impacts from historical waste disposal and proposed dredged material disposal operations, more limited fisheries resources, and possible, albeit minor, differences in potential impacts to benthic communities. The purpose of Table 4.1-1 was to assess NEPA type impacts for overall acceptability for ODMDS designation. This is fundamentally different from the purpose of Section 2.2.4 which evaluates the alternative sites relative to EPA's 11 specific site-selection criteria.

14-LL: Potential impacts, and the physical, chemical, and biological processes which could regulate the magnitude of impacts, at a deep-water disposal site are discussed in detail in Chapter 4 of the EIS. Where possible, information from previous studies of deep-water environments is used to evaluate impacts. If direct information from deep-water environments is unavailable, observations from shallow-water environments are used, and possible limitations of extrapolating to deep-water systems are discussed. However, because information concerning the impacts of dredged material disposal in deep-water environments is limited, EPA relied heavily on data collected in the study region to characterize existing site conditions and evaluate potential impacts.

14-MM: The 6,000 cubic yard barge capacity was an assumption used for developing the footprint model. This volume was chosen under the advisement of the COE. Actual barge capacity volumes may differ from the assumed volume.

14-NN: Sediment properties data from the Naval Supply Center (NSC) Oakland used in the model were based on discussions and recommendations with COE personnel prior to initiation of the modeling task (see SAIC 1992e).

14-OO: The comment is correct. However, note that the model-predicted footprint within the NMS corresponds to deposition over a one-year period of 1 millimeter of mostly sand material. This amount of material is two orders of magnitude less than the amount predicted to cause adverse impacts to benthic organisms.

14-PP: The term "significant" used in this instance was meant in a qualitative rather than quantitative fashion. However, due to the statistical implications of the term, it was replaced with a more appropriate term in the FEIS.

14-QQ: This statement regarding permit conditions was clarified in the FEIS.

14-RR: This statement has been clarified in the FEIS to indicate that, if dredged material shows statistically significant bioaccumulation following testing, Green Book (EPA/COE 1991) factors 1-8 (page 6-6) will be considered.

14-SS: The statement on page 4-63 of the DEIS indicates that because the preferred alternative site is outside of the Sanctuary boundaries, normal disposal operations at the ODMDS will not discharge material into the Sanctuary. No spillage or leakage from barges is allowed under the Navy Section 103 permit for use of the NODS. SMMP requirements will be based on Navy Section 103 permit special conditions.

14-TT: This comment refers to infaunal species (page 4-76) and not to page 3-134, which discusses new epifaunal species collected in Study Area 5 by Nybakken et al. (1992).

14-UU: This information is incorporated in the FEIS.

14-VV: This section of the FEIS has been revised to indicate that COE does not prepare draft permits. The Regional Implementation Agreement for Evaluating Dredged Material proposed for Ocean Disposal will be cited in the SMMP with respect to sediment testing. Site-use conditions also will be discussed in the SMMP.

14-WW: According to MPRSA Section 105(a), EPA is granted authority to take enforcement actions on violations of COE-issued permits. This is clarified in the FEIS.

14-XX: The EIS was revised to reflect that site management is the responsibility of EPA. As stated in 40 CFR Section 228.9(c), EPA will require full participation of permittees and encourages the participation of other Federal, State, and Local agencies.

14-YY: See response to Comment 14-Q.

14-ZZ: See response to Comment 14-Q.

Exhibit 15

15-A: The CDFG Trawler Database Report (Jow 1992) was not finalized in time for inclusion in the DEIS. However, this report is now available and its information is contained and cited in the FEIS.

15-B: Site management and monitoring will be discussed in the SMMP. Provisions of the SMMP are included in the FEIS. EPA intends to coordinate closely with the Navy to maximize the information obtained from the Navy's monitoring efforts, and apply the experience gained through management and monitoring at NODS to the management and monitoring of the ODMDS.

Exhibit 16

16-A: All dredged material proposed for ocean disposal must be tested according to protocols in the Green Book (EPA/COE 1991) and in the Regional Implementation Agreement. Only material deemed suitable will be permitted for disposal at the ODMDS.

16-B: An SMMP will be published as a separate document from the FEIS. However, major provisions of the SMMP are included in the FEIS. The issue of financing for monitoring studies is being studied by the LTMS Implementation Work Group.

Exhibit 17

Response: EPA appreciates your review and support of the DEIS.

Exhibit 18

18-A: This EIS evaluated three alternative sites within the ZSF and the No Action Alternative. The sites were selected because (1) they were believed to be far enough from the coast to prevent any potential negative impacts to shelf and coastal natural resources (including fisheries, marine birds, and marine mammals) or human activities (recreational fishing, naturalist expeditions, etc.); and (2) they were not so far from San Francisco Bay that transport of dredged materials to the potential site would be economically infeasible. Other regions outside of the ZSF were not evaluated because use of such a site would not be economically feasible.

18-B: The SMMP utilizes a tiered approach to identify any potential impacts related to disposal events. In the event that negative impacts are indicated, the SMMP may initiate a variety of management actions including (1) limiting the amount of dredged material disposed of at the site, (2) enforcing seasonal limitations on dredged material disposal events, or (3) designating a new disposal site.

18-C: The listed volumes of dredged material for ocean disposal (6 million cubic yards annually and 400 million cubic yards over a 50-year period) are planning estimates. All dredged material will have to pass Green Book (EPA/COE 1991) testing procedures before it can be disposed at the ODMDS. Therefore, the actual disposal volumes may be lower than the planning estimates. Further, the timing and frequency of site use is likely to vary from daily discharge events. Therefore, water column impacts are not expected to be significant due to the temporary nature of the disposal plumes.

18-D: As indicated in Section 4.2.2.1 of the FEIS, the patchy nature of plankton communities throughout the study region and the generally higher abundance of plankton in shallower waters inshore of the preferred alternative site suggest that a relatively small proportion of the plankton community is at risk. This, in conjunction with the limited duration and spatial extent of the disposal plume, suggests that the potential for negative impacts to plankton communities would be limited.

18-E: EPA has used worst-case estimates to predict impacts at the disposal site. Even so, impacts are expected to be minimal even when cumulative impacts over a 50-year period are considered. EPA agrees that disposal at a site of this depth is unprecedented, and the OSWG designed the monitoring program (specified in the SMMP) to address outstanding concerns and verify impact predictions.

Exhibit 19

19-A: EPA does not intend to prepare a supplemental Environmental Impact Statement (SEIS).

19-B: As discussed in Sections 3.3.4 and 3.3.5 of the FEIS, data from PRBO surveys were used to provide a long-term record of bird and mammal abundances within the study region during the June breeding season. These surveys include transects through each of the four study areas, but not necessarily through the alternative sites. Due to their mobile and migratory nature, surveys of bird and mammal populations using fixed location sampling are considered inappropriate. Sampling of transects through the study areas was done because this method is the most appropriate for characterizing marine bird and mammal communities. This type of sampling also provides a larger regional perspective concerning interannual patterns for these communities. Thus, the bird data and approach used to characterize these communities are considered valid.

19-C: This statement is incorrect. The PRBO and EPA survey data were collected in each of the four study areas (Study Areas 2, 3, 4, and 5). While some additional data were collected by the Navy for Study Area 5 only, these data were not used in the subsequent EPA analyses.

19-D: See response to Comment 19-B. Seasonal surveys conducted by the EPA served to supplement the long-term breeding season data collected by PRBO. As previously mentioned, both sets of surveys were conducted using the same census methodologies. Also, PRBO and EPA survey data were analyzed using the same methods. It is EPA's belief that, collectively, the two data sets adequately characterize marine bird and mammal populations within the study areas.

