Cosco Busan Oil Spill

Final
Damage Assessment and Restoration Plan/
Environmental Assessment

February, 2012

Prepared by:
California Department of Fish and Game
California State Lands Commission
National Oceanic and Atmospheric Administration
United States Fish and Wildlife Service
National Park Service
Bureau of Land Management

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FACT SHEET

Final Damage Assessment and Restoration Plan / Environmental Assessment for the *Cosco Busan* Oil Spill

Trustee Agencies: California Department of Fish and Game, California State Lands Commission, National Oceanic and Atmospheric Administration, United States Fish and Wildlife Service, National Park Service, Bureau of Land Management.

Abstract: The Natural Resource Trustee Agencies (Trustees) present a description and quantification of the injuries as well as the final selected restoration projects to compensate for the impacts of the *Cosco Busan* Oil Spill that occurred in San Francisco Bay on November 7, 2007. The spill affected wildlife (primarily birds and fish), habitat (primarily rocky intertidal, salt marsh, tidal flats, sandy beach, and eelgrass beds), and human recreational activities. The Trustees have selected 12 restoration projects to restore and compensate for the injured resources and created a process that is intended to identify numerous recreational use improvements. The projects are:

- Creation of grebe nesting habitat at Tule Lake National Wildlife Refuge;
- Creation of over-wintering duck and grebe habitat at the South Bay Salt Ponds;
- Creation of nesting and roosting habitat for cormorants, pelicans, and shorebirds at the Berkeley Pier;
- Creation of nesting habitat for seabirds at the Farallon Islands;
- Creation of a grant project to benefit Surf Scoters;
- Restoration of Marbled Murrelets in California;
- Restoration of eelgrass at several sites inside the Bay, to benefit both eelgrass and herring;
- Restoration of sandy beach habitats at Muir Beach and Albany Beach;
- Restoration of salt marsh and mudflat habitats at Aramburu Island;
- Restoration of native oysters and rockweed at several sites inside the Bay, to benefit rocky intertidal communities;
- Creation of a process to fund a wide variety of human recreational use projects at impacted sites across the spill zone.

The Trustees also present their environmental assessment of the selected projects under the National Environmental Policy Act (NEPA) and the California Environmental Quality Act (CEQA).

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Copies: Copies of the Damage Assessment and Restoration Plan/Environment Assessment are available from Steve Hampton at the above address. Copies are also available online at http://www.dfg.ca.gov/ospr/Science/cosco_busan_spill.aspx

Executive Summary

On November 7, 2007, the freighter *Cosco Busan* struck the Bay Bridge as it attempted to depart San Francisco Bay. The accident created a gash in the hull of the vessel, causing it to spill 53,569 gallons of oil into the Bay, according to US Coast Guard calculations. Wind and currents took some of the oil outside of the Bay, where it impacted the outer coast from approximately Half Moon Bay to Point Reyes. Inside the Bay, the oil primarily impacted waters and shoreline within the central portion of the Bay, from Tiburon to San Francisco on the west side and from Richmond to Alameda on the east side.

The responsible parties are Regal Stone Limited, the owner of the vessel, Fleet Management Limited, the operator of the vessel, and John Cota, the pilot of the vessel.

The spill precipitated widespread beach closures, fishery closures (both commercial and recreational), and the cancellation of many activities associated with boating or use of the Bay waters. A large-scale response ensued, with clean-up crews active for several weeks. The response was organized through a Unified Command, which was made up of several federal and state agencies as well as the responsible parties. The latter was primarily represented by the O'Brien Group, a company employed to manage the oil spill response.

Portions of the response were completed as beaches were inspected and determined to have met cleanup criteria. The US Coast Guard officially declared the response to be complete on November 9, 2008, one year and two days after the spill. Most of the active response ended less than two months after the spill. Some clean-up continued at several beaches (e.g. Rodeo Beach, Albany Beach) into summer 2008, as they continued to have oiling episodes as buried or sunken oil was uncovered or washed up by wave action.

In addition to the response and clean-up effort, the natural resources Trustee agencies conducted a Natural Resource Damage Assessment (NRDA) to quantify the injuries and seek compensation in the form of restoration projects. In this case, the Trustees for the injured natural resources are the United States Fish and Wildlife Service (USFWS), the National Park Service (NPS), the Bureau of Land Management (BLM), the National Oceanic and Atmospheric Administration (NOAA), the California Department of Fish and Game (CDFG), and the California State Lands Commission (CSLC) (the Trustees). As a designated Trustee, each of these agencies is authorized to act on behalf of the public under state and/or federal law to assess and recover natural resource damages and to plan and implement actions to restore, rehabilitate, replace, or acquire the equivalent of the affected natural resources injured as a result of a discharge of oil.

Damage Assessment and Restoration Plan (DARP)/Environmental Assessment (EA)
Under the Oil Pollution Act (OPA) NRDA regulations, the Trustees have cooperatively prepared this Damage Assessment and Restoration Plan (DARP). This document describes the injuries resulting from the spill and the restoration projects intended to compensate the public for those injuries. This document is also an Environmental Assessment (EA) intended to satisfy the Federal Trustees' requirement to evaluate the environmental impacts of the selected restoration projects and the alternatives under the National Environmental Policy Act (NEPA). This document is therefore called a

DARP/EA. Prior to releasing this Final DARP/EA, the Trustees released a Draft DARP/EA for public review and comment. After considering the public comments received, the Trustees prepared this Final DARP/EA. Additional review will be required for some of the projects selected in this DARP/EA. This will be determined once detailed engineering design work or operational plans are developed for those projects or locations are identified.

What was injured?

The spill caused significant impacts to wildlife, habitats, and human recreational uses.

- Birds: 6,849 birds were estimated killed, representing 65 different species. The primary species impacted were diving ducks, grebes, cormorants, and murres. Special status species impacted included Marbled Murrelet and Snowy Plover.
- Fish: An estimated 14 to 29% of the winter 2007-8 herring spawn was lost due to widespread egg mortality in some areas of the Bay.
- Shoreline Habitats: 3,367 acres of shoreline habitat were impacted, and recovery is expected to vary from a few months to several years, depending upon the habitat type and degree of oiling.
- Human Uses: 1,079,900 user-days were lost, representing a wide variety of activities (recreational fishing, general beach use, surfing, etc.).

What restoration projects will compensate the public for these injuries?

The Trustees select 12 restoration projects that are designed to address the various resources impacted by the spill, as well as a process to identify various recreational use projects. All of the projects are designed to restore, replace, or acquire the equivalent of the lost resources and/or their services through restorative on-the-ground actions. Furthermore, several of the projects address multiple resources. The projects were selected based upon the biological needs of the injured species and the feasibility of restoring the resources. Where feasible restoration project alternatives existed within the spill area, those projects were given priority. Section 1.3 provides short summaries of the selected projects; section 4.2 lists the criteria used in project selection; and section 4.3 lists all projects considered (by resource category) and provides detailed information on the selected projects.

How will these projects be funded?

Under OPA, the responsible party (RP) is liable for the cost of implementing restoration projects, as well as the costs incurred by the Trustees to undertake this damage assessment. The Trustees have settled this claim for natural resource damages with the RP. The following amounts are allocated to fund the projects described in this document:

- Birds: $5 million
- Fish/Eelgrass: $2.5 million
- Habitat: $4 million
- Recreational Use: $18.8 million

Abbreviations

BCDC	Bay Conservation and Development Commission
BLM	Bureau of Land Management
CBNMS	Cordell Bank National Marine Sanctuary
CCSF	City and County of San Francisco
CDFG	California Department of Fish and Game
CESA	California Endangered Species Act
CEQ	Council on Environmental Quality
CEQA	California Environmental Quality Act
CFR	Code of Federal Regulations
CSLC	California State Lands Commission
CSSC	California Species of Special Concern
CTA	Conditioned Taste Aversion
CWA	Clean Water Act
CZMA	Coastal Zone Management Act
DARP	Damage Assessment and Restoration Plan
DNA	Deoxyribonucleic acid
DOC	United States Department of Commerce
DOI	United States Department of the Interior
EA	Environmental Assessment
EBRPD	East Bay Regional Park District
EFH	Essential Fish Habitat
EIR	Environmental Impact Report
EIS	Environmental Impact Statement
ELER	Eden Landing Ecological Reserve
ESA	Endangered Species Act
ESI	Environmental Sensitivity Index
FLAT	Federal Lead Administrative Trustee
FONSI	Finding of No Significant Impact
FWCA	Fish and Wildlife Coordination Act
GGNRA	Golden Gate National Recreation Area
GFNMS	Gulf of the Farallones National Marine Sanctuary
HEA	Habitat Equivalency Analysis
IBA	Important Bird Area
IEc	Industrial Economics, Inc.
IFO	Intermediate Fuel Oil
LAT	Lead Administrative Trustee
MBNMS	Monterey Bay National Marine Sanctuary
MBTA	Migratory Bird Treaty Act
MMPA	Marine Mammal Protection Act
M/V	Motor Vessel
NCP	National Contingency Plan
NEPA	National Environmental Policy Act
NMFS	National Marine Fisheries Service
NMSA	National Marine Sanctuaries Act
NOAA	National Oceanic and Atmospheric Administration
NOI	Notice of Intent
NPDES	National Pollution Discharge Elimination System
NPFC	National Pollution Funds Center
NPS	National Park Service
NRDA	Natural Resource Damage Assessment
NWR	National Wildlife Refuge
ONMS	Office of National Marine Sanctuaries
OPA	Oil Pollution Act of 1990
PAHs	Polycyclic aromatic hydrocarbons
PEMD	Polyethylene Membrane Devices
PRBO	PRBO Conservation Science (formerly Point Reyes Bird Observatory)

PSRPA	Park System Resource Protection Act
REA	Resource Equivalency Analysis
RFP	Request for Proposals
ROD	Record of Decision
RP	Responsible Party
SBSPRP	South Bay Salt Ponds Restoration Project
SCAT	Shoreline Cleanup and Assessment Team
SFEI	San Francisco Estuary Institute
USDA	United States Department of Agriculture
USFWS	United States Fish and Wildlife Service
UV	ultraviolet light

Common and Scientific Names

Maritime Goldfield (*Lasthenia maritima*)
Pink Sand Verbena (*Abronia umbellata*)
Bull Kelp (*Nereocystis leutkeana*).
Giant Kelp (*Heterostichus rostratus*)
Southern Sea Palm Kelp (*Eisenia arborea*)
Eelgrass (*Zostera marina*)
European Beachgrass (*Ammophila arenaria*)
Rockweed (*Fucus gardneri*)
Widgeon Grass (*Ruppia maritima*)
Pickleweed (*Salicornia* sp.)
California Mussel (*Mytilus californianus*)
Ribbed Mussel (*Guekensia demissa*)
Olympia Oyster (*Ostrea lurida*)
Pink Abalone (*Haliotis corrugata*)
Red Abalone (*Haliotis rufescens)*
Black Abalone (*Haliotis cracherodii)*
Sand Dollar (*Clypeaster subdepressus*)
Inshore Squid (*Loligo opalescens*)
Dungeness Crab (*Metacarcinus magister*)
Bat Ray (*Myliobatis californica*)
Leopard Shark (*Trakis semifasciata*)
California Sardine (*Sardinops caeruleus*)
Northern Anchovy (*Engraulis mordax*)
Pacific Herring (*Clupea pallasii)*
Surf Smelt (*Hypomesus pretiosus*)
Jack Smelt *(Atherinopsis californiensis)*
California Grunion (*Leuresthes tenuis*)
Chinook Salmon (*Oncorhynchus tshawytscha*)
Coho Salmon (*Oncorhynchus kisutch*)
Steelhead (*Oncorhynchus mykiss*)
Inland Silverside (*Menidia beryllina*)
Sheepshead Minnow (*Cyprinodon variegatus*)
Tidepool Snailfish (*Liparis florae*)
Threespine Stickleback (*Gasterosteus aculeatus)*
Jack Mackerel (*Thyrsitops sp.*)
Sablefish (*Anoplopoma fimbria*)
Tidewater Goby (*Eucyclogobius newberryi*)
English Sole (*Parophrys vetulus*)
Petrale Sole (*Eopsetta jordani*)
Sand Sole (*Pegusa lascaris*)
Rockfish (*Sebastes sp.*)
Striped Bass (*Morone lineatus*)
Pacific Sanddab (*Citharichthys sordidus*)
Greenling (*Hexagrammos sp.*)
Lingcod (*Ophiodon elongatus*)
Monkeyface Prickleback (*Cebidichthys violaceous*)
Rock Gunnel (*Pholis gunnellus*)
Dwarf Surfperch (*Micrometrus minimus*)
Striped Surfperch (*Embiotoca lateralis*)

Tidepool Sculpin (*Oligocottus maculosus*)
Cabezon (*Scorpaenichthys marmoratus*)
Starry Flounder (*Platichthys stellatus*)
House Mouse (*Mus musculus*)
Rats (*Rattus* spp.)
Woodrats (*Neotoma* spp.)
Deer Mice (*Peromyscus spp)*
Douglas' Squirrel (*Tamiasciurus douglasii*)
Northern Flying Squirrel (*Glaucomys sabrinus*)
Western Gray Squirrel (*Sciurus griseus)*
Chipmunks (*Tamias spp.*)
Common Raccoon (*Procyon lotor*)
Virginia Opossum (*Didelphis virginiana*)
Ringtail (*Brassariscus astutus*)
Weasels and Mink (*Mustela spp.*)
Fisher (*Martes pennanti*)
Pine Marten (*M. americana*)
Spotted Skunk (*Spilogale gracilis*)
Striped Skunk (*Mephitis mephitis*)
Black Bear (*Ursus americanus*)
Sea Otter (*Enhydra lutris*)
River Otter (*Lontra canadensis*)
Northern Fur Seal (*Callorhinus ursinus*)
Guadalupe Fur Seal (*Arctocephalus townsendi*)
Steller Sea Lion (*Eumetopias jubatus*)
California Sea Lion (*Zalophus californianus*)
Northern Elephant Seal (*Mirounga angustirostris*)
Harbor Seal (*Phoca vitulina*)
Harbor Porpoise (*Phocoena phocoena*)
Dall's Porpoise (*Phocoenoides dalli*)
Pac. White-sided Dolphin (*Lagenorhynchus obliquidens*)
Killer Whale (*Orcinus orca*)
Minke Whale (*Balaenoptera acutorostrata*)
Gray Whale (*Eschrichtius robustus*)
Blue Whale (*Balaenoptera musculus*)
Humpback Whale (*Megaptera novaeangliae*)
Greater White-fronted Goose (*Anser albifrons*)
Brant (*Branta bernicla*)
Canada Goose (*Branta Canadensis*)
Greater Scaup (*Aythya marila*)
Lesser Scaup (*Aythya affinis*)
Surf Scoter (*Melanitta perspicillata*)
White-winged Scoter (*Melanitta fusca*)
Long-tailed Duck (*Clangula hyemalis*)
Bufflehead (*Bucephala albeola*)
Red-breasted Merganser (*Mergus serrator*)
Ruddy Duck (*Oxyura jamaicensis*)
Red-throated Loon (*Gavia stellata*)
Pacific Loon (*Gavia pacifica*)
Common Loon (*Gavia immer*)