19-E: See response to Comments 19-B and 19-D.

19-F: Although the preferred alternative site had relatively higher marine bird and mammal use than the other alternative sites, disposal impacts to these species are expected to be insignificant (Class III) due to the localized nature and short duration of the disposal plume.

19-G: EPA has utilized review comments received on the DEIS to help design the SMMP. The provisions of the SMMP have been incorporated into the FEIS. The monitoring plan portion of the SMMP includes a tiered strategy for assessing disposal impacts to marine bird and mammal species.

19-H: Funding for long-term monitoring programs is being addressed by the LTMS Implementation Work Group.

19-I: Surveillance and audits of documentation are considered by EPA to be important tasks for site management. Surveillance and enforcement methods are addressed in the SMMP and summarized in the FEIS. Provisions for surveillance include requirements for documenting (via direct printouts from navigational systems) of barge transit routes and discharge locations, verification by independent inspectors, specifications of navigational accuracy, and documentation review by the responsible agencies.

Exhibit 20

20-A: Verification of model predictions for dredged material transport and deposition is an important goal of the SMMP. Information will be obtained from monitoring studies conducted in conjunction with the Navy's dredged material disposal operations at NODS. These data will be reviewed and incorporated into decisions by EPA regarding the need for and design of further studies of dredged material dispersion to be conducted under the SMMP for the MPRSA 102 site.

20-B: The provisions of the SMMP have been incorporated into the FEIS. The Plan includes a strategy for assessing disposal impacts to marine birds, mammals, and other organisms. In addition, as discussed in the response to Comment 20-A, the monitoring program described in the SMMP provides verification of model-predicted dredged material transport and deposition.

20-C: The preferred alternative site is located approximately 10 nautical miles from the GOFNMS boundaries. The SMMP specifies that all material will be discharged within a 1.1 nautical mile diameter circle centered at 37°39'N, 123°29'W, and no portion of the barge shall be further than 3,200 feet from the site center. Transit routes for dredged material barges also are specified in the SMMP. Barges must remain outside of the territorial sea boundary surrounding the Farallon Islands by following the inner portion of the outbound western shipping lane for transit into and out of the Bay. When the vessel is west of the Vessel Separation Scheme (VSS), the tug shall proceed directly to the ODMDS, but remain at least 3 nautical miles from the Farallon Islands. These specifications are consistent with site-use conditions in the Navy MPRSA Section 103 permit for the use of NODS.

20-D: See response to Comment 20-C. Site-use conditions aimed at reducing the possibility of accidental spills and disposal of material outside the boundaries of the site, especially within protected areas such as the GOFNMS, are addressed in the SMMP. These provisions also have been summarized in the FEIS.

20-E: A draft version of the SMMP was reviewed by the members of the OSWG. The provisions of the SMMP have been summarized in the FEIS.

20-F: Monitoring, as outlined by the SMMP, will be carried out in the time frame specified. Time intervals for studies may be modified based on periodic review. Site-monitoring activities likely will not take place during each disposal event.

20-G: Requirements for monitoring tasks and field personnel are outlined in the SMMP. EPA and the COE believe that barge tug operators are capable of providing adequate documentation of permit compliance. Nevertheless, independent observers will be used for some surveillance and documentation activities specified in the SMMP.

20-H: EPA agrees with this comment and will make this integration through review of the Navy's monitoring plan and results and development of the SMMP for the ODMDS.

20-I: EPA feels that the studies conducted in support of this EIS sufficiently characterize the preferred alternative site and its vicinity.

20-J: The center of EPA's ODMDS is at 37°39'N, 123°29'W. This corresponds with the center of the NODS. Disposal at the coordinates you suggest would result in deposition of material on Gumdrop Seamount, which was not studied under EPA's LTMS efforts, and which may be associated with more diverse organisms, particularly if hard-bottom features are present.

20-K: The SMMP specifies that dredged material will be discharged within a 1.1 nautical mile diameter circle centered at the coordinates listed in the response to Comment 20-J.

20-L: Existing information on zooplankton communities within the study region, from the National Marine Fisheries Service (NMFS) surveys, is summarized in Section 3.3 of the EIS. As stated in Sections 3.3.1.1 and 3.3.1.2, plankton communities exhibit considerable temporal and spatial population variability. Because effects to the water column from disposal operations are expected to be temporary, impacts to plankton communities are expected to be insignificant.

20-M: Moderate, high, and low use are not meant as strictly quantitative, but as relative terms. Moderate use implies that the study area is more often frequented or used than a low use area, but less utilized than a high use areas. Use categories are based on results from biological censuses or other studies.

20-N: The total volume of sediment represented by a 10 centimeter thick deposit over a 10 square kilometer area is 10 million cubic meters (13 million cubic yards); a 1 centimeter thick deposit over the same area represents 1 million cubic meters (1.3 million cubic yards).

20-O: Minimal and temporary impacts are anticipated from disposal activities due to the limited spatial and temporal extent of the disposal plume. Vessel traffic is expected to increase slightly following ODMDS designation due to the dredge barges that will be transiting to and from the site; this in turn could cause some minimal interference with commercial, recreational, or scientific boat traffic. However, the additional vessel traffic represented by the barges is expected to be negligible.

20-P: The term "low probabilities" was meant to be qualitative, not quantitative.

20-Q: The SMMP specifies requirements for site use, including transit paths for dredge barges, navigational accuracy, documentation, and agency surveillance. These provisions have been incorporated into the FEIS.

20-R: See response to Comment 20-Q.

20-S: As stated in the FEIS, the locations of the NODS and the preferred alternative site coincide.

20-T: The distance from the preferred alternative site to the GOFNMS is approximately 7 nautical miles.

20-U: Site surveillance and monitoring issues are addressed in the SMMP. These provisions have been incorporated into the FEIS.

20-V: See response to Comment 20-D.

20-W: See response to Comment 20-B.

20-X: Issues identified in Section 1.5 of the DEIS have been resolved. This section of the FEIS has been revised accordingly.

20-Y: Monitoring of impacts to marine fish, bird, and mammal species, including endangered species, is included as part of the SMMP.

20-Z: Comment noted.

20-AA: The provisions of the SMMP have been incorporated into the FEIS.

Exhibit 21

21-A: Volumes of material dredged from San Francisco Bay and specific fractions of the total volumes that will be proposed for disposal at an ODMDS over the next 50 years are speculative. Data used in the DEIS were obtained from COE documents prepared for the LTMS. These data were considered the best existing information on potential volumes generated over the term of the LTMS, but these values will be revised as more information becomes available through the other ongoing LTMS study elements. Further, these quantities are viewed by EPA as maximum volumes and would only be realized if no non-aquatic disposal sites become available in the next 50 years and if all material proposed for dredging is of suitable quality for ocean disposal. If non-aquatic sites do become available, or if other beneficial uses for dredged material are identified, EPA will encourage their use. The LTMS Implementation Work Group will prepare guidance for evaluating all available disposal options for specific proposed dredging projects at the time that permit applications are being reviewed.

21-B: See response to Comment 21-A.

21-C: The purpose of the EIS is to evaluate designation of an ODMDS. One of the goals of the LTMS is to provide an array of disposal options, including ocean disposal. In this way, EPA believes that the need for an ocean disposal site, for some amount of material, has been established. It is not the purpose of this EIS to evaluate the potential benefits of non-aquatic and reuse disposal options relative to the potential benefits and impacts associated with ocean disposal. These evaluations will be made, according to the guidance being developed by the LTMS Implementation Work Group, at the time that permit applications for specific projects are being evaluated. At the present time, EPA is not aware of any additional information that could be used to further refine the dredging volumes and disposal requirements presented in recent COE documents, as cited in the EIS.

21-D: An SMMP has been prepared that includes specific monitoring tasks to evaluate impacts associated with dredged material disposal activities at the preferred alternative site. Provisions of the SMMP are included in the FEIS. EPA will have an approved SMMP before the site is designated.

21-E: See response to Comment 21-D. The design of the monitoring program in the SMMP facilitates monitoring of short-term and long-term impacts, enabling EPA and COE to make management decisions in a timely manner, should potential or actual unacceptable adverse impacts be detected. The physical, biological, and chemical monitoring will also help these agencies to verify whether disposal operations are carried out in compliance with permitting and environmental regulations.

21-F: See response to Comment 21-D. Section 4.6 of the EIS has been revised to define the goals and objectives of site management and monitoring. Funding for site monitoring is being addressed by the LTMS Implementation Work Group.

21-G: See response to Comment 21-D. The tiered approach to monitoring, as described in the SMMP, incorporates management decision triggers and options for mitigation, as deemed appropriate based on results from monitoring studies. Further model verification is one of the goals of the physical monitoring module of the SMMP.

21-H: EPA believes that adequate opportunities for input from the public and decision-makers on the SMMP through OSWG meetings, circulated drafts of the SMMP, and comments are being provided in accordance with the LTMS process, prior to issuance of the Final Rule on proposed rule site designation.

21-I: See the response to Comment 21-H.

21-J: See response to Comment 19-C. A logical sequence of monitoring, data evaluation, and management decisions/actions is an integral part of the tiered monitoring framework described in the SMMP. Model verification is an important goal of the physical monitoring module of the monitoring program. Surveillance and documentation requirements, including the use of independent inspectors, are specified in the SMMP.

21-K: The plume model actually assumed an annual disposal volume of 6 million cubic yards. The EIS has been revised to correct this discrepancy.

21-L: EPA acknowledges that there will likely be some impacts from dredged material disposal to both water column and benthic habitats. However, changes to the water column habitat are expected to be temporary, and the duration will be related to the rate of dispersion of the dredged material. Effects of disposal on midwater and demersal fishes are expected to be temporary due to the transient nature of the disposal plume. A higher frequency of discharge events may temporarily increase the percentage of time that organisms in the vicinity of the disposal site are exposed to plumes of settling particles. Regardless, in the worst case, only a small portion of the habitat will be affected.

21-M: The EIS envisions that the worst-case scenario for releases of dredged material within a sanctuary is related to discharges of an entire barge load (i.e., up to 6,000 cubic yards). These releases would represent isolated events (both temporally and spatially). Factors such as short dumping and spillage will be identified and managed by provisions of the management portion of the SMMP. Provisions such as use of independent inspectors, requirements of the permittees to generate hard-copy documentation of transit paths and disposal coordinates, and navigational accuracy specifications have been implemented under the Navy MPRSA Section 103 permit for the NODS. Additional, possible mitigation measures/management actions are being incorporated into the monitoring program specified in the SMMP.

21-N: Based on the available data, Study Area 2 is considered a productive area containing the highest abundances of commercially important species. However, compared to other locations within Study Area 2 (Sites B1, B1A, B2, or B5), COE data indicated that Site B1B had lower abundances of commercially important species.

21-O: Previous studies conducted within the study region provided useful background information concerning characterization of the various shelf sites. However, because the information was incomplete and/or contradictory, EPA conducted additional surveys within the study region. Only the Navy and EPA survey results were used to select alternative sites, and no alternative sites were established on the shelf because of the highly productive fishery resources and designation of the MBNMS. The purpose of the COE studies was to evaluate areas on the shelf. EPA studies compared shelf areas to slope areas.

21-P: EPA acknowledges that disposal operations at the B1B site were extremely limited and the use of the site was halted by court action. Regardless, some dredged material was released at or near this site. Therefore, Site B1B is considered a historically used site. EPA has no intention of using this fact as a precedent for designating a site in this area. (Note that no alternative sites were identified in this area or on the adjacent shelf.)

21-Q: The DEIS does not mean to imply that a ZSF is required by the Ocean Dumping Regulations. However, evaluation of a ZSF does represent an important step in the site designation process, and is recommended in several existing EPA and COE documents that provide guidance on ODMDS designation. Inclusion in the EIS of a discussion of the ZSF performed by the COE for evaluation of potential ocean disposal sites does not obviate or minimize use of the 5 general and 11 specific site-selection criteria for comparisons of alternative ocean sites. Sections 2.2.2 and 2.2.3 of the EIS evaluate the alternative sites with respect to these criteria.

Exhibit 22

22-A through 22-F, 22-H through 22-Q, 22-S, and 22-X through 22-Z: These comments are addressed by incorporating the recommended revisions into the FEIS.

22-G: This section in the DEIS discusses dominant flatfishes on a study area by study area basis. There is no mention of rank order in terms of biomass or number of species. Also, according to Table 2 in Jow (1992), Dover sole rank highest in the study region followed by English sole, Pacific sanddab, petrale sole, and rex sole.

22-R: While this comment is factually correct, this section is not designed to address rank order of the number of rockfish or flatfish species collected in the study area, but rather to describe what species are predominant in bottom trawls.

22-T: The depth ranges reported for individual species often vary between literature sources. The depth ranges are not critical to the major points of the discussion in this section, and our original statements are consistent with the references cited.

22-U: See response to Comment 22-T.

22-V: See response to Comment 22-T.

22-W: See response to Comment 22-T.

22-AA: The CDFG Trawler Database Report (Jow 1992) was not finalized in time for inclusion in the DEIS. However, this report is now available and its information is contained and cited in the FEIS.

Exhibit 23

23-A: An SMMP has been prepared that includes specific monitoring tasks to evaluate impacts associated with dredged material disposal activities at the preferred alternative site. The monitoring program uses a tiered framework with physical, biological, and chemical modules. The specific objectives (i.e., hypotheses or management questions) are different for different modules and for individual tiers within each module. Specific monitoring issues include evaluations of the spatial extent of bottom deposits of dredged material, assessments of concentrations of chemical contaminants in bottom sediments, and censusing of birds and mammals in the vicinity of the disposal site. Management actions/mitigation will depend on results from the monitoring studies. Surveillance of disposal activities and enforcement actions also are specified in the SMMP. Use of independent inspectors and reviews of records of transit routes and discharge locations will facilitate oversight and compliance assessments. Provisions of the SMMP are included in the FEIS.

23-B: The SMMP is designed to allow flexibility to accommodate unforeseen needs and the ability to revise the plan as changes are required. Consequently, the SMMP will be reviewed periodically by EPA Region IX, COE San Francisco District, and the OSWG. Management and monitoring issues and public concerns will be resolved cooperatively.

23-C: Due to high natural variability and the limited number of turbidity measurements taken during the field program, EPA believes that any turbidity measurements collected would not be representative of the range of conditions possible. Further, EPA believes that existing information is adequate for characterizing the physical environment of the study areas. Turbidity data will be collected as part of the Navy's monitoring program at NODS.

Marine bird and mammal survey data were collected by PRBO and EPA within each of the four study areas using the same census methodologies. There are no differences in the methodologies used to collect data for Study Area 5 as compared to Study Areas 3 or 4.

23-D: The purpose of this EIS is to evaluate designation of an ODMDS. Comprehensive analyses of disposal alternatives, including options for beneficial uses of dredged material, are beyond the scope of this EIS. Designation of an ODMDS does not preclude use of other disposal alternatives, or potential uses of dredged material for beneficial purposes. These alternatives will be evaluated on a case-by-case basis, using guidance being developed by the LTMS Implementation Work Group, during the permit application review process for individual projects.

Exhibit 24

24-A: This table has been revised to include this information.