Pied-billed Grebe (*Podilymbus podiceps*)
Horned Grebe (*Podiceps auritus*)
Eared Grebe (*Podiceps nigricollis*)
Western Grebe (*Aechmorphorus occidentalis*)
Clark's Grebe (*Aechmorphorus clarkii*)
Short-tailed Albatross (*Phoebastria albatrus*)
Northern Fulmar (*Fulmarus glacialis*)
Ashy Storm-Petrel (*Oceanodroma homochroa*)
Brandt's Cormorant (*Phalacrocorax penicillatus*)
Double-crested Cormorant (*Phalacrocorax auritus*)
Pelagic Cormorant (*Phalacrocorax pelagicus*)
Brown Pelican (*Pelecanus occidentalis*)
Great Blue Heron (*Ardea herodias*)
Black-crowned NightHeron (*Nycticorax nycticorax*)
California Condor (*Gymnogyps californianus*)
Red-shouldered Hawk (*Buteo lineatus*)
Red-tailed Hawk (*Buteo jamaicensis*)
Peregrine Falcon (*Falco peregrinus*)
Clapper Rail (*Rallus longirostris*)
Common Moorhen (*Gallinula chloropus*)
American Coot (*Fulica americana*)
Black-bellied Plover (*Pluvialis squatarola*)
Snowy Plover (*Charadrius nivosus*)
Semipalmated Plover (*Charadrius semipalmatus*)
Killdeer (*Charadrius vociferous*)
Black Oystercatcher (*Haematopus bachmani*)
Black-necked Stilt (*Himantopus mexicanus*)
American Avocet (*Recurvirostra americana*)
Spotted Sandpiper (*Actitis macularius*)
Willet (*Tringa semipalmata*)
Whimbrel (*Numenius phaeopus*)

Long-billed Curlew (*Numenius americanus*)
Marbled Godwit (*Limosa fedoa*)
Black Turnstone (*Arenaria melanocephala*)
Sanderling (*Calidris alba*)
Western Sandpiper (*Calidris mauri*)
Least Sandpiper (*Calidris minutilla*)
Dunlin (*Calidris alpine*)
Red Phalarope (*Phalaropus fulicarius*)
Bonaparte's Gull (*Larus philadelphia*)
Heermann's Gull (*Larus heermanni*)
Mew Gull (*Larus brachyrynchus*)
Western Gull (*Larus occidentalis*)
California Gull (*Larus californicus*)
Herring Gull (*Larus smithsonianus*)
Glaucous-winged Gull (*Larus glaucescens*)
Glaucous Gull (*Larus hyperboreus*)
Parasitic Jaeger (*Stercorarius parasiticus*)
Common Murre (*Uria aalge*)
Pigeon Guillemot (*Cepphas columba*)
Marbled Murrelet (*Brachyramphus marmoratus*)
Xantus's Murrelet (*Synthliboramphus hypoleucus*)
Ancient Murrelet (*Synthliboramphus antiquus*)
Cassin's Auklet (*Ptychoramphus aleuticus*)
Rhinoceros Auklet (*Cerorhinca monocerata*)
Tufted Puffin (*Fratercula cirrhata*)
Gray Jay (*Perisoreus canadensis*)
Steller's Jay (*Cyanocitta stelleri*)
Common Raven (*Corvus corax*)
Fox Sparrow (*Passerella iliaca*)

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1.0 Introduction and Purpose

There are typically four types of claims that are made against responsible parties in an oil spill such as this one:

1. reimbursement for clean-up costs;
2. natural resource damages (including the costs of assessment);
3. fines and penalties under various laws; and
4. third party claims (e.g. such as from commercial fisheries).

This document is only concerned with the second item, natural resource damages.

This Final Damage Assessment and Restoration Plan and Environmental Assessment (DARP/EA) has been prepared by state and federal natural resource Trustee agencies responsible for restoring natural resources[1] and resource services[2] injured by the release of oil from the *M/V Cosco Busan* oil spill occurring in San Francisco Bay on November 7, 2007. This document provides details regarding the injuries and their quantification, restoration planning, and the selected restoration projects to address the injuries. The purpose of restoration, as stated in this Final DARP/EA, is to make the environment and the public whole for injuries resulting from the spill by implementing restoration actions that return injured natural resources and services to baseline conditions and compensate for interim losses.

The United States Fish and Wildlife Service (USFWS), the National Park Service (NPS), the Bureau of Land Management (BLM), the National Oceanic and Atmospheric Administration (NOAA), the California Department of Fish and Game (CDFG), and the California State Lands Commission (CSLC) are Trustees for the natural resources injured by the spill. As a designated Trustee, each agency is authorized to act on behalf of the public under state and/or federal law to assess and recover natural resource damages and to plan and implement actions to restore, rehabilitate, replace, or acquire the equivalent of the affected natural resources injured as a result of a discharge of oil. For purposes of coordination and compliance with the Oil Pollution Act (OPA) and National Environmental Policy Act (NEPA), the USFWS and NOAA are designated as the joint lead federal Trustees.

The Trustees have prepared this Final DARP/EA to inform the public about the natural resource damage assessment (NRDA) and restoration planning efforts that have been conducted following the spill. This document is also an Environmental Assessment (EA) intended to satisfy the Federal Trustees' requirement to evaluate the environmental impacts of the selected restoration projects, and the alternatives considered, under NEPA. As environmental review would be premature for some of the projects in the document,

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[1] Natural resources are defined under the Oil Pollution Act as "land, fish, wildlife, biota, air, water, groundwater, drinking water supplies, and other such resources belonging to, managed by, held in trust by, appertaining to, or otherwise controlled by the United States, any State or local government or Indian tribe, or any foreign government.

[2] Services (or natural resources services) means the functions performed by a natural resource for the benefit of another natural resource and/or the public.

additional review may be required in some instances. This will be determined once recreational use and scoter projects are identified and/or when more detailed engineering design work or operational plans are developed for those projects selected in this DARP/EA are available or when locations are identified.

The Trustees sought comments on the proposed restoration alternatives and the environmental assessment presented in the draft DARP/EA. The Trustees considered comments received during the public comment period before selecting projects and finalizing this DARP/EA. A summary of the public comments and the Trustees' replies are provided in Appendix L.

1.1 Overview of the Incident

On November 7, 2007, the freighter *Cosco Busan* struck the Bay Bridge as it attempted to depart San Francisco Bay. It was en route from the Port of Oakland to Pusan, South Korea. The accident created a gash in the hull of the vessel, causing it to spill 53,569 gallons of Intermediate Fuel Oil (IFO-380) into the Bay, as estimated by the US Coast Guard. This is the bunker fuel that propels the 902-foot container ship. The accident happened at 8:30 am. Oil escaped from the vessel for approximately 53 minutes. After that, the vessel was shifted such that oil could no longer leak. The vessel turned around and anchored off San Francisco. It was repaired at the Port of Oakland and left the Bay on December 20, bound for South Korea and additional repairs. It has since been renamed the *Venezia*.

Wind and currents quickly took some of the oil outside of the Bay, where it impacted the outer coast from approximately Half Moon Bay to Limantour Beach at Point Reyes. Inside the Bay, the oil primarily impacted waters and shoreline within the central portion of the Bay, from Tiburon to San Francisco on the west side and from Richmond to Bay Farm Island and Alameda on the east side.

The movement of the oil was sporadic. Not all of the waters depicted in gray in Figure 1 were necessarily impacted, nor were all of the shorelines. This figure merely illustrates the general location and maximum extent of oil movement.

Clean-up operations recovered an estimated 22,991.5 gallons of oil, both from beaches and from on-water operations in the days immediately after the spill. Dispersants were not used during the response. The remaining 30,577.5 gallons of oil either remains on beaches where it is buried or cannot be removed, washed to sea, or evaporated. Small amounts may be sunken.

Figure 1: Spill Area

1.2 Summary of Natural Resource Injuries

The injuries from the oil spill can be divided into the following categories: birds; mammals; fish; shoreline habitats (including rocky intertidal, salt marsh, tidal flats, and sandy beach habitat); eelgrass beds; and human recreational uses. The injuries to each category are summarized here and presented in greater detail in Chapter 4.

- Birds: 6,849 birds were estimated killed, representing 65 different species. The primary species impacted were diving ducks, grebes, cormorants, and murres. Special status species impacted included Marbled Murrelet and Snowy Plover.
- Mammals: No significant injuries.
- Fish: An estimated 14% to 29% of the winter 2007-8 herring spawn was lost due to widespread egg mortality in some areas of the Bay.

- Shoreline Habitats: 3,367 acres of shoreline habitat were impacted, and recovery is expected to vary from a few months to several years, depending upon the habitat type and degree of oiling.
- Human Uses: Approximately 1,079,900 user-days were lost, representing a wide variety of activities (recreational fishing, general beach use, surfing, etc.).

1.3 Summary of Selected Restoration Projects

The Trustees' authority under OPA (see 33 U.S.C. 2706(b)) is to make the environment and the public whole for injuries to natural resources and natural resource services resulting from the discharge of oil. This must be achieved through the restoration, rehabilitation, replacement, or acquisition of equivalent natural resources and/or services. Thus, for a project to be considered there must be a connection, or nexus, between the natural resource injuries and the proposed restoration actions.

Restoration actions under OPA are termed primary or compensatory. Primary restoration is any action taken to accelerate the return of injured natural resources and services to their baseline condition-- the condition the resource would have been in were it not for the spill. Trustees may elect to rely on natural recovery rather than active restoration where feasible or cost-effective active restoration actions are not available, or where the injured resources will recover relatively quickly without human intervention.

Compensatory restoration is any action taken to compensate for interim losses of natural resources and services pending recovery to baseline conditions. The scale, or amount, of the required compensatory restoration will depend on the extent and severity of the initial resource injury and how quickly each resource and associated service returns to baseline. Primary restoration actions that speed resource recovery will reduce the amount of required compensatory restoration.

The Trustees considered over 25 restoration concepts and alternatives with the potential to provide primary and compensatory restoration. These were evaluated based on selection criteria developed by the Trustees consistent with the legal guidelines provided in the OPA regulations (15 C.F.R. 990.54(a)). Section 4.2.2 presents OPA-based selection criteria developed by the Trustees for this spill. Based on the Trustees' evaluation, and after considering public comment, a total of 12 restoration projects have been selected, including a general category for recreational use projects which have yet to be delineated. These are summarized below and presented in detail in section 4.3.

It is the intent of the Trustees to address all injuries. However, rather than develop separate restoration projects for each wildlife species impacted, the Trustees have grouped the injuries into categories, sometimes combining impacts to similar species. In this way, one restoration project, benefiting a suite of species or one primary species, may address all injuries for that category.

Figures 2 and 3 provide a conceptual guide to the injury categories and the restoration projects that address each injury.

Figure 2: Matching Bird Injury Categories to Restoration Projects

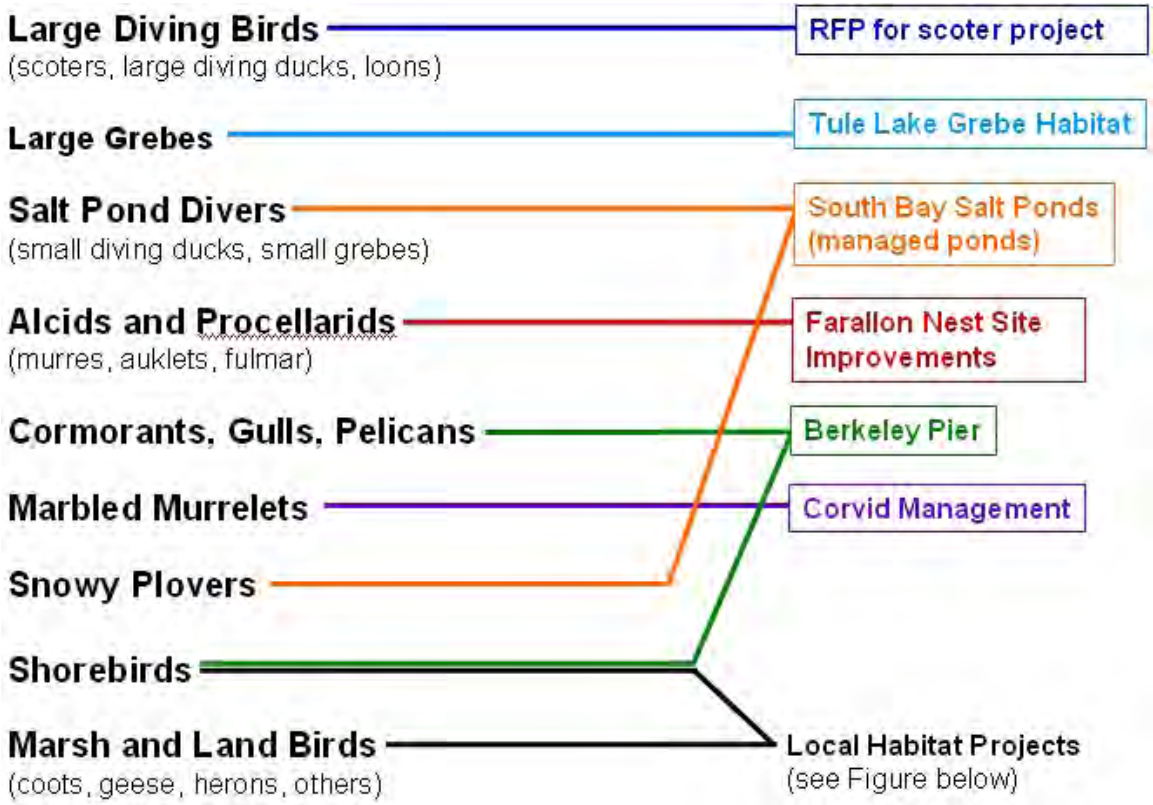
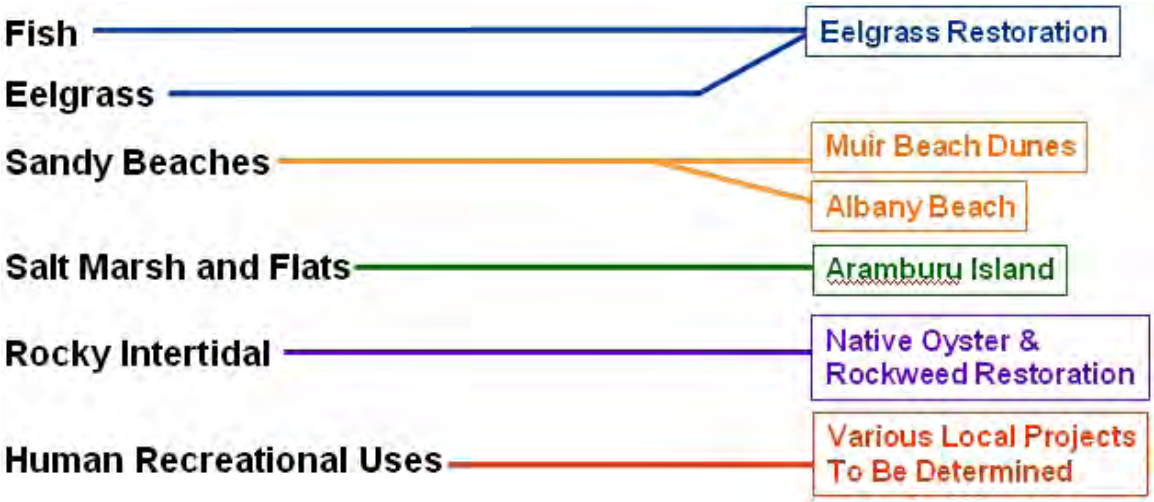


Figure 3: Matching Other Injury Categories to Restoration Projects



In accordance with OPA regulations, all of the selected projects have been "scaled" in size, such that the benefits of the restoration offset the injuries caused by the spill. Summaries of the proposed restoration projects are provided below. More details on the projects are provided in Chapter 4.

PROJECT: ***Request for Proposals for project benefiting Surf Scoters***
BENEFITS: scoters and other large diving ducks
This project will seek proposals and award a grant to one or more projects that will provide benefits to Surf Scoters, the bird species most impacted by the spill.

PROJECT: ***Tule Lake Grebe Habitat***
BENEFITS: Western/Clark's Grebes
This project seeks to create more suitable nesting habitat for Western and Clark's Grebes at Tule Lake National Wildlife Refuge. These species spend the winter in the Bay and along the outer coast. The project primarily involves the managing of water levels in Tule Lake's Upper Sump to create over 500 acres of new freshwater marsh, in which the birds would nest.

PROJECT: ***Winter Diving Duck Habitat at the South Bay Salt Ponds***
BENEFITS: small diving ducks and small grebes
This project complements on-going efforts to restore the South Bay Salt Ponds by maintaining and managing habitat for wintering Lesser Scaup and Eared Grebes, among other species. The same ponds would be managed for Snowy Plover nesting during the summer.

PROJECT: ***Farallon Island Nest Site Improvements***
BENEFITS: Alcids and Procellarids
This project seeks to increase suitable nest sites for seabirds at Southeast Farallon Island. Specifically, it will replace up to 60 Rhinoceros Auklet and 200 Cassin's Auklet nest boxes, and create nest sites for up to 60 pairs of Ashy Storm-Petrels.

PROJECT: ***Berkeley Pier Enhancements***
BENEFITS: pelicans, cormorants, gulls, shorebirds
This project will enhance the dilapidated tip of the Berkeley Pier for cormorant and gull nesting and pelican roosting. It will also enhance another section nearer the base as a high tide roost site for shorebirds.

PROJECT: ***Marbled Murrelet Restoration***
BENEFITS: Marbled Murrelets
This project seeks to restore Marbled Murrelets through a variety of measures, including corvid management. This project may be implemented anywhere in California where there are opportunities.

PROJECT: ***Eelgrass Restoration***
BENEFITS: eelgrass habitat, invertebrates, herring, and other bay fishes
This project will create or expand eelgrass beds at multiple locations inside the Bay. Eelgrass beds are a vital part of the Bay ecosystem, providing benefits to a variety of eelgrass-dependent organisms, as well as herring, which use eelgrass beds for spawning.

PROJECT: ***Muir Beach Dunes Restoration***
BENEFITS: sandy beach habitat
This project will enhance dune vegetation and habitat at Muir Beach by removing non-native vegetation, planting native vegetation, and re-routing pedestrian traffic. It is part of a larger effort to restore Redwood Creek, including the creek, wetlands, lagoon and sand dunes in the Muir Beach area.

PROJECT: ***Albany Beach***
BENEFITS: sandy beach habitat
This project will enhance and expand Albany Beach in the East Bay by removing non-native vegetation, planting native vegetation, and importing more sand, among other activities.

PROJECT: ***Aramburu Island Restoration***
BENEFITS: salt marsh and mud/sand flats
This project seeks to restore tidal marsh and shoreline habitat on Aramburu Island in Richardson Bay. Project elements include rehabilitation of tidal marsh and flats, improvements to upland grassland areas and creation of roost habitat for herons and egrets, and expansion of existing sand and gravel areas for shorebird roosting and to reduce wave erosion.

PROJECT: ***Native Oyster Restoration***
BENEFITS: rocky intertidal habitat
This project will create rocky intertidal habitat by installing hard substrates augmented with oyster shells in low intertidal areas. These provide a substrate for the attachment and development of native oyster community. The hard surfaces will also permit the establishment of algae and any nooks and crevices would harbor small fish and crabs, creating a diverse rocky intertidal community. There will be several project sites within the Central Bay.

PROJECT: ***Rockweed Restoration***
BENEFITS: rocky intertidal habitat
Rockweed habitat in the Central Bay will be created at mid-intertidal elevations using two techniques: seed bags and direct transplant. Some of the proposed sites for rockweed restoration include rocky intertidal habitats heavily damaged by hot water pressure washing. Once established, the rockweed habitat provides shelter for many invertebrates, particularly from desiccation during very low tides.

PROJECT: ***Recreational Use Projects***
BENEFITS: human recreational uses
There will be a suite of local projects to enhance recreational uses. The projects will be located in the East Bay, San Francisco Peninsula, and Marin County, proportional to the levels of lost uses in each region. While this plan does not specify any particular project, it proposes a process, working with local governments and affected users, to select projects.

Under OPA, the responsible party (RP) is liable for the cost of the compensatory restoration projects, as well as the costs incurred by the Trustees to undertake this damage assessment. The Trustees have settled this claim for natural resource damages with the RP for $32.3 million. The following amounts are allocated to fund the projects described in this document:

- Birds: $5 million
- Fish/Eelgrass: $2.5 million
- Habitat: $4 million
- Recreational Use: $18.8 million (see section 4.3.5 for allocation details)

Another $2 million is allocated to cover administrative and oversight costs, but could be used to augment projects if available.

2.0 Environment Affected by the Spill

This section presents a brief description of the physical and biological environment affected by the oil spill. The physical environment includes approximately 200 miles of shoreline from Drakes Bay to Half Moon Bay, including central San Francisco Bay, as well as the Pacific Ocean extending several miles offshore. This section also provides information on the affected environment for the preferred restoration projects within the spill area. Information on the environments for preferred projects outside the spill area is provided along with the project descriptions in section 4.3.

2.1 Physical Environment

The area affected by the spill is rich with marine life and encompasses a wide diversity of protected natural resources, both at sea and along the coast. The at-sea impacted areas include:

- Gulf of the Farallones National Marine Sanctuary
- Point Reyes National Seashore (boundary extends ¼ mile offshore)
- Golden Gate National Recreation Area (boundary extends ¼ mile offshore)
- Monterey Bay National Marine Sanctuary
- Farallon National Wildlife Refuge (where oiled birds came ashore)

Along the mainland coastline, the impacted areas include:

- California Coastal National Monument
- Point Reyes National Seashore
- Golden Gate National Recreation Area (includes portions inside the Bay)
- Duxbury Reef Marine Reserve
- James V. Fitzgerald Marine Reserve
- Mount Tamalpais State Park
- Big Basin Redwoods State Park
- Montara State Beach
- Half Moon Bay State Beach

Inside the Bay, the impacted areas include:

- Alcatraz Island
- Angel Island State Park
- Miller/Knox Regional Shoreline
- Brooks Island Regional Preserve
- Point Isabel Regional Shoreline
- East Shore State Park
- Middle Harbor Shoreline Park
- Crown Memorial State Beach
- San Francisco Maritime National Historical Park
- Fort Point National Historic Site

This region contains a wide range of coastal habitats, including sandy beaches and rocky intertidal areas, open ocean, protected bays, harbors and jetties, offshore rocks, tidal flats, and wetlands. Brief descriptions of the areas affected by the oil spill are presented below. The Gulf of the Farallones National Marine Sanctuary (GFNMS) and the Monterey Bay National Marine Sanctuary (MBNMS) were established in 1981 and 1992, respectively, to protect the thousands of seabirds, sea mammals, fish, and other wildlife off the California coast.

Farallon National Wildlife Refuge is a group of islands located 28 miles west of San Francisco, which was established in 1969 to protect some of the largest colonies of seabirds and marine mammals on the Pacific Coast of North America. The refuge sustains the largest seabird breeding colony south of Alaska and contains 30 percent of California's nesting seabirds. Thirteen species, representing up to 250,000 individuals breed here, including the largest colonies of Brandt's Cormorant, Ashy Storm-Petrel, and Western Gull found anywhere.

California Coastal National Monument, which was designated by Presidential Proclamation in 2000, runs the entire length of the California coast (840 miles) between Oregon and Mexico. It extends 12 nautical miles from the shoreline and encompasses thousands of BLM-administered islands, rocks, exposed reefs, and pinnacles above mean high tide.

Point Reyes National Seashore, which was established in 1962 to protect both the natural and cultural resources within its boundaries, encompasses about 73,000 acres of land and the boundary of the seashore extending ¼ mile offshore. It includes 20,000 acres of coastal and estuarine waters. Point Reyes is the center of one of only five coastal boundary upwelling ecosystems in the world and the only one in North America. Located at the convergence of a number of ocean currents, the adjacent waters are rich in nutrients and support an abundant fishery and associated fauna. The geology of the peninsula and its association with the Pacific Ocean have created unique estuarine environments that have been described as some of the most unspoiled in the United States. Tomales Bay, formed by seismic activity along the San Andreas Fault, is a long narrow bay included within the National Seashore. Much of the area (33,000 acres) is a congressionally designated wilderness area. Drake's Estero, Estero de Limantour, and Abbott's Lagoon are also significant estuarine resources. Drake's Estero has been characterized as possibly the most pristine estuary on the Pacific Coast. The estero is used by numerous avian species, many of which are either state or federally listed. Limantour Estero is a state marine reserve, designated by the California Department of Fish and Game in 1970s. Tomales Bay also harbors tens of thousands of migratory waterfowl and the federally-listed Tidewater Goby. Point Reyes Headland and several large near shore rocky islands along the peninsula support several thousand nesting and roosting seabirds, particularly large colonies of Common Murre, cormorants, Ashy Storm-petrels, and Brown Pelicans.

Golden Gate National Recreation Area (GGNRA) comprises approximately 75,000 acres of coastal lands and waters including the mouth of San Francisco Bay. The legislative boundary of this federal park, which was established in 1972, encompasses the Marin Headlands north of and the ocean shoreline south of the Golden Gate, shorelines within

Golden Gate straights, and Alcatraz Island. Alcatraz supports several species of nesting and roosting seabirds and waterbirds, including Brown Pelicans. Rodeo Lagoon also harbors migratory waterfowl and the Tidewater Goby. San Francisco Maritime National Historical Park, located within San Francisco's Fisherman's Wharf neighborhood, is the location for the Hyde Street Pier and its many historic ships including six National Historic Landmark vessels including the 1886 square-rigger *Balclutha*. The park boundary encompasses the national historic landmark, Aquatic Park Historic District, and includes a heavily used boating and swimming lagoon.

In addition to these areas, numerous other federal, state, and local parks dot the coastline within the impacted area, many with a rich or unique array of natural resources. These include Mount Tamalpais State Park, Duxbury Reef and Fitzgerald Marine Reserves, and several state beaches.

The dominant oceanic current within the affected environment is the California Current, which flows southward from Alaska to Mexico. During the year, several oceanic phenomena affect this current, including the northward-flowing Davidson Counter Current prevailing during the winter, upwelling processes, local gyres and eddies, and tidal exchanges with San Francisco and Monterey Bays. The average annual ocean surface temperature is 55° F.

The three distinct ocean seasons along the central California coast are the oceanic period (July-October), the Davidson Current period (October- March), and the upwelling period (March/April-August). The oceanic period is the season in which the California Current dominates the circulation pattern. This period is characterized by low temperature, low salinity, high-nutrient, and highly oxygenated sub-arctic water. The Davidson Counter Current carries oxygen-poor, nutrient-rich waters that are characteristically warmer and more saline than the California Current. Low temperatures, high salinities, and high nutrient levels usually characterize coastal upwelling. This process increases primary productivity of surface waters by supporting large phytoplankton blooms. Rich zooplankton and fisheries production ensues.

The coastal terrestrial landscapes are equally significant, diverse, and rare, representing a high degree of endemism. They include such diverse vegetation alliances as active coastal fore dunes, coastal terrace prairie, and northern coastal salt marsh.

2.2 Biological Environment

The affected area has one of the most diverse and abundant assemblages of marine organisms in the world. A rich array of habitats─including the open ocean, rugged rocky shores, sandy beaches, lush kelp forests, and wetlands─support large numbers of seals and sea lions, whales, fish stocks, otters, and seabirds. The environment is home to, or a migration corridor for, at least 36 species of marine mammals, 94 species of seabirds and waterbirds, 400 species of fish, 4 species of sea turtles, 31 phyla of invertebrates, and over 500 species of marine algae. Other species in the impacted area include the Sea Otter, Gray Whale, Blue Whale, Humpback Whale, Market Squid, Brown Pelican, California Coho Salmon, rockfish, commercial sea urchin, and Giant Kelp. For many

migratory species, such as the whales, seals, salmonids, and Brown Pelicans, the affected area is also an important link to other habitats beyond their boundaries.

Marine Mammals

Thirty-six species of marine mammals have been observed in the affected area, including six species of the sub-order pinnipedia (seals and sea lions), two species from the sub-order fissipedia (Sea Otter and River Otter), and twenty-eight species of the order cetaceans (whales and dolphins).

Point Reyes and the Farallon Islands are important pinniped breeding sites in the area and the most important pinniped rookeries and resting areas in central and northern California. The five species of pinnipeds considered common within the affected area include California Sea Lions, Steller Sea Lions, Northern Elephant Seals, Northern Fur Seals, and Pacific Harbor Seals. An additional species, the Guadalupe Fur Seal, has been documented on the Farallon Islands and at Point Reyes.