24-B: This table has been revised to include this information.

24-C: Comment noted.

24-D: The fraction of the total dredging volume from planned and proposed projects in the Bay considered potentially suitable for ocean disposal has been estimated by the COE (1992a) as 6 million cubic yards per year. The chemical characteristics of potential dredged sediments are unknown. Contaminant concentrations in Bay sediments, and the associated toxicity and/or bioavailability of sediment contaminants, are expected to vary widely. Impacts at the ODMDS associated with the presence of chemical contaminants in sediments which pass Green Book testing protocols (EPA/COE 1991) can not be predicted with certainty. However, the purpose of testing the sediments prior to approval for ocean disposal is to minimize the potential for significant adverse biological impacts. Analysis of bottom sediments from within the ODMDS for chemical contaminants is specified in the monitoring program portion of the SMMP.

Exhibit 25

25-A: It is EPA's belief that adequate characterization and baseline data have been provided on use of the preferred alternative site by marine birds and mammals. Further, EPA feels that the data discussed within Sections 4.2.2.5 and 4.2.2.6 indicate that disposal impacts to these species will be insignificant (Class III).

25-B: The preferred alternative site is located approximately 50 nautical miles from shore, in depths ranging from 2,500 to 3,000 meters. It was chosen as the preferred alternative primarily because it is located in deep water away from productive fishery areas and in an area that has been used historically for disposal of low-level radioactive waste and chemical and conventional munitions. The preferred alternative site also corresponds to the NODS, which has been permitted under MPRSA Section 103 for use by the Navy to dispose of dredged material from the Naval Air Station Alameda and Naval Supply Center Oakland.

25-C: An SMMP is being developed. Provisions of the SMMP are summarized in the FEIS. EPA does not intend to prepare an SEIS.

25-D: The purpose of this EIS is to evaluate designation of an ODMDS. Evaluation of other possible disposal options is beyond the scope of this EIS. Nevertheless, ODMDS designation does not preclude use of other disposal and/or reuse options. Guidance on the evaluation and use of other disposal options is being developed by the LTMS Implementation Work Group.

25-E: The suitability of alternative sites as an ODMDS is evaluated according to 5 general and 11 specific site-selection criteria. Criteria for evaluating changes to conditions within and adjacent to the ODMDS associated with dredged material disposal, as indicated by results from site monitoring, are presented in the SMMP. In some cases, these assessments will rely on the best professional judgment of EPA staff and will be made in consultation with the LTMS OSWG.

25-F: See response to Comment 25-C. Termination of site use and designation of new sites are discussed in the SMMP, which will be finalized before the site is designated.

25-G: Alternative Site 3 is located in the western portion of Study Area 3 and outside of MBNMS boundaries. The fact that the eastern portion of Study Area 3 is located inside MBNMS boundaries did not affect EPA's evaluation of Alternative Site 3 relative to the other alternative sites.

25-H: The Migratory Bird Treaty Act (16 U.S.C. 703-711) was passed in 1916 to control the taking, killing, or possessing of migratory birds. It is EPA's belief that the proposed designation of use of an ODMDS will not result in the capture or killing of migratory birds. Therefore, this act is not germane to the proposed action.

25-I: Information on ranking this non-ocean disposal site came from the LTMS Non-Aquatic/Re-Use Work Group. The Montezuma Wetlands site is an option for dredged material disposal, and is still being evaluated. This EIS was not intended to evaluate options other than ocean disposal.

25-J: As discussed in Chapter 4 of the EIS, impacts to water quality from dredged material disposal are expected to be temporary, with plumes dispersing within 48 hours of discharge. Perturbations in water quality are expected to be temporary and reduced to the range of background conditions prior to reaching any NMS or shoreline. Subsequent monitoring will determine the accuracy of these predictions.

25-K: It is unlikely that deposition of dredged material would compromise the integrity of radioactive waste containers beyond that which has already occurred. Provisions for site use will include a requirement that larger objects will be screened from dredged materials during the dredging process.

25-L: All dredged material proposed for disposal at the ODMDS must be tested according to Green Book protocols (EPA/COE 1991) prior to discharge at the site. These tests involve sediment chemistry, bioassay, and bioaccumulation evaluations. Decisions regarding suitability for ocean disposal are based on evidence of biological effects, not on sediment chemistry concentrations.

25-M: Sediments from Alternative Site 5 were analyzed for the complete list of EPA priority pollutants. Based on the results from these analyses (i.e., the absence of detectable amounts of most extractable organic compounds), it was decided to analyze sediments from the other study areas for a modified list of analytes [that included non-priority pollutant compounds such as n-alkanes and alkyl-substituted polynuclear aromatic hydrocarbons (PAHs)] using methods offering higher sensitivity.

25-N: The ZSF evaluation indicated that use of any of the three alternative sites is considered economically feasible. The costs associated with transit to the preferred alternative site relative to transit to the other alternative sites were not considered in the site-selection process.

25-O: As discussed in Sections 3.3.4 and 3.3.5 of the FEIS, data from PRBO surveys were used to provide a long-term record of bird and mammal abundances within the study region during the June breeding season. These surveys include transects through each of the four study areas, but not necessarily through the alternative sites. Due to their mobile and migratory nature, surveys of bird and mammal populations using fixed location sampling are considered inappropriate. However, sampling of transects through the study areas was done because this method is appropriate for characterizing marine bird and mammal communities. This type of sampling also provides a larger regional perspective concerning interannual patterns for these communities. Thus, the bird and mammal data and approach used to characterize these communities are considered valid.

Transect surveys were also used to characterize fish populations within the study region. Trawling was conducted along transects located within each study area, but not necessarily within each alternative site. A large commercial trawl, along with 35-millimeter still photographs and color video from a remotely-operated vehicle (ROV), were used to characterize fishes and invertebrates within Study Areas 2, 3, and 4. A beam trawl and camera sled were used to characterize these communities in Study Area 5, including the preferred alternative site. EPA believes that these were the best methods for characterizing the biological communities within the study region.

25-P: EPA is confident that the information presently available and discussed in the FEIS is adequate to describe the physical, biological, and socioeconomic environments of the alternative sites and to predict potential environmental impacts associated with the use of an ODMDS. EPA does not intend to prepare an SEIS.

25-Q: Although the area near the preferred alternative site may have relatively high marine bird and mammal use, disposal impacts to these species are expected to be insignificant (Class III). It must be noted that the potential for biological impacts is not the only consideration used in designating a disposal site. The preferred alternative site is located approximately 50 nautical miles from shore and in 2,500 to 3,000 meters of water. It was chosen primarily because it is located in deep water away from productive fishery areas and in an area that has been used historically for disposal of low-level radioactive waste and chemical and conventional munitions. Also, the preferred alternative site corresponds to the NODS as discussed in the response to Comment 25-B.

25-R: Based on the information discussed in Sections 4.2.2.5 and 4.2.2.6 of the EIS, disposal impacts to these species are considered insignificant (Class III). No seasonal restrictions have been identified as necessary for the protection of Farallon breeding populations. However, site-use restrictions are possible management actions that could be instituted if indicated by results from the site-monitoring program.

25-S: As discussed in Section 3.3.6, formal consultation letters requesting advisement of any critical habitat for threatened or endangered species that may be impacted by dredged material disposal are included in the FEIS. EPA feels that dredged material disposal at the preferred alternative site will not impact critical habitat for threatened and endangered species. Response letters from the U.S. Fish and Wildlife Service (USFWS), NMFS, and CDFG are included in Chapter 5 of this FEIS.