In any season, California Sea Lions are the most abundant pinniped in the area (Bonnell et al. 1983, Keiper et al. 2005). They breed farther south along the coast in the summer and then migrate northward, reaching their greatest numbers in central California in autumn. Sea lions haul out on offshore rocks and islands. Both haul-out sites and foraging grounds are essential to the species' health. In contrast, the Steller Sea Lion, a federally-listed species, is declining in the region and currently breeds at the Farallon Islands (Sydeman and Allen 1999). Historically, Steller Sea Lions bred at Point Reyes. But since the 1970s their numbers have diminished significantly. Reasons for their decline are unclear but may be a combination of exposure to pollutants, disease, decreases of favored prey such as salmonids and sardines, and competition with California Sea Lions.

Northern Elephant Seals breed in the winter months and then disperse to feed in pelagic waters throughout the eastern North Pacific and Alaskan waters. The population returns to the terrestrial colony later in the year to undergo an annual molt. Peak abundances occur on land in the spring when juveniles and females haul out to molt. The largest populations are on Año Nuevo Island, the adjacent mainland point, and at Point Reyes Headland. The winter population of Northern Elephant Seals on land during the breeding season exceeds 2,000 at Point Reyes (S. Allen pers. com.).

Pacific Harbor Seals are year-round residents in the area. They haul out at dozens of sites along the coast and within San Francisco Bay. Peak abundance on land is reached in late spring and early summer when they haul out to give birth to pups, breed, and molt. Favorite haul-out sites in the outer coast are isolated sandy beaches and rocky reef areas exposed at low tide. Harbor seals also use the estuarine habitats of Drake's and Limantour Esteros. More than 20 percent of the breeding population of harbor seals in the state of California occurs at Point Reyes, accounting for around 7,000 seals (Sydeman and Allen 1999, Allen et al. 2004).

Northern Fur Seals can be found in the open waters in winter and spring. They feed offshore after migrating from the Pribilof Islands in Alaska and the Channel Islands off southern California. The greatest density of individuals is found well offshore over the

continental slope in waters from 100 to 1,000 fathoms (200 to 2,000m) deep. Northern Fur Seals have a declining population currently estimated to be 1.2 million animals. Many causes have been attributed to this decline, including entanglement in marine debris and competition with commercial fisheries. This species has been proposed for designation as a depleted species by NOAA. Northern Fur Seals regularly haul out on the Farallon Islands and have pupped on the island every year since 1996. Fur seals also occasionally haul out at Point Reyes.

Approximately 20 species of whales and dolphins have been sighted within the affected areas. Ten species are seen regularly and of these, the Killer Whale, Minke Whale, Harbor Porpoise, Dall's Porpoise, and Pacific White-sided Dolphin are considered year-round "residents." The affected area also lies on the migratory pathway of the Gray Whale and other large baleen whales. More than a third of the world's cetacean species occur off San Francisco Bay and Point Reyes. Of particular note are Gray Whales that migrate close to shore and forage within the waters of Point Reyes and around the Farallon Islands. Blue and Humpback Whales are also common and are annually seen foraging in the region.

Seabirds

Marine habitats along the affected coast are among the most productive in the world as evidenced by the numbers of seabirds supported year-round. These populations forage in nearshore waters within the GFNMS, Cordell Bank National Marine Sanctuary (CBNMS) and MBNMS and are highly dependent on the productive waters of the three sanctuaries, and in the nearshore waters of Point Reyes National Seashore and GGNRA (Veit et al. 1996, Ford et al. 2004). The Farallon Islands, a National Wildlife Refuge surrounded by the waters of GFNMS, support the largest concentrations of breeding marine birds in the continental United States (Ainley and Boekelhide 1990). The islands support a diverse nesting community of 13 species, including nearly 100,000 breeding pairs of Common Murres, the species most heavily impacted by the oil spill. The populations of Brandt's Cormorants, Ashy Storm-Petrels, and Western Gulls breeding on the Farallones are the largest for these species worldwide; although, in recent years a large population of Brandt's Cormorants has begun breeding at Alcatraz Island in San Francisco Bay. The Ashy Storm-Petrel reaches the northern limit of its breeding range on the Farallones and Bird Rock off Point Reyes (Ainley and Boekelheide 1990, Ainley 1995). Rhinoceros Auklets disappeared from the Farallones in the 1860s, but re-colonized and began breeding in the 1970s (McChesney and Whitworth 1995). In addition the island supports breeding colonies of Cassin's Auklets and Tufted Puffins.

Several significant seabird colonies occur along the mainland as well, including one of the largest concentrations of Common Murres in California at Point Reyes. Eleven known seabird species nest at Point Reyes, but a much larger number of seabirds, shorebirds and waterbirds (nearly 200 species) forage in the area, including two federally- and state-listed species: the Marbled Murrelet and the Short-tailed Albatross. The Western Snowy Plover, a federally-listed shorebird, also breeds at Point Reyes and on several beaches along the San Mateo County coast. Several Species of Special Concern also nest at Point Reyes, including Rhinoceros Auklets, Ashy Storm-Petrels, and Tufted Puffins.

Many seabird species use the affected area for foraging and during migrations from their nesting areas. These include waterfowl (e.g., scoters), loons, grebes, various Procellarids, Brown Pelican, various gulls, various shorebirds (such as Red Phalarope), and various alcids (e.g., Ancient Murrelet). These species that migrate through or winter within the affected area nest around the Pacific Rim, including Alaska, Canada, Baja California, and New Zealand.

San Francisco Bay is a critically important site for migratory waterfowl and shorebirds along the Pacific Flyway. Over one million waterbirds use the Bay and adjacent habitats each winter. San Francisco Bay is considered a site of Hemispheric Importance by the Western Hemisphere Shorebird Reserve Network and is one of the most important sites for wintering diving ducks on the Pacific Flyway.

The American Bird Conservancy recognized Point Reyes as one of 100 Globally Important Bird Areas (IBA) in the world for bird diversity. Populations of some species of seabirds are among the most abundant of western North American, south of the Aleutians (Carter et al. 1995). Both Bolinas Lagoon and Tomales Bay were designated as Wetlands of International Importance under the United Nations Educational, Scientific, and Cultural Organization's Convention on Wetlands (known as Ramsar) because of their significance to migratory waterfowl and shorebirds.

Fish

Fish within the affected area are diverse and abundant, making them a significant resource. Generally, the area exhibits the very rich cold-water fish fauna of the Oregonian province (Briggs et al. 1987). The same environmental factors that determine the distribution, abundance, and species composition of the other living resources of the area also affect the fish communities.

Approximately 400 species of fish are found within the affected area. The diverse habitats of the area each have their own characteristic assemblage of fishes. Fishes of the near shore subtidal habitats exhibit the greatest diversity. This habitat includes many commercially important fishes such as the pelagic schooling species (Northern Anchovy, Pacific Herring, Jack Mackerel, and California Sardine), the large predators (King or Chinook salmon, Sablefish, sharks), and some demersal species (English and Petrale Sole). Many important species of rockfish are found over rocky reefs, and federally-listed California coastal Chinook, Central California Coast Coho Salmon, and Steelhead can all be found within the boundaries of the affected waters.

Small pelagic species, such as California Grunion and smelt, use sandy intertidal habitat of Tomales Bay and San Francisco Bay for spawning. Other species that forage near sand flats include surfperch, Striped Bass, Jacksmelt, Sand Sole, Pacific Sanddab, and Starry Flounder. Most of the finfish found in shallow rocky reefs are also common in kelp beds. The kelp canopy, stips, and holdfasts increase the available habitat for pelagic and demersal species and offer protection to juvenile finfish. Greenling, Lingcod, and numerous species of rockfish are the dominant fishes.

The rocky intertidal habitat is characterized by a rather small and specialized group of fish adapted for life in tide pools and wash areas. The most representative species are the

Monkeyface Prickleback, Rock Gunnel, Dwarf Surfperch, juvenile cabezon, sculpins, and blennies.

Few fishes live year-round in sloughs and estuaries although some fish such as the Tidewater Goby and the Threespine Stickleback depend upon the more brackish upper reaches of the estuarine habitats. Full time residents such as the Staghorn Sculpin and the bay pipefish depend upon the mud, eelgrass and other microhabitats to feed, reproduce and hide from predators. Mid-water swimmers such as the northern anchovies, Pacific Herring, Topsmelt and Jacksmelt also use the area for feeding while simultaneously using the microhabitats for protection from predators. Large marine predators such as Bat Rays and Leopard Sharks forage extensively on the benthic fauna of the more saline lower reaches of the estuaries. Sardines were the basis for an extensive fishery in the 1930s. Overfishing in combination with environmental factors caused stocks of the Pacific sardine to decrease until the fishery collapsed in the late 1950s.

Point Reyes supports a diverse and abundant assemblage of marine fish and crustaceans, several of which also have state or federal protection, including about eight species such as California Freshwater Shrimp, Coho Salmon, and Steelhead Trout. A recent inventory documented over 170 species of fish in the park waters that extend ¼ mile offshore and include estuaries (NPS 2005). There are also numerous important commercial and sport fish and shellfish including about 20 species of rockfish, Pacific Herring, Dungeness Crab, and Pink Abalone, and Red Abalone. Within the boundary of the park there are numerous commercial oyster operations at Tomales Bay and Drake's Estero.

Algae

Large marine algae, or seaweeds, are diverse and abundant within the affected area. The extent of this diversity is shown by the presence of over 500 of the 669 species of algae described for California (Abbott and Hollenberg 1976). The area has the largest marine flora of the temperate northern hemisphere, with numerous endemic species and the only population of one large understory kelp between southern California and Canada.

The seaweeds within the Bay and of the Gulf of the Farallones region and Monterey Bay area are composed of three main phyla: Red Algae (Division *Rhodophycota*), Brown Algae (Division *Phaeophycophyta*), and Green Algae (Division *Chlorophycota*). They occur primarily in areas of rocky substrate and only rarely in water deeper than 40 m (Abbott and Hollenberg 1976). The most extensive offshore algal communities are dominated by forests of Bull Kelp.

In addition to the marine and coastal types of algae, the estuary and slough habitats provide sheltered areas for an abundant growth of marine algae as well as specifically adapted vascular plants, such as eelgrass, pickleweed, and widgeon grass. These in turn provide rich micro-habitats for other organisms, and some species are dependent on them such as Black Brant and Pacific herring on eelgrass beds.

Fauna of Sandy and Rocky Shoreline Habitats

Sandy beaches are the dominant intertidal habitat within the affected area. This is a very dynamic habitat, particularly along the outer coast, with constantly shifting sands caused by wave action. Most animals capable of tolerating the stresses of the intertidal area are

burrowing organisms. The overall productivity of this habitat is lower than that for rocky intertidal habitats (Nybakken 1982).

Polychaete worms, bivalve mollusks, and crustaceans, including sand or mole crabs, are the predominant invertebrates on sandy beaches along the outer coast. Sand Dollars and gastropod mollusks are also found here (Wilson 1986). The only fishes that are common are those that use sandy beaches for spawning (e.g., the Surf Smelt). In addition, other fish species such as Barred Surfperch can be found in the surf zone. Benthic diatoms are the only marine algae that may be present and growing within this habitat, although kelp beds may be common in subtidal habitats just offshore from sandy beaches. However, drift algae may accumulate on some sandy beaches, providing refuge and food for amphipods, insects, and shorebirds. Sandy beaches are important winter foraging habitat for migratory shorebirds and nesting habitat for the Western Snowy Plover. Peregrine Falcons nest along numerous rocky shoreline areas in the region including around Muir Beach, the Golden Gate and Tomales Point.

Rocky intertidal habitats are highly productive, diverse environments and are located throughout the affected area between the lowest and highest tidal level. Organisms living in this area must be able to withstand periodic desiccation, high temperature and light, low salinities, and along the open coast, strong wave action (Nybakken 1982). Variation in the degree of exposure to these environmental factors can create marked zonation patterns within this habitat (Foster et al. 1988). Marine plants are primarily red, brown, and green algae. The invertebrates include mostly sessile species such as mussels, barnacles (Infraclass *Cirripedia*), and anemones (Order *Actiniaria*). Mobile grazers and predators include crabs (Order *Decapoda*), amphipods (*Stygobromus sp.*), littorine snails (Class *Gastropoda*), limpets (Subclass *Streptoneura*), sea stars (Subclass *Asteroidea*), and sea urchins. Tidepool fishes include the Striped Surfperch, Tidepool Sculpin, and Tidepool Snailfish.

Within the Central Bay, there is an east-west gradation in the types of species, with areas nearest the Golden Gate straits having species of marine origin whereas eastern portions of the bay include more brackish tolerant species (Silva 1979). The majority of rocky shorelines in the Central Bay include seawall and riprap structures although many of the older riprap shorelines such as at Fort Point have high species diversity, with 159 taxa documented by Moss Landing Marine Labs (Foss 2008). Although rarer, natural rocky outcrops are present along the Richmond shoreline as part of East Bay Regional Park. Most of the rocky shorelines within the Central Bay support rockweed, bay or California mussels (*Mytilus* spp.) mid-intertidal red algae (such as *Ceramium* spp.), and barnacles (such as *Chthamalus dalli*).

Fitzgerald Marine Reserve supports one of the largest intertidal reefs in California, supporting an extremely diverse and abundant array of invertebrate species. California Department of Fish and Game, federal agencies (NOAA and NPS), and the Partnership for Interdisciplinary Studies of Coastal Oceans maintain numerous intertidal monitoring stations throughout the study area, some of which have been monitored for over 30 years.

2.2.1 Threatened and Endangered Species

There are several species known to be impacted by the spill that are of special concern due to their population status. The various federal and state levels of special-status designations include:

- Federally Endangered
- Federally Threatened
- State Endangered
- State Threatened
- State Fully Protected Species
- California Species of Special Concern (pursuant to the 2008 list)

The federal Endangered Species Act (ESA) of 1973 (16 USC Section 1531 *et seq*.) and the California Endangered Species Act (CESA) of 1970 (Ca. Fish and Game Code Section 2050 *et seq*.) direct the protection and conservation of listed endangered and threatened fishes, plants, and wildlife. The habitat of endangered, threatened, and rare species takes on special importance because of these laws, and the protection and conservation of these species requires diligent management. Three state- and/or federally-listed species were impacted by the spill: the California Brown Pelican, the Western Snowy Plover, and the Marbled Murrelet. The California Brown Pelican has been delisted by both the state and federal governments since the spill.

Several other state- and/or federally-listed sensitive species are found in the affected area. These species are not thought to have been affected by the spill either because they were not present in the area due to migration patterns or because of low overall population density or regional scarcity. These species include the Short-tailed Albatross, the Peregrine Falcon (recently federally delisted), the California Least Tern, the Xantus's Murrelet, the Southern Sea Otter, the Steller Sea Lion, Guadalupe Fur Seal, the Blue, Fin, and Humpback Whales, Coho Salmon, and Steelhead. In addition, the oil spill is not thought to have affected Tidewater Goby which reside in Rodeo Lagoon.

Additionally, the North American Waterbird Conservation Plan (Kushlan et al. 2002), supported by NOAA and the USFWS, assigns "categories of conservation concern" for all colonial or semi-colonial species. The National Audubon Society also has evaluated bird population status and trends and has developed a "watchlist," in which the most vulnerable species are on the "red list" and less vulnerable species are on the "yellow list" or "green list." Table 1 below lists species impacted by the oil spill and their special status or level of concern on the various lists at the time of this writing.

Table 1: Special Status Species Impacted by the Spill

SPECIES	FEDERAL STATUS	STATE STATUS	CATEGORY OF CONSERVATION CONCERN	AUDUBON WATCHLIST STATUS
Eared Grebe			Moderate	
Western/Clark's Grebe			Moderate	Yellow List
Northern Fulmar			Moderate	
Brown Pelican		Fully Protected	Moderate	
Brandt's Cormorant			High	
Pelagic Cormorant			High	
Western Snowy Plover	Threatened	CSSC	Not evaluated	Yellow List
Bonaparte's Gull			Moderate	
California Gull			Moderate	
Common Murre			Moderate	
Pigeon Guillemot			Moderate	
Marbled Murrelet	Threatened	Endangered	High	Yellow List
Ancient Murrelet			High	Yellow List
Cassin's Auklet		CSSC	Moderate	
Black-crowned Night Heron			Moderate	

Notes: CSSC = California Species of Special Concern. Category of Conservation Concern refers to the status assigned by the North American Waterbird Conservation Plan. Those species considered under that plan as "Low Concern" or "Not currently at risk," and with no other special status, are not included above.

2.3 Archeological and Cultural Resources

Humans settled in the vicinity of the affected environment at least 10,000 years ago. At the time of Spanish arrival in the early 1700s, about 40 Native American tribes populated the coastal areas. The size of coastal middens suggests that Native Americans were the principal controllers of animal population sizes in the intertidal zone in some areas. The Spanish, the first European settlers, arrived in the late 1700s, and began to exploit local marine resources by hunting Sea Otters and harvesting abalone for trade with northwest coast Native Americans.

Many shipwrecks along the outer coastline are a result of significant maritime exploration and trade coupled with a coastline dotted with shallow, rocky headlands that are largely exposed to prevailing winds and storms. More than 100 shipwrecks have been documented in this region, and there are undoubtedly more that are unrecorded. Some of the most significant shipwrecks of North America are in the region, including the Spanish galleon *San Augustin* that sank in 1592 at Point Reyes.

Today, San Francisco Maritime National Historical Park is a heavily visited unit of the National Park System located just west of Fishermen's Wharf in San Francisco. The park includes Hyde Street Pier, a visitor center, the Aquatic Park Bathhouse Building, and the Aquatic Park Historic Landmark District along the waterfront including Aquatic Park Beach and Lagoon, and Municipal Pier.

Hyde Street Pier was built in 1922 for automobile ferries between San Francisco and Sausalito. The ferry route was part of U.S. 101 until the Golden Gate Bridge opening in

1927. A number of historic vessels are moored at the pier and open to the public. Five vessels - *Alma, Balclutha, Eureka, Hercules*, and *C.A. Thayer* - are designated National Historic Landmarks.

2.4 Recreational Services

San Francisco Bay and its shorelines are well known for their recreational opportunities, with their dramatic skyline, bridges, and fog banks providing one of the most recognizable and stunning urban and natural landscapes in the world. Activities range from dog-walking, strolling, bicycling, and general beach use to specialized skills such as surfing, wind-surfing, kite-boarding, open water swimming, and sailing. Recreational fishing from piers, jetties, and boats is also common. Special events range from triathlons to regattas. The Golden Gate Bridge, Fisherman's Wharf, and Alcatraz Island are internationally known tourist destinations.

The outer coast is well known for its scenic rocky coastline, open sandy beaches, and picturesque coves. Because much of the San Mateo and Marin County coast is undeveloped, many of these beaches have a remote, wild feeling. At the same time, Highway 1 and ample parking lots and pull-outs provide easy public access. These beaches host a wide range of recreational activities, including general beach use, hiking, biking, fishing, surfing, camping, wildlife viewing, horseback riding, and other specialized uses. Campgrounds are located near several beaches in Half Moon Bay and in Marin County. Some of the beaches are characterized by the remote locations and/or rugged beauty (e.g., Limantour Beach in Marin County and various cove beaches along the San Mateo County coastline), while others are located near urban areas and receive considerable beach use (e.g., Ocean Beach, Rodeo Beach, Stinson Beach).

3.0 Coordination and Compliance

3.1 Federal and State Trustee Agencies

The CDFG, CSLC, NOAA on behalf of the US Department of Commerce (DOC); and the USFWS, NPS, and BLM, on behalf of the US Department of the Interior (DOI), are the state and federal trustee agencies (Trustees) who are addressing the natural resources injured by the spill. NOAA, USFWS, NPS, and BLM are designated Trustees for natural resources pursuant to subpart G of the National Oil and Hazardous Substances Pollution Contingency Plan (NCP) (40 CFR § 300.600 et seq.) and Executive Order 12580 (3 CFR, 1987 Comp. p. 193, 52 Fed. Reg. 2923 (January 23, 1987) as amended by Executive Order 12777 (56 Fed. Reg. 54757 (October 19, 1991)). CDFG has been designated as a state trustee for natural resources pursuant to Section 1006(b)(3) of the OPA and has state natural resource trustee authority pursuant to Fish and Game Code §§ 711.7 and 1802 and the Lempert-Keene-Seastrand Oil Spill Prevention and Response Act (Government Code § 8670.1 *et seq*.). The CSLC is participating as a Trustee pursuant to its jurisdiction under California state law over all state sovereign lands, including ungranted tidelands and submerged lands. As a designated Trustee, each agency is authorized to act on behalf of the public under state and/or federal law to assess and recover natural resource damages and to plan and implement actions to restore, rehabilitate, replace, or acquire the equivalent of the affected natural resources injured as a result of a discharge of oil.

3.2 Coordination

3.2.1 Coordination among the Trustees

Federal regulations implementing OPA provide that where an oil spill affects the interests of multiple Trustees, they should act jointly to ensure that full restoration is achieved without double recovery (15 CFR § 990.14(a)). The Trustees in this matter have worked together closely in a shared effort to fully assess the nature and extent of injuries to natural resources and plan appropriate actions to restore the injured resources.

At the beginning of the NRDA, the Trustees jointly designated CDFG as the Lead Administrative Trustee (LAT) to act as coordinator pursuant to 15 CFR § 990.14(a)(1). In addition to coordinating amongst themselves, the Trustees also coordinated NRDA activities with other affected entities, including the City and County of San Francisco (CCSF), the East Bay Regional Parks District (EBRPD), and other local municipalities (e.g., Alameda County, Contra Costa County, Marin County and San Mateo County).

3.2.2 Coordination with Response Agencies

Pursuant to 15 CFR § 990.14(b), the Trustees coordinated with state and federal response agencies on activities conducted concurrently with response operations and in a manner consistent with the NCP. Specifically, this coordination concerned the locations and levels of health and safety training and briefing by NRDA field teams.

3.2.3 Coordination with the Responsible Party

The OPA NRDA regulations provide in pertinent part that Trustees must invite the RPs to participate in the NRDA (15 CFR § 990.14(c)); however, the regulations give the Trustees broad discretion to determine the nature and extent of participation. The regulations also encourage the Trustees to enter into binding agreements with RPs to facilitate their interactions, resolve disputes related to the assessment, and promote cost-effectiveness.

In this case, the Trustees extended such an invitation to the RPs within days of the Incident, and the RPs accepted. Thereafter, the Parties established an active cooperative assessment process by which Trustee representatives would coordinate studies and other technical activities in the injury determination and quantification stages of the assessment with representatives of the RP. Biologists, economists, toxicologists, and other specialists representing the Trustees formed technical working groups that included RP specialists and cooperatively developed work plans that were used to guide injury assessment activities. The parties then cooperatively designed and executed various injury studies and gathered, shared, and analyzed data and other information regarding injuries to various species and habitats and loss of use and enjoyment of natural resources by the public.

These technical specialists also gathered and discussed information regarding potential actions that would restore injured species and habitats and compensate the public. Consultants were employed by both sides to assist with certain issues requiring specialized expertise not possessed by representatives of the Trustees or RPs.

The Parties also considered a written agreement, as suggested by 15 CFR § 990.14(c)(3). The Trustees provided a draft agreement to the RPs; however, the Parties did not reach agreement on certain terms of the document, and the task was ultimately deferred.

This DARP/EA, while prepared solely by the Trustees, reflects consideration of the input provided by technical representatives of all parties.

3.2.4 Coordination with the Public

Throughout the NRDA process, the Trustees have made information available to the public. The Trustees held public meetings in Oakland and Mill Valley shortly after the oil spill in January 2007 and published a series of fact sheets to keep the public up to date on the progress of the NRDA.

The Trustees also sought the public's input on a draft version of this document. Public review of the Draft DARP/EA occurred between September 19 and October 31, 2011 and included two public meetings, a press release, an email announcement to over 900 individuals, and a two-page newsletter and a 3 ½ minute YouTube video that summarized the Draft DARP/EA. This was an integral component of the restoration planning process because public input helps inform the Trustees' decisions regarding the selection of appropriate restoration. It was also required pursuant to Section 1006(c)(5) of OPA (33 USC § 2706(c)(5)). The public comments are available in the Administrative Record

(described below). The Trustees responses to the comments are in Appendix L.

After considering the public comments, the Trustees modified this document in a number of ways (detailed in Appendix L), most significantly the section regarding restoration for Marbled Murrelets. The Trustees sought additional public comment on these changes, with public review occurring between December 28, 2011 and January 27, 2012.

In addition, the Trustees published a Notice of Intent (NOI) to Conduct Restoration Planning, pursuant to 15 CFR § 990.44, and concurrently opened an Administrative Record in compliance with 15 CFR § 990.45. The Record includes documents relied upon or considered by the Trustees during the assessment and restoration planning process.

The Administrative Record is available at
http://www.dfg.ca.gov/ospr/Science/cosco_busan_spill.aspx

It is also on file at:

California Department of Fish and Game
Office of Spill Prevention and Response
1700 K Street, Suite 250
Sacramento, CA 95814

Arrangements may be made to review the Administrative Record by contacting Steve Hampton by telephone at (916) 323-4724.

3.3 Compliance with Environmental Laws, Regulations, and Policies

3.3.1 The Oil Pollution Act

OPA, Title 33 USC § 2701 *et seq*. (OPA), establishes a liability regime for oil spills into navigable waters or adjacent shorelines that injure or are likely to injure natural resources and/or the services that those resources provide to the ecosystem or humans. Pursuant to OPA, federal and state agencies and Indian tribes may act as Trustees on behalf of the public to assess the injuries, scale restoration to compensate for those injuries, and implement restoration. The DARP/EA has been prepared jointly by the USFWS, NPS, NOAA, CDFG, and CSLC. As described above, each of these agencies is a designated Trustee for natural resources injured by the Spill. OPA defines "natural resources" to include land, fish, wildlife, water sources, and other such resources belonging to, managed by, held in trust by, appertaining to, or otherwise controlled by the United States, any State or local government or Indian tribe, or any foreign government. Assessments are intended to provide the basis for restoring, replacing, rehabilitating, and/or acquiring the equivalent of injured natural resources and services. OPA authorizes the Trustees to assess damages for injured natural resources under their trusteeship. OPA further instructs the designated Trustees to develop and implement a plan for the

restoration, rehabilitation, replacement, or acquisition of the equivalent of the injured natural resources under their trusteeship.

The regulations for natural resource damage assessments under OPA are found at 15 CFR Part 990. These regulations provide the Trustees with guidelines on processes and methodologies for carrying out an NRDA, including guidelines for conducting assessments cooperatively with the RPs. While the decision whether or not to follow the NRDA regulations is left to the discretion of the Trustees, OPA provides that if the Trustees conduct the NRDA in accordance with the regulations, their determination or assessment of damages to natural resources will have the force and effect of a rebuttable presumption in an administrative or judicial proceeding under OPA (33 USC. § 2706(e)(2). In this case, the Trustees conducted the assessment in accordance with the regulations.

3.3.2 National Marine Sanctuaries Act, 16 USC. § 1431, et seq.

The National Marine Sanctuaries Act (NMSA) authorizes the Secretary of Commerce (Secretary) to designate and manage areas of the marine environment with special national significance due to their conservation, recreational, ecological, historical, scientific, cultural, archeological, educational, or esthetic qualities as national marine sanctuaries. Day-to-day management of national marine sanctuaries has been delegated by the Secretary to the Office of National Marine Sanctuaries (ONMS). The primary objective of the NMSA is to protect marine resources, such as coral reefs, sunken historical vessels or unique habitats.

The NMSA prohibits the destruction, loss of, or injury to any sanctuary resource. The Secretary is required to conduct such enforcement activities as are necessary and reasonable to carry out the Act. The Secretary may issue special use permits which authorize specific activities in a sanctuary to establish conditions of access to and use of any sanctuary resource or to promote public use and understanding of a sanctuary resource. The NMSA also establishes, similar to OPA, liability for response costs and natural resource damages for injury to sanctuary natural resources.

In this case, the ONMS participated as part of the Trustee group to identify and quantify injuries to Sanctuary resources concurrently with similar work being conducted under OPA. The Sanctuaries impacted by the spill include the CBNMS, the GFNMS, and the MBNMS.

In addition to participating in the injury assessment, the ONMS also participated in restoration planning, identifying appropriate restoration projects to compensate for injuries to Sanctuary resources. This coordination will continue for restoration projects that have the potential to affect resources within a sanctuary.

The NMSA does not contain public participation requirements like OPA; however, since certain Sanctuary resource injuries in this case are also compensable under OPA, they are dealt with concurrently in this document.

3.3.3 Park System Resource Protection Act, 16 USC. 19jj

The Park System Resource Protection Act (PSRPA), 16 USC. 19jj, authorizes the Secretary of the Interior to assess and monitor injuries, and to seek damages for injuries to resources located within the boundaries of an NPS unit. A "park system resource" is defined by the PSRPA as "any living or nonliving resource that is located within the boundaries of a unit of the National Park Service…." Like OPA and the NMSA, the PSRPA specifically allows the Secretary to seek response costs and damages from the responsible party causing the destruction, loss of, or injury to park system resources.

In this case, the NPS participated as part of the Trustee group to identify and quantify injuries to park system resources, and the loss of their use, concurrently with similar work being conducted under OPA. The NPS units impacted by the spill include Golden Gate National Recreation Area (which includes Alcatraz Island and Fort Point National Historic Site, among many other well known and popular shoreline destinations), Point Reyes National Seashore, and San Francisco Maritime National Historic Park.

In addition to participating in the injury assessment, the NPS also participated in restoration planning, identifying potential restoration projects to compensate for injuries to park system resources. This coordination will continue for restoration projects that have the potential to affect resources within a NPS unit and to address the lost human use that occurred within the National Park System boundaries.