25-T: Specific sightings for gray, humpback, and blue whales, and northern sea lions were provided in Section 3.3.5 of the DEIS (see Figures 3.3.5-7, 3.3.5-8, 3.3.5-9, and 3.3.5-13, respectively); California brown pelican sightings were shown in DEIS Section 3.3.4 (see Figure 3.3.4-5). The remaining marine bird and mammal species that are threatened or endangered (finback whale, sperm whale, and peregrine falcon) were not observed in the study region during EPA or PRBO surveys. Therefore, no sightings for these species were provided. All of these figures were referenced in DEIS Section 3.3.6 (Threatened, Endangered, and Special Status Species) and are included in the FEIS. Note that the gray whale has been de-listed from its endangered species status subsequent to DEIS publication and is not included as an endangered species in the FEIS. Further, based on evaluation of the existing data, EPA does not believe presently that seasonal restrictions for disposal activities are needed to protect threatened and endangered species.

25-U: EPA used worst-case estimates for modeling potential impacts from dredged material disposal on water quality. Assumptions regarding the frequency of discharge events were made, although actual frequencies and disposal volumes are likely to vary somewhat (e.g., lower than estimated). Elevated concentrations of suspended particles may be present in the water column for periods of hours to days after discharge. However, the water quality model discussed in Chapter 4 predicts that disposal plumes containing particle concentrations higher than those in ambient waters will be at subsurface depths following an initial mixing period, and are unlikely to affect primary productivity. Therefore, model predictions, using conservative conditions, indicate that effects to water quality (exemplified by concentrations of suspended particles) outside of the ODMDS will be insignificant. EPA does not believe that seasonal restrictions on site use are necessary.

25-V: Perturbations to water quality are expected to be transient, affecting a small portion of foraging areas available to local and migrating marine fish, birds, and mammals.

25-W: See response to Comments 25-P, 25-R, and 25-V.

25-X: Continuous disposal of dredged material at Alternative Site 5 most certainly would have a continuing effect on the recruitment to and recolonization of the disposal site by benthic infauna, epifauna, and megafauna. Although there is no way to predict accurately what the effects on benthic infauna will be until the site is monitored, a wide range of responses to the disposal activities is likely. In areas where the maximal annual disposal depths of 10 centimeters per year are attained, rates of sediment disposal may be too high to permit successful recolonization by larvae and the establishment of stable resident populations. However, on the fringes of the disposal mounds where annual deposits are less than 5 centimeters, it is possible that dense populations will be recruited and maintained. For example, unusually dense populations of benthic infauna are maintained on the continental slope off Cape Hatteras, North Carolina, in an environment where depositional rates of mixed marine and terrigenous sediments are high (more than 1 centimeter per year) (Diaz *et al.* 1993). It is possible that the sediments that will accumulate at the preferred alternative site following dredged material disposal will support an equally dense, yet somewhat different, species complex than currently exists at the site.

25-Y: The SMMP contains specific provisions to minimize the potential for intentional violations of site-use conditions. Provisions include tracking systems on each tug and barge, inspectors to verify barge routes, requirements for documenting and reporting transit routes and discharge locations, and navigational accuracy specifications.

25-Z: No albatross were observed during EPA or PRBO surveys of the study areas. However, EPA acknowledges in Section 4.2.3.5 of the FEIS potential impacts from barge transit to recreational activities such as bird watching.

25-AA: An SMMP is being developed that addresses and incorporates many of these concerns. Provisions of the SMMP are included in the FEIS. Input to, and review of, the SMMP is being accomplished through the LTMS process. The SMMP will be in place before the site is designated, and will be reviewed and updated periodically. The monitoring portion of the SMMP uses a tiered approach to evaluate physical, biological, and chemical processes. This information will help address specific management concerns and questions. Specific monitoring tasks will validate model predictions of plume transport and dispersion, evaluate deposition of dredged material on the bottom, assess effects of discharges on concentrations of chemical contaminants in bottom sediments, and determine whether discharge events have a significant effect on site use by marine birds and mammals.

25-BB: Site management is addressed in the SMMP.

25-CC: The advisory committee recommended by this comment already exists in the form of the LTMS OSWG. This forum will continue with responsibilities for reviewing monitoring results and evaluating recommendations for changes to the monitoring requirements.

25-DD: EPA does not feel that frequency and timing restrictions on dredged material disposal are necessary. However, if site-monitoring results indicate that there are unacceptable adverse impacts which can be mitigated by such restrictions, this will be considered by EPA and the OSWG.

Exhibit 26

26-A: The limited duration and spatial extent of the disposal plume is not expected to adversely affect foraging or other activities of marine mammals including northern fur seals. Modeling studies predict that suspended particles associated with disposal activities will be found at depths greater than the typical foraging range of most marine mammals. The SMMP addresses impacts to marine mammals, including provisions for additional census work conducted during the June breeding season and studies conducted by trained observers aboard disposal tugs traveling to the site.

26-B: As discussed in Section 4.2.2.4 of the FEIS, disposal impacts to fish species are expected to be insignificant due to inherent avoidance responses by most species. Further, as discussed in the response to Comment 26-A, dredged material plumes are expected to sink to depths which are beyond the typical foraging range of most marine mammals. Therefore, effects from disposal activities on the prey of marine mammals are expected to be insignificant. Nevertheless, the monitoring program in the SMMP addresses potential impacts to midwater fishes as well as marine mammals.

26-C: EPA feels that foraging habits of marine cetaceans and pinnipeds have been adequately described in the EIS. The extreme depth of the preferred alternative site (approximately 2,000 to 3,000 meters) lies beyond the feeding range of most marine mammals, including the 1,500 meter maximum foraging depth of elephant seals. Further, all material permitted for ocean disposal will have to meet Green Book (EPA/COE 1991) testing requirements and ocean disposal regulation criteria.

26-D: As discussed in Section 4.2.2.6, foraging of both marine birds and mammals may be impacted temporarily by reductions in water clarity attributable to the disposal plume. EPA believes that impacts have been adequately addressed for site designation. Monitoring will be conducted as specified in the SMMP to assess impact predictions.

26-E: Although the majority of numerical models of dredged material disposal and transport have been aimed at relatively shallow (< 100 meter) sites, there have been models developed for applications in deep-water environments (Stoddard et al. 1985). For the present study, SAIC developed a site-specific numerical model to address the physical processes affecting initial dilution, particle settling, particle cloud dispersion, and advection due to the wide variety of oceanographic processes acting in the Gulf of Farallones. Detailed bathymetric data were incorporated and actual current measurement data from a variety of locations were used to simulate the horizontal transport of particles in the water column. It is, therefore, incorrect to say that the numerical modeling effort for the present study was simply an extrapolation of a shallow-water model.

The physical assumptions of the SAIC model follow the approach developed by past modeling studies that have appeared in the refereed oceanographic literature (Csanady and Churchill 1986; Churchill 1987). This approach also has been tested recently and validated for predicting the transport and dispersion of sewage sludge particles discharged at a deep-water (2,700 meter) disposal site offshore New York (EPA 1993).

We agree that more field measurements will be needed to validate the SAIC numerical model of dredged material transport at the alternative sites, including current measurements from near-bottom levels at locations in the study domain and, possibly, measurements of particulate plume dispersion during the first 12 hours after disposal. Actual monitoring studies are specified in the SMMP and will incorporate feedback from the Navy's 103 site monitoring.

26-F: Section 3.2.1.5 of the EIS presents sediment grain-size data from the preferred alternative site indicating that natural sediments at this site were predominantly fine grained, especially when compared to the other alternative sites. This section also stated that "some gravel sized material occurred on a knoll just south of Study Area 5 that showed other features typical of erosional areas" and "earthquakes and/or density currents periodically may initiate movement of accumulated sediment in a downslope direction." Section 3.3.2.1 makes the statement that "bottom photographs ... revealed a lumpy bottom that suggested a local disturbance, possibly related to turbidity flow."