The PSRPA does not contain public participation requirements like OPA; however, since certain park system resource injuries in this case are also compensable under OPA, they are dealt with concurrently in this document.

3.3.4 The National Environmental Policy Act

NEPA, 42 USC 4321, et seq.; 40 CFR Parts 1500-1508, is the basic national charter for the protection of the environment, and it sets forth a specific process of impact analysis and public review for federal agency actions that may significantly affect the environment. Its purposes are to "encourage productive and enjoyable harmony between man and the environment; to promote efforts which will prevent or eliminate damage to the environment and biosphere and stimulate the health and welfare of man; and to enrich the understanding of the ecological systems and natural resources important to the Nation" 42 USC §4321. NEPA provides a mandate and a framework for federal agencies to consider all reasonably foreseeable environmental effects of their proposed actions and to potentially involve and inform the public in their process. NEPA also established the Council on Environmental Quality (CEQ) in the Executive Office of the President to formulate and recommend national policies which ensure that the programs of the federal government promote improvement of the quality of the environment.

In order to consider whether a proposed federal action may have significant effects on the environment, federal agencies may prepare an environmental assessment (EA). The EA may undergo a public review and comment period and concludes with either a finding of no significant impact (FONSI) or a determination that an Environmental Impact Statement (EIS) should be prepared. An EIS is prepared for actions considered to have

significant effects on the environment and, after public review and comment, findings are documented in a record of decision (ROD). When it is uncertain at the outset whether an action will have a significant effect on the environment, federal agencies will begin the NEPA planning process by preparing an EA, review the public comments, and then make a determination whether the proposed action will have significant impacts on the environment and either issue a FONSI or prepare an EIS and issue a ROD.

In accordance with the regulations implementing the OPA NRDA process, the Trustees have attempted to integrate OPA restoration planning with the NEPA process (15 CFR § 990.23). Accordingly, the DARP serves as a NEPA EA document, as well. The Trustees anticipate that this DARP/EA will meet NEPA requirements for most of the restoration projects described herein. However, subsequent NEPA compliance may be required prior to implementation of some of the restoration actions that are conceptual at this stage pending development of sufficient project-level detail. Additional NEPA compliance will be necessary for scoter and recreational use projects, which are yet to be selected.

3.3.5 Other Federal and State Laws, Regulations, and Policies

As described above, OPA, NMSA, PSRPA, and NEPA, and federal regulations implementing these laws are the major federal laws and regulations guiding the development of this DARP/EA for restoration of injured resources and services resulting from the *Cosco Busan* oil spill. However, there are other federal and state laws, regulations or policies that may be pertinent to this DARP/EA and/or to implementation of the specific restoration actions proposed herein. Potentially relevant laws, regulations, and policies are set forth below.

3.3.5.1 Federal Laws, Regulations, and Policies

Clean Water Act, 33 USC. 1251, et seq.

The federal Water Pollution Control Act (commonly referred to as the Clean Water Act or CWA) is the principal federal statute governing water quality. The CWA's objective is to restore and maintain the chemical, physical, and biological integrity of the Nation's waters. The CWA regulates both the direct (point source) and indirect (non-point source) discharge of pollutants into the Nation's waters.

Section 402 of the CWA established the National Pollution Discharge Elimination System (NPDES) program. The CWA allows EPA to authorize state governments to implement the NPDES program. Section 301 of the CWA prohibits the discharge into navigable waters of any pollutant by any person from a point source unless it is in compliance with a National Pollution Discharge Elimination System (NPDES) permit. Section 319 of the CWA directs states to identify best management practices and measures to reduce non-point source pollution.

Section 311 of the CWA regulates, among other things, the discharge of oil and other hazardous substances into navigable waters, adjoining shorelines, and waters of the contiguous zone. The CWA allows the federal government to remove the discharges and assess the removal costs against the responsible party. The CWA defines removal costs

to include costs for the restoration or replacement of natural resources damaged or destroyed as a result of a discharge of oil or a hazardous substance.

Section 404 of the CWA authorizes the US Army Corps of Engineers (the Corps) to issue permits, after notice and opportunity for public hearings, for the discharge of dredged or fill material into the waters of the United States. Section 401 of the CWA provides that any applicant for a federal permit or license to conduct any activity which may result in any discharge into navigable waters must obtain certification of compliance with state water quality standards.

The Trustees anticipate that some restoration projects may trigger CWA permitting requirements. For those projects, the implementing entity will be required, as a condition of receiving *Cosco Busan* restoration funds, to obtain the appropriate permits prior to project implementation.

Rivers and Harbors Appropriation Act of 1899, 33 USC. § 401 et seq.

The Rivers and Harbors Act regulates the development and use of the nation's navigable waterways. Section 10 of the Act prohibits unauthorized obstruction or alteration of navigable waters and vests the US Army Corps of Engineers with authority to regulate discharges of fill and other materials into such waters.

The Trustees do not believe that any of the restoration projects set forth in this DARP/EA have the potential to negatively affect navigable waters because none of the projects will result in the obstruction or alteration of navigable waters.

Coastal Zone Management Act, 16 USC § 1451, et seq

The goal of the Coastal Zone Management Act (CZMA) is to encourage and assist states to preserve, protect, develop and, where possible, restore and enhance valuable natural coastal resources. Participation by states is voluntary. California developed the California Coastal Management Program pursuant to the requirements of the federal CZMA, and NOAA approved the program in 1977. The State has also enacted the federally approved California Coastal Act.

Section 1456 of the CZMA requires that any federal action inside or outside of the coastal zone that affects any land or water use or natural resources of the coastal zone be consistent to the maximum extent practicable with the enforceable policies of approved state management programs. It states that no federal license or permit may be granted without giving the State the opportunity to concur that the project is consistent with the state's coastal policies. The regulations implementing the CZMA outline the consistency procedures.

The San Francisco Bay Conservation and Development Commission (BCDC) is the federally-designated state coastal management agency for the San Francisco Bay segment of the California coastal zone. This designation empowers the BCDC to use the authority of the federal CZMA to ensure that federal projects and activities within the Bay are consistent with the policies of the Bay Plan and state law. The California Coastal

Commission has similar authority, under the California Coastal Management Program, for areas in the coastal zone outside BCDC's jurisdiction.

The Trustees believe that the projects selected in this DARP/EA within the geographic jurisdiction of the BCDC can be implemented in a manner that will either have no effect on coastal resources or uses or will be consistent to the maximum extent practicable with the CZMA, the McAteer-Petris Act (California Government Code Sections 66600 to 66694) and the San Francisco Bay Plan. The Trustees anticipate that the BCDC will concur; however, prior to implementation, the Trustees and/or the project implementers, as appropriate, will seek concurrence for these projects.

The Trustees believe that each of the projects selected in this DARP/EA within the geographic jurisdiction of the Coastal Commission can be implemented in a manner that will either have no effect on coastal resources or uses or is consistent to the maximum extent practicable with the CZMA, the California Coastal Act (California Public Resources Code Sections 30000, et seq.), and the California Coastal Management Program. The Trustees anticipate that the Coastal Commission will concur; however, prior to implementation, the Trustees and/or the project implementers, as appropriate, will seek concurrence for these projects.

Endangered Species Act, 16 USC. § 1531, et seq.

The purpose of the ESA is to conserve endangered and threatened species and the ecosystems upon which they depend. The ESA directs all federal agencies to utilize their authorities to further these purposes. Pursuant to Section 7 of the ESA, federal agencies shall, in consultation with the Secretaries of the Interior and/or Commerce, ensure that any action that they authorize, fund, or carry out is not likely to jeopardize the continued existence of any endangered or threatened species, or result in the destruction or adverse modification of designated critical habitat.

Under the ESA, the National Marine Fisheries Service (NFMS) and the USFWS publish lists of endangered and threatened species. Before initiating an action, the federal action agency, or its non-federal permit applicant, must ask the USFWS and/or NMFS to provide a list of threatened, endangered, proposed, and candidate species and designated critical habitat that may be present in the project area. If no species or critical habitats are known to occur in the action area[3], the federal action agency has no further ESA obligations under Section 7. If the federal action agency determines that a project may affect a listed species or designated critical habitat, consultation is required.

If the federal action agency concludes that the project will not adversely affect listed species or critical habitat, the agency submits a "not likely to adversely affect" determination to the USFWS and/or NMFS. If the USFWS and/or NMFS concur with the federal action agency's determination of "not likely to adversely affect," then the consultation (informal to this point) is completed and the decision is put in writing.

[3] Action Area: All areas that may be affected directly or indirectly by the selected action and not merely the immediate area involved in the action.

If the federal action agency determines that the project is likely to adversely affect either a listed species or its critical habitat, then more formal consultation procedures are required. There is a designated period in which to consult (90 days), and beyond that, another set period for the USFWS and/or NMFS to prepare a biological opinion (45 days). The determination of whether or not the proposed action would be likely to jeopardize the species or adversely modify its critical habitat is contained in the biological opinion. If a jeopardy or adverse modification determination is made, the biological opinion must identify any reasonable and prudent alternatives that could allow the project to move forward.

Several federally-listed species occur in the project areas for this DARP/EA. The federally endangered Sea Otter and the federally threatened Marbled Murrelet and Snowy Plover may utilize waters and lands which may be included in selected areas for implementing restoration projects. Additionally, some of these species are the target for the restoration in some of the selected projects.

For each project that is selected in this Final DARP/EA, the Trustees and/or the project implementer, as appropriate, will evaluate the potential effects of the project on listed species and critical habitat. Based on this analysis, the Trustees and/or project implementer will perform the appropriate level of consultation with the USFWS and/or NMFS pursuant to Section 7 of the ESA.

Magnuson-Stevens Fishery Conservation and Management Act, 16 USC. § 1801, et seq.

The federal Magnuson-Stevens Fishery Conservation and Management Act, as amended and reauthorized by the Sustainable Fisheries Act of 1996, establishes a program to promote the protection of essential fish habitat (EFH) in the review of projects conducted under federal permits, licenses, or other authorities that affect or have the potential to affect such habitat. After EFH has been described and identified in fishery management plans by the regional fishery management councils, federal agencies are obligated to consult with the Secretary of Commerce with respect to any action authorized, funded, or undertaken, or proposed to be authorized, funded, or undertaken, by such agency that may adversely affect any EFH.

The Trustees do not believe that any of the restoration projects set forth in this Final DARP/EA will adversely affect EFH.

Fish and Wildlife Coordination Act*, *16 USC.§ 661, et seq.

The Fish and Wildlife Coordination Act (FWCA) provides the basic authority for the USFWS involvement in the evaluation of impacts to fish and wildlife from proposed water resource development projects. The FWCA requires that federal agencies consult with the USFWS (and/or NMFS as may be appropriate) and state wildlife agencies for activities that affect, control or modify waters of any stream or bodies of water, in order to minimize the adverse impacts of such actions on fish and wildlife resources and habitat. This consultation is generally incorporated into the process of complying with

Section 404 of the Clean Water Act, NEPA or other federal permit, license or review requirements.

The Trustees or the project implementer, as appropriate, will consult with the necessary agencies on any of the selected restoration projects that involve activities that affect, control, or modify water bodies.

Marine Mammal Protection Act, 16 USC. § 1361, et seq.

The Marine Mammal Protection Act (MMPA) prohibits, with certain exceptions, the take of marine mammals in US waters and by US citizens on the high seas, and the importation of marine mammals and marine mammal products into the US. The Secretary of Commerce is responsible for the conservation and management of pinnipeds (other than walruses) and cetaceans. The Secretary of Commerce delegated MMPA authority to NMFS. The Secretary of the Interior (through the USFWS) is responsible for walruses, sea and marine otters, polar bears, manatees, and dugongs. Title II of the MMPA established an independent Marine Mammal Commission (and its Advisory Committee) which provides independent oversight of the marine mammal conservation polices and programs being carried out by federal regulatory agencies. The Commission is charged with developing, reviewing, and making recommendations on domestic and international actions and policies of all federal agencies with respect to marine mammal protection and conservation and with carrying out a research program. The MMPA provides for several exceptions to the moratorium on taking and importation of marine mammals and marine mammal products. The Secretary may issue permits for take or importation for purposes of scientific research, public display, photography for educational or commercial purposes, enhancing the survival or recovery of a species or stock, importation of certain polar bear parts taken in sports hunting in Canada, and incidental taking in the course of commercial fishing operations.

The Trustees do not believe that any of the restoration actions set forth in this Final DARP/EA have the potential to result in the take, injury, or harassment of any species protected under the MMPA.

Migratory Bird Treaty Act of 1918, 16 USC. § 703, et seq.

The Migratory Bird Treaty Act (MBTA) implements four international treaties involving protection of migratory birds, including all marine birds, and is one of the earliest statutes to provide for avian protection by the federal government. The MBTA generally prohibits actions to "pursue, hunt, take, capture, kill, attempt to take, kill, possess, offer for sale, sell, offer to purchase, deliver for shipment, ship, cause to be shipped, deliver for transportation, transport, cause to be transported, carry, or cause to be carried by any means whatever, receive for shipment, transportation or carriage, or export, at any time, or in any manner, any migratory bird...or any part, nest, or egg of such bird." Exceptions to these prohibitions are only allowed under regulations or permits issued by the USFWS. Hunting of migratory game birds is regulated annually through a process in which the USFWS sets "framework regulations" and "special regulations" designed to maintain sustainable hunting levels. Framework regulations are the foundation of annual regulations and consist of the outside dates for opening and closing seasons, season

length, daily bag and possession limits, and shooting hours. Special regulations consist of framework regulations that are applied on a small scale and consist of split seasons, zones and special seasons, state regulations conform to the federal regulations. All other actions prohibited by the MBTA are only allowed under specific permits issued by the USFWS Regional Bird Permit Offices. These permits include special use permits for rehabilitation, possession and salvage of oiled birds during spill response, which usually provides the primary data for determining extent of injury to marine birds and the need for restoration.

Implementation of restoration projects selected in this Final DARP/EA will be conducted in full compliance with the MBTA, with oversight of such compliance provided by the USFWS, one of the Trustees for this oil spill.

National Historic Preservation Act of 1966 as amended (16 USC 470-470t, 110)

Section 106 of the National Historic Preservation Act mandates federal agencies undergo a review process for all federally-funded and permitted projects that will impact sites listed on, or eligible for listing on, the National Register of Historic Places. Specifically it requires the federal agency to "take into account" the effect a project may have on historic properties.

The Trustees have evaluated the selected projects and concluded that none of the projects is likely to adversely impact historic sites.

***Wilderness Act, 16 USC.* Public Law 88-577**

The Wilderness Act established a National Wilderness Preservation System to be composed of federally owned areas designated by Congress as wilderness areas, to be administered in such a manner that will leave them unimpaired for future use and enjoyment as wilderness. In 1976, Congress designated a portion of Point Reyes National Seashore (33,000 acres) as wilderness, including Point Reyes Headlands, the shoreline north of the peninsula, and the shoreline from Limantour Estero south.

Executive Order 11988 – Construction in Flood Plains

The 1977 Executive Order 11988 seeks to avoid, to the extent possible, the long-and short-term adverse impacts associated with the occupancy and modification of flood plains and to avoid direct or indirect support of development in flood plains wherever there is a practicable alternative. Each federal agency is responsible for evaluating the potential effects of any action it may take in a flood plain. Before taking an action, the federal agency should determine whether the proposed action would occur in a flood plain. For any major federal action significantly affecting the quality of the human environment, the evaluation would be included in the agency's environmental impact statement prepared pursuant to NEPA. The agency should consider alternatives to avoid adverse effects and incompatible development in flood plains. If the only practicable alternative requires sitting in a flood plain, the agency should: (1) design or modify the action to minimize potential harm, and (2) prepare and circulate a notice containing an explanation of why the action is proposed to be located in the flood plain.

None of the restoration projects set forth in this Final DARP/EA involve construction in a floodplain.

Executive Order 13112 - Invasive Species

The 1999 Executive Order 13112 requires that all federal agencies whose actions may affect the status of invasive species shall, to the extent practicable and permitted by law, (1) identify such actions, and (2) take actions specified in the Order to address the problem consistent with their authorities and budgetary resources; and (3) not authorize, fund, or carry out actions that they believe are likely to cause or promote the introduction or spread of invasive species in the United States or elsewhere unless, "pursuant to guidelines that it has prescribed, the agency has determined and made public its determination that the benefits of such actions clearly outweigh the potential harm caused by invasive species; and that all feasible and prudent measures to minimize risk of harm will be taken in conjunction with the actions."

The Trustees do not believe that any of the restoration projects set forth in this Final DARP/EA have the potential to cause or promote the introduction or spread of invasive species. However, several of the restoration projects considered in this DARP/EA are aimed at the removal or control of non-native species.

Executive Order 12898 - Environmental Justice

The 1994 Executive Order 12898 requires each federal agency to identify and address, as appropriate, disproportionately high and adverse human health or environmental effects of its programs, policies, and activities on minority and low-income populations. In the memorandum to heads of departments and agencies that accompanied executive Order 12898, the President specifically recognized the importance of procedures under NEPA for identifying and addressing environmental justice concerns. The memorandum states that "each federal agency shall analyze the environmental effects, including human health, economic and social effects, of federal actions, including effects on minority communities and low-income communities, when such analysis is required by [NEPA]." The memorandum particularly emphasizes the importance of NEPA's public participation process, directing that "each federal agency shall provide opportunities for community input in the NEPA process." Agencies are further directed to "identify potential effects and mitigation measures in consultation with affected communities, and improve the accessibility of meetings, crucial documents, and notices." The CEQ has oversight of the federal government's compliance with Executive Order 12898 and NEPA.

The Trustees have involved the affected communities by providing notice to the public, seeking public comments, holding public meetings and providing public access to the Administrative Record. In addition, all actions selected in this Final DARP/EA are expected to have positive environmental impacts and not to impose any adverse impacts on any community.

Information Quality Law, Public Law 106-554, Section 515

Information disseminated by federal agencies to the public after October 1, 2002, is subject to information quality guidelines developed by each agency pursuant to Section 515 of Public Law 106-554 that are intended to ensure and maximize the quality of the objectivity, utility and integrity of such information. This Final DARP/EA is an information product covered by information quality guidelines established by NOAA and DOI for this purpose. The quality of the information contained herein is consistent with these guidelines, as applicable.

3.3.5.2 State Laws, Regulations, and Policies

California Lempert-Keene-Seastrand Oil Spill Prevention and Response Act, Government Code § 9574.1, et seq.

The Lempert-Keene-Seastrand Oil Spill Prevention and Response Act became effective on September 24, 1990. This legislation is the key state compensatory mechanism for subsequent oil spills and establishes a comprehensive liability scheme for damages resulting from marine and inland oil spills. The legislation also established an Administrator for oil spill response, appointed by the Governor, and the Office of Spill Prevention and Response (OSPR) within the CDFG. The Administrator is required to ensure that, as part of the response to any significant spill, damages to natural resource are assessed. Recoverable damages include damages for the injury to, destruction of, or loss of natural resources, including the reasonable costs of assessing the injury, destruction, or loss, the cost of rehabilitating wildlife, habitat, and other resources, and the loss of use and enjoyment of natural resources, public beaches, and other public resources.

The Administrator, a chief deputy director of CDFG, must coordinate all actions required by state or local agencies to assess injury to, and provide full mitigation for injury to, or to restore, rehabilitate, or replace, natural resources, including wildlife, fisheries, wildlife or fisheries habitat, and beaches and other coastal areas, that are damaged by an oil spill. Such actions include actions required by State trustees under Section 1006 of OPA (requiring state trustees to assess natural resource damages under their trusteeship and to develop and implement a plan for restoration of natural resources).

In this case, the CDFG-OSPR participated as part of the Trustee group to identify and quantify injuries to natural resources, including wildlife, fisheries, wildlife or fisheries habitat, and beaches and other coastal areas, and the loss of their use, under the Lempert-Keene-Seastrand Oil Spill Prevention and Response Act concurrently with similar work being conducted under OPA.

The Lempert-Keene-Seastrand Oil Spill Prevention and Response Act does not contain public participation requirements like OPA; however, since the natural resources belonging to, managed by, controlled by, or appertaining to the State of California or political subdivision thereof that were injured by the Spill are also compensable under OPA, they are dealt with concurrently in this document.

California Environmental Quality Act, Pub. Res. Code 21000-21178.1

The California Environmental Quality Act (CEQA) was adopted in 1970. Its basic purposes are to inform California governmental agencies and the public about the potentially significant effects of proposed activities, to identify ways that environmental damage can be avoided or significantly reduced, to prevent significant avoidable damage to the environment through adoption of feasible alternatives or mitigation measures, and to disclose the reasons for agency approval of a project resulting in significant environmental effects.

The CEQA process begins with a preliminary review as to whether CEQA applies to the project in question. Generally, a project is subject to CEQA if it involves a discretionary action that is carried out, funded or authorized by an agency (i.e., the lead agency), and that has the potential to impact the environment. Once the lead agency determines that the project is subject to CEQA, the lead agency must then determine whether the action is exempt from CEQA compliance under either a statutory or categorical exemption. Examples of categorical exemptions include actions taken by regulatory agencies for protection of natural resources and actions by regulatory agencies for protection of the environment (Title 14 CCR, Chapter 3, §§ 15307-15308).

If the lead agency determines that the project is not exempt, then an Initial Study is generally prepared to determine whether the project may have a significant effect on the environment. Based on the results of the Initial Study, the lead agency determines whether to prepare a Negative Declaration (i.e., the project will not result in significant adverse effects to the environment) or an Environmental Impact Report (EIR). The test for determining whether an EIR or negative declaration must be prepared is whether a fair argument can be made based on substantial evidence that the project may have a significant adverse effect on the environment.

CEQA encourages the use of a federal EIS or FONSI prepared pursuant to NEPA when such documents are available, or the preparation of joint state/federal documents, in lieu of preparing a separate EIR or negative declaration under CEQA. Accordingly, this DARP/EA and subsequent FONSI, if issued, may be relied upon by the lead agency towards compliance with CEQA as required for discretionary projects that are authorized, funded or carried out by California state or local agencies. Toward this end, the state Trustees will coordinate with the federal Trustees to ensure the DARP/EA and FONSI (if issued) are consistent with the provisions of CEQA Guidelines including state public review requirements. (Title 14 CCR, Chapter 3, § 15220 *et seq*.).

The Trustees anticipate that this Final DARP/EA and subsequent FONSI, if issued, will comply with the CEQA guidelines for most of the restoration projects described herein. However, subsequent CEQA compliance may be required prior to implementation of some of the restoration actions that are conceptual at this stage pending development of sufficient project-level detail. This will be determined once detailed engineering design work or operational plans are developed for the selected projects, and once the scoter and recreational use projects have been defined.

California Coastal Act, California Public Resources Code § 30000, et seq.

The California Coastal Act was enacted by the California State Legislature in 1976 to provide long-term protection of California's 1,100-mile coastline for the benefit of current and future generations. The Coastal Act created a partnership between the state (acting through the California Coastal Commission [Commission]) and coastal cities and counties to manage the conservation and development of land and water in the coastal zone through a comprehensive planning and regulatory program. New development in the coastal zone may require a permit from the Commission or the appropriate local governmental agency. Development activities are broadly defined to include construction projects, divisions of land, and activities that change the intensity of use of land or public access to coastal waters. The Commission also reviews and approves Local Coastal Programs, which are the basic planning tools used by local governments to guide development in the coastal zone. The coastal zone established by the Coastal Act does not include San Francisco Bay which is regulated by the BCDC pursuant to the McAteer-Petris Act.

The Trustees do not anticipate that any of the restoration projects will adversely affect coastal resources or involve development in the California Coastal Zone. However, the implementing entity for each project will be required to apply for any necessary permits and approvals, including any required coastal development permit.

McAteer-Petris Act, California Government Code Sections 66690, et seq.

The McAteer-Petris Act established the BCDC as a state agency with authority to regulate development in and around San Francisco Bay. The Act describes the broad policies the BCDC must use to decide whether to issue permits for activities in and along the shoreline of San Francisco Bay. The Act was first adopted in 1965 to establish the BCDC as a temporary State agency. The BCDC was charged with preparing a plan for the long-term use of the Bay and regulating development in and around the Bay. The San Francisco Bay Plan was completed in January 1969. In August 1969, the McAteer-Petris Act was amended to make BCDC a permanent agency and to incorporate the policies of the Bay Plan into State law.

The Trustees do not anticipate that any of the restoration projects set forth in this Final DARP/EA will adversely affect coastal resources in the San Francisco Bay segment of the California Coastal Zone. However, the implementing entity for each project will be required to apply for any necessary permits and approvals, including any required San Francisco Bay permit.

California Endangered Species Act,* Fish and Game Code 2050 *et seq.

Pursuant to CESA (California Fish and Game Code Sections 2050 et seq.), it is the policy of the State of California that state agencies should not approve projects that 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.

However, if reasonable alternatives are infeasible, individual projects may be approved if appropriate mitigation and enhancement measures are provided.

Pursuant to the CESA, the Fish and Game Commission has established a list of threatened and endangered species based on criteria recommended by the California Department of Fish and Game. Section 2080 of the California Fish and Game Code prohibits "take" of any species that the Commission determines to be an endangered species or a threatened species. Take is defined in Section 86 of the Fish and Game Code as "hunt, pursue, catch, capture, or kill, or attempt to hunt, pursue, catch, capture, or kill." The CESA allows for take incidental to otherwise lawful development projects. The CESA emphasizes early consultation to avoid potential impacts to rare, endangered, or threatened species and to develop appropriate mitigation planning to offset project-caused losses of populations of listed species and their essential habitats.

Several state-listed species occur in the affected area for this Restoration Plan. The state fully-protected Sea Otter, endangered Brown Pelican, and endangered Marbled Murrelet may utilize waters or lands which may be included in selected areas for implementing restoration projects. Additionally, these species are the target of the restoration in some of the selected projects. While the Trustees do not believe the restoration projects set forth in this Final DARP/EA will result in the take of any state-listed species, the Trustees will evaluate the potential effects of the projects on these species and consult with the CDFG as may be appropriate pursuant to the requirements of the CESA.

Public Resources Code, Division 6,* § 6001*, et seq.

The Public Resources Code, Division 6, gives the California State Lands Commission trustee ownership over State sovereign tide and submerged lands. Permits or leases may be required from the State Lands Commission if a restoration project is located on such lands.

3.3.5.3 Other Potentially Applicable Statutes and Regulations

Additional legal requirements may be applicable to NRDA restoration planning activities. The statutes listed below, or their implementing regulations, may require permits from federal or state permitting authorities.

- National Park Act of August 19, 1916, 16 USC 1, *et seq*.
- Archaeological Resources Protection Act, 16 USC 460, *et seq*.
- National Historic Preservation Act of 1966 as amended (16 USC 470-470t, 110)
- Clean Air Act, 42 USC 7401, *et seq*.
- Porter-Cologne Water Quality Control Act, Water Code Sections 13000 et seq.

4.0 Injury Quantification and Restoration Planning

The goal of injury assessment is to determine the nature, extent and severity of injuries to natural resources, thus providing the technical basis for evaluating and properly scaling potential restoration actions to compensate for resource injuries. The Oil Pollution Act NRDA regulations define injury as "an observable or measurable adverse change in a natural resource or impairment of a natural resource service." An impairment or loss of recreational use of the natural resources is a compensable "value" as defined by the OPA NRDA regulations, as well.

For each of the injury categories evaluated following the spill and discussed in this Final DARP, the Trustees, informed in part by the contributions of the RPs, selected assessment procedures based on (1) the range of procedures available under section 990.27(b) of the OPA regulations; (2) the time and cost necessary to implement the procedures, and considering whether the additional cost of more complex procedures were related to the expected increase in the quantity and/or quality of the information to be acquired; (3) the potential nature, degree, and spatial and temporal extent of the injury; (4) potential restoration actions for the injury; (5) the relevance and adequacy of information generated by the procedures to meet information requirements of planning appropriate restoration actions; and (6) input from scientific experts.

4.1 Quantification of Damages

Each injury assessment focused on determining both the magnitude of the injury (e.g., number of animals killed, acres impacted, or days of lost recreational opportunity) and the time to full recovery. This produced an estimate of the initial and interim (from the time of injury until full recovery) losses resulting from the oil spill.

The Trustees' task is to determine the scale of restoration actions that adequately compensate the public for the injuries resulting from the spill. For wildlife and habitat, the Trustees have used Resource Equivalency Analysis (REA), an approach that quantifies both the injury from the spill and the benefits of potential restoration projects, such that they may be compared with each other. For human recreational losses, the Trustees have used a valuation approach, estimating the number of lost user-days for various activities and locations, and then calculating the lost value, in dollars, of that lost use. These methods are further described below.

4.1.1. Resource Equivalency Analysis

For the quantification of injuries to wildlife and habitat, the Trustees have relied on a service-to-service restoration-based approach, in accordance with 990.53(d)(2). In other words, the Trustees have sought appropriate restoration projects to both restore the injured resources and compensate for the interim losses between the time of the spill and full recovery to the conditions that would have existed had the spill not occurred (see NOAA 1997). Restoration scaling is the process of determining the appropriate size of a restoration project so as to compensate for the injuries and lost services. These projects, because of their compensatory nature, are intended to provide resources "of the same type and quality, and of comparable value" as those injured (NOAA 1995). For this task, the

Trustees relied upon REA, which is also called Habitat Equivalency Analysis (HEA) when applied to habitat injuries. The REA method is described in greater detail in Appendix A.