Although these statements imply that the observed near-bottom currents may alter the bottom sediments, we do not have direct observations of bottom sediment resuspension. The depositional characteristics of the preferred alternative site suggest that resuspension of and erosion of bottom sediments is minimal. Thus, we disagree with your statement that "there is strong indication of turbidity flows and subsequent resuspension of fine silt and clay sediment." The available information can only lead to speculation that the bottom irregularities may be a result of turbidity flows caused by geological disturbances or other deep-ocean dynamical processes.

It is unlikely that the monitoring program will entail a major, costly measurement program to obtain (1) detailed maps of the small-scale sea floor characteristics within the disposal site and (2) long-term measurements of near-bottom currents and sediment resuspension that would be necessary to answer the questions you have raised. Note that turbidity flows, like earthquakes, are not predictable. EPA does not feel that resuspension will occur due to normal bottom currents. Monitoring of such aperiodic processes requires resources that are beyond the scope and time constraints of the present study.

26-G: This EIS evaluates designation of an ODMDS. Evaluations of the suitability of dredged sediments for ocean disposal are considered under the COE Section 103 permitting process and potentially NEPA evaluation in a separate EIS. As discussed in Section 3.1.2 of the DEIS, chemical characteristics of potential dredged material are expected to vary considerably depending on the location of the dredging site and site-specific history of contaminant inputs. Regardless, all material proposed for disposal at the ODMDS will be tested according to Green Book (EPA/COE 1991) testing requirements to ensure that the material is not toxic to marine organisms and that chemical constituents are not biologically available. Further, site monitoring will be performed periodically to determine whether chemical contaminant concentrations in bottom sediments are significantly elevated as a result of dredged material disposal operations.

26-H: As stated in Section 4.2.2 of the FEIS, disposal impacts to plankton, fish, birds, and mammals within the preferred alternative site are expected to be insignificant (Class III). No impact to the overall productivity of the site is anticipated due to the limited spatial and temporal extent of the disposal plume.

26-I: The fauna at the preferred alternative site is indeed rich, and there are many species that only rarely have been recorded previously. There is no evidence, however, that any of the species collected from this site are limited to that location. With repeated sampling in adjacent areas, rare species tend to appear. For example, four box cores taken to the west of Study Area 4 in depths that approximated those of Study Area 5 yielded many of the same species that had been collected from Study Area 5.

The disturbance event documented by camera sled and infaunal results is very interesting from the point of view of natural disturbance in the deep sea. The relevant biological result from these data is that the structure of the infauna was generally unchanged from that of adjacent sites, but the density was considerably reduced. It is possible that deposition of sediment from dredged material disposal activities will provide a similar type of disturbance. The ability of the resident fauna to survive burial will depend on the rate of deposition and the depth of the deposit, which will vary considerably throughout the footprint on the bottom.

26-J: EPA is not aware of any data or studies supporting the contention that the presence of El Niño conditions would significantly increase the frequency or mass of dredged material transported into the NMS. Model predictions of the dispersion of suspended particles associated with dredged material disposal operations at the preferred alternative site indicated very low probabilities of detectable amounts of material being transported into the adjacent marine sanctuaries. One of the initial tasks in the SMMP will be verification of the model predictions.

26-K: Provisions for monitoring the preferred alternative site are contained in the SMMP and summarized in the FEIS. EPA is confident that the baseline characterization data collected within Study Area 5 are adequate for describing the physical, biological, and socioeconomic environments of the site. The SMMP includes specific monitoring tasks to evaluate impacts to physical, biological, and chemical processes associated with dredged material disposal activities at the ODMDS and verification of computer model predictions. The monitoring program will be established prior to any ocean disposal. Components of the SMMP will be reviewed periodically to verify impact predictions.

26-L: Dredged material volumes cited in the EIS are based on estimates developed by COE for the LTMS studies. The purpose of this EIS is to evaluate designation of an ODMDS, which is only one option considered by the LTMS for the disposal or use of dredged material. Projects proposing to use the ODMDS will be evaluated on an individual basis. Each potential project will have to demonstrate the need to use the ODMDS and that the proposed material is suitable for dumping.

26-M: Barge traffic to the ODMDS will be confined to the inner portion of the outbound shipping lane extending southwest below the Farallon Islands. Further, barges must remain at least 3 nautical miles from the Farallon Islands. No water or dredged material will be permitted to leak or spill from barges in transit. In the event of an accidental spill, it is anticipated that any potential impacts will be reduced to undetectable levels before reaching sensitive areas. The SMMP contains additional specific provisions, such as a tracking system on each tug and barge, inspectors to verify barge routes, and tracking of barges by the U.S. Coast Guard (USCG), to minimize potentials for intentional violations of site-use conditions.

Exhibit 27

27-A: An SMMP, that includes a monitoring plan, will be finalized prior to site designation. Provisions of the Plan are contained in the FEIS. The monitoring plan is based on a tiered approach, and the results will be used to address specific technical/scientific and management questions.

27-B: See response to Comment 27-A. Public and agency review of the SMMP is being accomplished through the LTMS process.

27-C: The SMMP also addresses site management issues, including surveillance and possible enforcement and management actions. Site-use conditions will require disposal within a spatially defined watch circle (within the disposal site), instrument documentation of discharge locations, independent observers, and precision navigational equipment.

Exhibit 28

28-A: Barge tugs will be required to use an electronic positioning system or global positioning system. The tug captains will be required to generate a printout from the navigation system that shows transit routes and disposal coordinates, including the time and position when the barge doors open and close. These procedures and systems will be tested during the Navy 103 program and will be revised or improved as necessary.

28-B: Site-use conditions contained in the SMMP state that the barges must remain within the specified traffic lanes and at least 3 nautical miles from the Farallon Islands during transit to the ODMDS. The site-use conditions restrict the location where discharges can occur, but not the directions in which the barge can turn.

28-C: We agree that field measurements must be conducted to observe actual plume dispersion and transport, accumulation of dredged material on the sea floor for validation of numerical models, and possible impact of suspended particulates on adjacent NMS. Detailed measurement components of a tiered monitoring program are described in the SMMP. Each measurement component will be implemented in response to the need for specific data and information such as for model validation, environmental effects evaluation, or permit compliance.

With regard to the duration of current velocity observations and dredged material plume measurements, it will be important to make observations in each of the dynamical regimes that are known to occur in this region. Measurements during periods of El Niño circulation will be considered, but even with a plan for long-term measurements, it may not be possible to obtain field observations during all dynamical regimes given the unpredictable nature of the ocean and the considerable cost of interannual monitoring programs.

28-D: These suggestions were taken into consideration during development of the SMMP. The SMMP includes biological monitoring components which involve continuation of the PRBO breeding season surveys and additional studies conducted by trained observers aboard disposal tugs traveling to the ODMDS.

28-E: Monitoring of contaminant bioaccumulation would be performed only if warranted based on the results from Tier 1 and 2 monitoring elements. Bioaccumulation studies using bird eggs are not planned. Monitoring is planned using bottom-dwelling organisms. Results from the State and/or Federal "Mussel Watch" programs could be evaluated, if available.

28-F: These suggestions were taken into consideration during development of the SMMP. The biological component of the SMMP includes a provision for additional studies conducted by trained observers aboard disposal tugs traveling to the ODMDS. EPA agrees that population trends are more sensitive to habitat alterations. However, to evaluate trends, good baseline data are needed. The only baseline data that exist for local marine birds and mammals are from PRBO breeding season surveys and EPA's four season surveys.

28-G: EPA does not believe that any marine bird or pinniped species will be significantly affected by dredged material disposal at the ODMDS, including threatened, endangered, and special status species.

28-H: The SMMP has a component for monitoring marine birds and mammals, which includes provisions for continuation of PRBO breeding season censuses and additional studies to be conducted by trained observers aboard disposal tugs traveling to the ODMDS.

28-I: EPA will have the SMMP in place before site designation. SMMP does have vertebrate components, including birds, mammals, and fishes, in the monitoring program.

28-J: See response to Comment 28-G.

Exhibit 29

29-A: The management program contained in the SMMP includes provisions for surveillance during transport to the ODMDS. The provisions include independent inspectors on tugs or barges, documentation of transit routes, and tracking of transit routes (up to 38 miles from Mount Tamalpais) using the U.S. Coast Guard Offshore Vessel Movement Reporting System. Funding and implementation will be addressed by the LTMS Implementation Work Group. Public review and input to the SMMP are accomplished through the LTMS process and public review of the Proposed Rule.

Exhibit 30

30-A: The costs of the monitoring program, and specific responsibilities for providing funding, are being developed through the LTMS Implementation Work Group. The Implementation Work Group and the LTMS Policy Environmental Impact Report/Environmental Impact Statement (EIR/EIS) also will address allocation or comparability of use between ocean and non-ocean disposal alternatives.

30-B: EPA will cover the cost of developing the SMMP. Objectives of the SMMP are contained in the FEIS. The SMMP will be finalized prior to site designation.

30-C: EPA agrees that the implementation mechanism is beyond the scope of this EIS. Implementation mechanisms will be specified in the LTMS Policy EIR/EIS. However, this EIS provides general provisions of the SMMP, which will be finalized prior to site designation.

Exhibit 31

31-A: The FEIS has been revised to indicate the BCDC's regulation of disposal sites within the Bay and the BCDC's preference for ocean and non-aquatic disposal alternatives.

31-B: EPA appreciates BCDC's support of the proposed action.

31-C: EPA believes that there is a need for an ocean disposal site and is confident that this site will provide one of several options for dredged material disposal or reuse. EPA also supports reuse and beneficial uses of dredged material, whenever feasible. The need for ocean disposal will be evaluated on a case-by-case basis, and only material suitable for ocean disposal will be discharged at the ODMDS.

31-D: These corrections were incorporated in the FEIS.

31-E: This correction was incorporated in the FEIS.

31-F: Comment noted; these objectives are consistent with EPA's goals.

31-G: These issues will be the subject of the LTMS Policy EIR/EIS, and are being developed by the various subcommittees of the LTMS Implementation Work Group.

Exhibit 32

32-A: Comment noted.

32-B: An SMMP is being developed, and monitoring and management provisions of the SMMP have been incorporated into the FEIS. The issue of funding for the SMMP is being addressed by the LTMS Implementation Work Group.

32-C: Site management and monitoring will be coordinated by EPA. The U.S. Coast Guard will likely assist with some surveillance and enforcement activities. A Memorandum of Understanding between EPA, COE, and USCG will be used to formalize these roles.

32-D: EPA does not feel this is necessary. Surveillance requirements in the SMMP are based on permit special conditions for the Navy Section 103 permit project. These include independent inspections, documentation of transit routes and discharge locations, and review of documentation by the responsible agencies. These provisions will be evaluated at the conclusion of the Navy project and will be used in the SMMP, if found acceptable, or modified as appropriate.

32-E: A comprehensive SMMP, that addresses site management, monitoring, and surveillance, is being developed. Draft versions of the SMMP are being reviewed by the OSWG. The SMMP will be finalized prior to site designation.

32-F: EPA does not intend to prepare an SEIS.

32-G: See response to Comment 32-E.

32-H: See response to Comment 32-E. Monitoring of deeper sites is more difficult. However, logistical problems associated with sampling are being resolved by EPA and Navy characterization studies and by the Navy monitoring program associated with use of the NODS. The SMMP has been developed to address issues regarding detection and mitigation of adverse impacts without compromising technical goals due to sampling difficulties at depth.

32-I: EPA prepared the site designation EIS under its voluntary EIS policy for ODMDSs. Many of the supporting technical studies may eventually be published in peer-reviewed journals. However, these publications are ancillary to the EIS requirements of NEPA.

32-J: We are not aware of studies that directly address impacts to plankton from dredged material disposal. These references cite the limited information available concerning impacts to plankton from other disposal practices.

32-K: See response to Comment 32-J.

32-L: Continuous disposal of dredged material at the preferred alternative site would have an effect on the recruitment to and recolonization of the disposal site by benthic infauna and epifauna. There is no way to predict accurately what the effects on benthic infauna will be until the site is monitored; however, it is likely that a wide range of responses to the disposal activities will be apparent. In areas where annual disposal thicknesses of 10 centimeters per year are attained, rates of sediment deposition may be too high to permit successful recolonization by larvae and the establishment of stable resident populations. However, on the fringes of the disposal mounds where annual deposits are less than 5 centimeters, it is possible that dense populations will be recruited and maintained. EPA acknowledges that some adverse effects (including mortality to benthic organisms) will occur. These impacts are estimated to be acceptable when weighed against the project's benefits and do not require specific mitigation.

32-M: Section 4.2.2.4 of the FEIS states that information about impacts of dredged material disposal on fish communities is extremely limited. EPA is not aware of any studies which have directly measured effects of turbidity plumes on pelagic fish species. However, EPA believes that such effects will be minimal because fish can avoid plumes and plumes will be limited in duration. It is also stated in Section 4.2.2.4 of the EIS that "deep-water mesopelagic and bathypelagic species of deep-sea smelts and lanternfishes should be able to avoid the disposal plume, although there are no specific studies on avoidance behavior of these species."

32-N: See response to Comment 32-M.

32-O: See response to Comment 32-E. The SMMP addresses in detail all tasks associated with site monitoring and oversight. The major provisions of the Plan have been summarized in the FEIS. EPA does not intend to prepare an SEIS.

32-P: EPA supports the beneficial use of dredged material, whenever feasible. As mentioned in the EIS, designation of an ODMDS is not intended to express a preference by LTMS member agencies for ocean disposal, nor does designation of an ODMDS preclude beneficial uses or other disposal options. Rather, LTMS requested a range of options for dredged material disposal (including identification and designation of an ocean site), and EPA is responding to that need. Decisions regarding use of an ODMDS in lieu of other disposal alternatives will be made on a case-by-case basis according to guidelines being developed by the LTMS Implementation Work Group.

32-Q: See response to Comment 32-O; detailed discussions regarding use of non-aquatic sites for dredged material disposal are beyond the scope of this EIS and are being considered by the LTMS Non-Aquatic and Re-Use Work Group. Policy guiding the use of various disposal site options or scenarios for Bay area dredging projects is being developed by the LTMS Implementation Work Group and will be presented in the LTMS Policy EIR/EIS.

32-R: These impacts were designated Class II because EPA believes that the potential threat to the GOFNMS was significant, but impacts could be mitigated by specifying barge transit routes and prohibiting spillage from the barges. These mitigation measures were imposed on the Navy 103 project as special conditions under the permit. These permit requirements will be evaluated during and after the Navy 103 project and included in the SMMP after any necessary revisions are made.

32-S: The 6,000 cubic yards corresponded to the maximum capacity of a single barge that could be used for disposal operations. Subsequent discussions with the COE indicated that barges used for disposal operations likely will have maximum capacities of 3,000 cubic yards. The EIS has been revised to reflect this change.

32-T: Site-use conditions contained in the SMMP specify that the barges must remain within specified traffic lanes and at least 3 nautical miles from the Farallon Islands during transit to the ODMDS. Although these conditions would not prevent spillage, such as from a vessel accident, the small volumes and the considerable distance from the Farallon Islands would minimize potentials for impacts. It is not anticipated that additional restrictions will be placed on disposal tugs, other than standard vessel regulations imposed by USCG and GOFNMS regulations. Also, only dredged material deemed suitable for ocean disposal will be transported to the ODMDS. Thus, this material would not comprise sewage or untreated contaminated sediments.

32-U: See response to Comment 32-T.

Exhibit 33

33-A: Discussion and resolution of issues occurs within the LTMS OSWG forum, led by EPA. Resolution also is discussed in responses to comments from various reviewing agencies and by revisions which are incorporated into the FEIS. Criteria used to address the suitability of the preferred alternative site include the general and specific site-selection criteria and best professional judgment. The preferred site for an ODMDS would not have been selected if it did not meet the site-selection criteria. Any unresolved issues will be addressed by the LTMS OSWG forum.

33-B: There is currently no database for historical information on San Francisco Bay dredging projects. Most recent dredging projects have not proposed ocean disposal due to cost, lack of site, or both. Therefore, EPA and COE decided to use data from NSC and Oakland Middle Harbor as representative of typical Bay sediments since the COE felt these sites fit the range of sediment types in the Bay. Also, these were the most recent data available.

33-C: In response to a letter from the Bay Planning Commission, the CDFG made recommendations (letter to M. Kahoe, EPA, March 16, 1991) regarding seasonal restrictions on dredging activities that may impact populations of the State Endangered and Federally Threatened winter-run chinook salmon. These recommendations include reductions in disposal volumes and prohibition of disposal within the Bay of dredged material of questionable or unsuitable quality when outmigrant winter-run chinook salmon are present within the Bay (November 1 to May 31).

These recommendations restrict dredged material disposal within the Bay from November 1 to May 31, but impose no restrictions on disposal at the preferred alternative site.

Further, as stated in Section 3.1.2, the CDFG recommends that "suction dredging in parts of north San Francisco and San Pablo Bays be prohibited from May 1 to August 1" to protect early-stage Dungeness crabs. According to the CDFG, suction dredging has a greater impact on Dungeness crabs than does clamshell dredging. Thus, as the statement indicates, some dredging restrictions are recommended based on the location of the area to be dredged (parts of north San Francisco and San Pablo Bays) and the type of dredging (suction or clamshell) utilized. Predictions of impacts associated with more frequent disposal events at the ODMDS within such a limited disposal window are impractical and unnecessary.

33-D: Surveillance and monitoring requirements for the ODMDS are specified in the SMMP. The U.S. Coast Guard will likely assist with some surveillance and enforcement activities. A Memorandum of Understanding between EPA, COE, and USCG will be used to formalize these roles. Site-use conditions and surveillance requirements in the SMMP are based on permit special conditions for the Navy 103 project. These provisions will be evaluated at the conclusion of the Navy project and will be used in the SMMP, if found acceptable. Monitoring of deeper sites is more difficult, but still is possible based on EPA and the Navy's experience with site characterization studies and monitoring for disposal operations at NODS. The SMMP has been developed to address issues regarding detection and mitigation of adverse impacts without compromising technical goals due to sampling difficulties at depth.

33-E: As discussed in Section 3.2.5.5, concentrations of the priority pollutant organic compounds were measured in sediments from Study Area 5 (SAIC 1992c). With few exceptions, concentrations of all organic compounds were below the respective method detection limits. Decisions regarding allowable constituent concentrations in dredged material deemed suitable for ocean disposal will be made according to protocols described in the Green Book (EPA/COE 1991) and EPA Region IX recommendations for sediment testing.

33-F: Table 3.3.6-1 provides general information on threatened and endangered species that are known to occur in the study region. Because these species are generally rare, and because detailed surveys of the study areas are limited, it may be misleading to indicate that the species occur within specific study areas or alternative sites (i.e., the areas in which these species occur would be under-represented). More detailed information on threatened and endangered marine fish, bird, and mammal species, including maps of sightings for numerous species, are included in Sections 3.3.3, 3.3.4, and 3.3.5, respectively.

33-G: Section 4.2.1.1 discusses impacts related solely to barge traffic. As Table 4.2-1 indicates, predicted maximum concentrations of air pollutants related to ambient concentrations plus project-related operations from barge transit are far below State and Federal standards.

33-H: The numerical model of dredged material behavior used all of the current meter data obtained from the year-long EPA current measurement program. This program consisted of current measurements at various depths at six locations within the study region. At most locations, near-bottom current data were acquired from within 10 meters of the sea floor. Consequently, the model used actual data on near-bottom currents for predictions of sediment transport and deposition. The model did not consider sediment resuspension followed by lateral transport of bottom sediments because resuspension is unlikely to occur at the depths where the alternative sites are located, as indicated by the depositional character of the bottom. Similarly, the model did not address sediment resuspension on the outer continental shelf, and analyses of potential sediment resuspension on the shelf were not performed because no alternative site was identified in this region.

33-I: The term "suitable" is used to characterize dredged material that has passed required Green Book (EPA/COE 1991) testing. According to the protocols, material deemed suitable for ocean disposal is considered non-toxic, will not result in significant bioaccumulation of contaminants in the tissues of test organisms, and will not result in unacceptable adverse impacts to the marine environment. Site monitoring, as described in the SMMP, is designed to confirm that contaminants are not accumulating in bottom sediments and, depending on the results from higher-tiered monitoring tasks, in the tissues of bottom-dwelling organisms.

33-J: As stated in Section 4.2.2.7, potential impacts to threatened and endangered species at the preferred site may include avoidance, alteration of migration, and/or temporary impairment of feeding activities. Impacts to marine birds and mammals will be evaluated during monitoring tasks as described in the SMMP.

Exhibit 34

34-A: This designation action does not include proposals to dispose of any particular project's dredged material at the ODMDS. Policy on the allocation of dredged material to various disposal options is being developed by the Implementation Work Group for the LTMS Policy EIR/EIS. MPRSA, not the Clean Water Act (CWA), governs ocean disposal outside the baseline. Beneficial uses of dredged material, land disposal, and disposal in the Bay, are listed as alternatives to ocean disposal. All available alternatives must be considered before a permit to dispose dredged material can be issued.

34-B: It is anticipated that temporary perturbations in water quality and/or environmental conditions at the ODMDS will be reduced to ambient or undetectable levels before reaching any beach, shoreline, or sensitive habitats or resources. The preferred alternative site is located approximately 50 nautical miles from shore in 2,500 to 3,000 meters of water. It was chosen as the preferred alternative site primarily because it is located in deep water away from productive fishery areas and in an area that has been used historically for disposal of low-level radioactive waste and chemical and conventional munitions. The preferred alternative site corresponds to the Navy NODS. An SMMP is being developed which will be finalized before the site is designated and which contains provisions for site surveillance and enforcement against disposal outside of the ODMDS. All material deemed suitable for ocean disposal must be in accordance with Green Book (EPA/COE 1991) testing criteria.

34-C: Impacts to most biological communities are expected to be minimal. An SMMP has been developed which contains provisions to verify impact predictions. EPA believes that use of an ODMDS may help reduce impacts to biological resources from disposal at sites within the Bay, such as Alcatraz.

34-D: Non-aquatic and Re-Use options are being evaluated by LTMS under the direction of BCDC. Environmental effects of these disposal options will be compared to ocean disposal options in the LTMS Policy EIR/EIS. Although part of BCDC's task is to evaluate possibilities to reduce the need for dredging, it is likely that dredged material disposal options, including an ocean disposal site, will be required for the near future.

Exhibit 35

Response: Comment noted.