4.1.2. Value of Lost Recreational Use

To quantify lost and impaired human uses resulting from the Incident, the Trustees, partially in cooperation with the RPs, have gathered data regarding visitor use of impacted sites and associated activities. To value those lost uses the Trustees used a Travel Cost Model for general beach use and are employing the Benefits Transfer Method for boating and fishing. To compensate for the lost and diminished human uses arising from the Incident, the Trustees intend to solicit project ideas from local, regional, state, and federal managers of parks and other recreational areas, as well as from the general public. The Trustees will then select restoration actions using a value to cost approach, by which the cost of the restoration actions are scaled to the monetary value of lost and diminished human uses.

Thus, the selected compensatory restoration projects will have an implementation cost equivalent to the value of the public's lost and diminished recreational services.

For a number of reasons the value-to-cost method is the most commonly used approach to address lost recreational use in NRD cases across the nation. A value-to-value or service-to-service approach, which attempts to compare the value or benefits of specific restoration actions to the injury, was deemed impractical as the scope and/or number of studies required to implement either approach would be prohibitively time-consuming and expensive, and therefore less desirable under the assessment procedure criteria laid out in 990.27(c).

A wide variety of recreational activities, ranging from dog walking to kite-surfing to angling, was affected by the spill. Additionally, a wide variety of shoreline locations (East Bay, San Francisco, Marin County, outer coast) and shoreline types (sandy beaches, fishing piers, trails, parks, etc.) was impacted. The Trustees anticipate implementing a suite of restoration projects to compensate for impacts to the various types of activities across the spill zone. There are likely to be multiple projects designed to compensate for recreational use impacts. Each project will require significant coordination among the land owner or manager where the projects will be implemented, the local governments and the public. To properly implement a value-to-value or service-to-service approach in these circumstances would have required the Trustees to separately study, evaluate and determine the value and benefits of each individual project. Such studies of the potential benefits of the projects could easily take several years and cost several times more than the lost use studies.

4.2 Restoration Project Selection Criteria

The Trustees considered numerous restoration alternatives to compensate the public for spill-related injuries. Each restoration alternative has been evaluated using the regulatory factors and additional criteria described below. This process resulted in the Trustees'

selection of preferred restoration alternatives for this Final DARP/EA. All alternatives, both selected and non-preferred, are discussed in subsequent sections below.

In accordance with Section 990.53(a)(2) of the OPA NRDA regulations only those alternatives considered technically feasible and in accordance with applicable laws, regulations, or permits were carried forward for further evaluation.

Section 990.54(a) of the OPA regulations list the following factors which the trustees have used to evaluate the alternatives put forth in this Final DARP/EA:

(1) The cost to carry out the alternative;
(2) The extent to which each alternative is expected to meet the trustees' goals and objectives in returning the injured natural resources and services to baseline and/or compensating for interim losses;
(3) The likelihood of success of each alternative;
(4) The extent to which each alternative will prevent future injury as a result of the incident, and avoid collateral injury as a result of implementing the alternative;
(5) The extent to which each alternative benefits more than one natural resource and/or service; and
(6) The effect of each alternative on public health and safety.

In addition to these regulatory factors, the trustees considered the following criteria when evaluating restoration alternatives, to the extent information on them could be obtained.

A. Cost-Effectiveness. If multiple proposed projects deliver an equivalent amount and type of benefits, the Trustees seek the least costly approach. This closely aligns with factor (1) above.

B. Relationship to Injured Resources and/or Services (nexus). Projects that restore, rehabilitate, replace, enhance, or acquire the equivalent of the same or similar resources or services injured by the spill are preferred to projects that benefit other comparable resources or services; this includes consideration of the proximity of the restoration project to the location of the injured resources.

C. Time to Provide Benefits. A proposed project that provides benefits to the target resource or public sooner is preferred over a project that would provide those benefits later.

D. Duration of Benefits. The Trustees consider the expected duration of benefits from the proposed project. Long-term benefits are preferred.

E. Multiple Resource and Service Benefits. The Trustees consider the extent to which the proposed project benefits more than one natural resource or resource service. This is measured in terms of the quantity and quality of natural resource services expected to result from the project. This closely aligns with factor (5) above.

F. Comprehensive Range of Projects. The Trustees consider the extent to which a

project contributes to the overall restoration plan. This includes the degree to which a project may benefit any otherwise uncompensated spill injuries.

G. Maintenance and Oversight of Project. The Trustees consider the opportunities to protect an implemented project and resulting benefits over time through conservation easements, land acquisition, or other types of resource dedication. Long-term protection is preferable.

H. Opportunities for Collaboration. The Trustees consider the possibility of matching funds, in-kind services, volunteer assistance, and coordination with other ongoing or proposed projects. External funding and support services that reduce costs or extend benefits are preferable. Funds, however, shall not be used to offset the costs of ongoing mitigation projects required pursuant to state or federal law.

I. Total Project Cost and Accuracy of Estimate. The total cost estimate of a proposed project should include the full costs to design, implement, monitor, and manage the project (including indirect rates and overhead costs). The cost estimate is evaluated by its completeness, accuracy, and the reliability of the methods used in its development, as well as the credibility of the person or entity submitting the estimate.

J. Ability to Document Benefits to the Public. The Trustees consider the ability to document receipt or delivery of benefits to the public as a result of a project or other use of funds.

K. Educational/Research Value. The Trustees consider the potential for public education and outreach.

L. Non-Duplication. Projects should not duplicate other efforts already ongoing at the same location.

4.3 Injury Quantification and Restoration Alternatives

This section describes the nature, extent, and severity of injuries to natural resources and human recreational uses resulting from the spill, as well as potential restoration alternatives that may compensate for these injuries. This section is divided into the following resource categories:

- Birds
- Mammals
- Fish and other Aquatic Fauna
- Rocky Intertidal Habitat
- Salt marsh, Mud and Sand Flats, and Sandy Beach Habitats
- Eelgrass Habitat
- Human Recreational Uses

At the time of the spill, the Trustees created these categories to organize the assessment of injuries to natural resources. A team was assigned to each category that included representatives from several Trustee agencies, one or more consultants with expertise in the field, and at least one representative of the Responsible Party (see section 3.2.3).

The Trustees have used available information, field data, focused studies, and expert scientific judgment to arrive at their best estimate of the injuries. Principal investigators included state and federal scientists, consultants with damage assessment experience, and recognized experts within each field.

As discussed throughout this section, the Trustees have concluded that the magnitude of the injuries caused by the spill has been sufficiently delineated so as to be sufficient to identify appropriate restoration. While there is some uncertainty inherent in the assessment of impacts from oil spills, and while collecting more information may increase the precision of the estimate of the impacts, the Trustees believe that the type and scale of potential restoration actions would not substantially change as a result of more research. The Trustees have sought to balance the desire for more information with the reality that further research would be costly and would delay the implementation of the restoration projects.

Each resource category section below begins with an overview of the studies conducted during the assessment, and the results of those studies. The conclusions of the injury assessment are then summarized and the injury is quantified. Finally, the potential restoration alternatives are then described, with the preferred projects described in detail. The project descriptions include a discussion of the anticipated environmental impacts, or consequences, of the selected projects. The potential cumulative impacts are summarized in section 4.5.

The non-preferred projects are also listed and described, in lesser detail, as well. *These projects may be reconsidered if funds become available or if selected projects prove to be infeasible.*

4.3.1 Birds

Birds are especially vulnerable to oil spills, as the oil compromises the ability of their feathers to keep them warm in the cold ocean water. For a species that forages in the water, even a relatively small amount of oil (e.g., the size of a nickel) may result in death. Like a hole in a wetsuit, the oil destroys the feathers' ability to insulate the bird, thus allowing cold ocean water to spread against the bird's skin. Birds which contact oil typically die of hypothermia. With their rapid metabolism, birds also suffer starvation when they cannot forage for a few days. They can also ingest toxic amounts of oil while preening, as they attempt to clean themselves. Finally, larger amounts of oil can smother birds, affecting their mobility and ability to survive.

Nearly 3,000 birds were collected live and dead after the oil spill, encompassing over 60 species. For restoration planning purposes, the Trustees concluded that it was not practical to develop and implement restoration projects for each of these species. For many of these species, no restoration project has ever been attempted or successfully

implemented, creating uncertainties with respect to feasibility. For others, the impact was relatively small, such that a small restoration project would suffice for compensation. The implementation of many small projects, however, is economically inefficient, because each project incurs some level of fixed costs. Thus, in order to focus restoration efforts on larger projects, that are more efficient and feasible, the Trustees created restoration categories according to the following criteria:

1. The species in each group should be similar in their habitat preferences and life histories.
2. The species in each group are likely to benefit from a single restoration action.
3. Each grouping must contain one or more species for which there are feasible restoration alternatives.
4. Species with declining populations and/or that have special restoration needs should be specifically addressed to the extent feasible.

Using these criteria, the impacted species were grouped as follows:

- Large diving ducks, loons
- Large grebes
- Salt pond divers (small diving ducks, small grebes)
- Alcids and Procellarids
- Marbled Murrelets
- Brown Pelicans, cormorants, gulls
- Shorebirds

Spill-related mortality was estimated for each species and all injuries within each grouping were counted when scaling potential restoration actions. Five million dollars from the settlement has been allocated to implement the projects selected below.

4.3.1.1 Overview of Data Collection and Studies

This list below summarizes the various field studies, data collection tasks, and analyses used for the assessment of bird injuries. It also summarizes the results of each task.

- **Live and Dead Bird Intake Data**
  - These data were collected as a normal part of the spill response. They describe the collection of each bird, with such information as date, location, condition of bird, degree of oiling, etc. These data provided the foundation for estimating total bird mortality.

- **Search Effort Data Compilation**
  - These data were collected as a normal part of the spill response. They describe the wildlife response effort, with such information as the date and time of each beach searched, regardless of whether birds were collected. These data were key elements in estimating total bird mortality.

- **Brown Pelican Surveys**
    - Due to their large size, pelicans can survive for many days after oiling. Surveys of known pelican roost sites were performed in the days immediately after the spill. Few oiled pelicans were observed.

- **Marbled Murrelet Aerial Surveys**
    - Special aerial surveys to estimate the number of Marbled Murrelets within the spill zone were conducted in the days immediately after the spill. A high count of 56 Marbled Murrelets were found off the Marin County coast between Rodeo and Drakes Beaches on November 21. This was used to estimate the number of murrelets potentially in the path of the oil.

- **Snowy Plover Surveys**
    - The majority of the Snowy Plovers at Ocean Beach were lightly oiled. This study banded many of the birds and followed them through the winter after the spill, as well as the following winter. The results suggested that most oiled plovers survived as well as plovers that were not oiled.

- **Other Shorebird Surveys**
    - As oiled shorebirds are unlikely to be collected due to their small size, surveys were conducted after the spill both inside the Bay and on the outer coast to estimate the percentage of shorebirds that were oiled. The surveys showed that 4 to 18% of the shorebirds, depending on location, were still oiled three to four weeks after the spill. Surveys were also conducted to estimate the total number of shorebirds in the spill impact area during the week of the spill.

- **Shorebird Oiling Analysis**
    - Shorebird surveys, including the surveys described above, the BeachWatch data described below, and the PRBO Conservation Science/Audubon Bay-wide shorebird surveys conducted during the spill, were analyzed to estimate an overall number of shorebirds that were oiled from the spill. Not including Snowy Plovers, 2,841 shorebirds were estimated to have been oiled.

- **Alcatraz Bird Surveys**
    - Because parts of Alcatraz Island that are used by breeding birds were heavily oiled and because cleanup was difficult on the rocky shoreline, surveys through spring 2008 were conducted to determine if remaining oil impacted wintering or breeding birds. Very little re-oiling of birds was detected, as little oil remained at Alcatraz.

- **Compilation and Analysis of Oiled Bird Observations**
    - Many citizens, as well as organized groups (e.g., Golden Gate Audubon and Richardson Bay Audubon), reported oiled birds. These data were compiled and checked against intake data and the Beached Bird Model (discussed below) results to ascertain if bird mortality may have been underestimated by the model. The analysis concluded that the Beached Bird Model reasonably modeled total bird mortality. Focusing on birds (except shorebirds, which were modeled separately) inside the Bay, a minimum of 904 different individual birds were observed oiled in the surveys by the Audubon groups. The model estimated 2,193 birds were oiled and beached within this area.

- **Rehabilitated Surf Scoter Survival Study**
    - This study was carried out by the Oiled Wildlife Care Network to evaluate the success of their rehabilitation efforts with regard to Surf Scoters, the bird species collected in greatest numbers. The results showed that 26% of the rehabilitated birds were confirmed alive several months after the spill, and only 16% were confirmed dead. The fate of the remainder is unknown.

- **DNA Analysis of Marbled Murrelets**
    - DNA from the three Marbled Murrelets collected dead was analyzed in order to determine whether the birds came from the Santa Cruz Mountain population or populations farther to the north (including Humboldt and Del Norte Counties). All three birds matched DNA from the northern populations.

- **Oiled Feather Sample Analysis**
    - Oiled feathers from 12 collected birds were analyzed for the presence of *Cosco Busan* oil to determine the geographic extent and duration of the spill impacts. This analysis included birds collected in December, a month after the spill, and from Monterey Bay, both in the period immediately following the spill and a month after. The results suggested that about half the birds collected in December and half the birds from Monterey Bay were oiled with the *Cosco Busan* oil.

- **Outer Coast Beachcast Small Bird Carcass Persistence Study**
    - This field experiment was carried out to determine how long small-bodied dead beached birds (such as Marbled Murrelets) persist on outer coast beaches in Marin County. After placing carcasses on the beach, monitoring indicated that half the carcasses disappeared after four days.

- **Bay Beachcast Bird Carcass Persistence Study**
    - This field experiment was carried out to determine how long dead birds (such as scoters) persist on beaches and coastlines inside the Bay. After placing carcasses along the shoreline, monitoring indicated half the carcasses disappeared after six days.

- **Bay Natural Bird Carcass Deposition Study**
    - This study counted dead beachcast birds, not affected by the oil spill, which washed ashore on certain beaches inside the Bay over a set time interval in order to estimate natural deposition. It was determined that natural deposition is relatively high and could explain the 278 non-visibly oiled dead birds that were collected inside the Bay.

- **Bay Bird Carcass Search Efficiency Study**
    - This was a field experiment designed to measure the effectiveness of search teams in finding oiled birds along Bay shorelines, including rip-rap. Carcasses were placed along shorelines for teams to discover. The search teams in the study found 68% of the birds.

- **Bird Mortality Estimation**
    - This was a comprehensive modeling effort, taking into account the birds likely not collected because they were scavenged, not found, or otherwise not collected, as estimated by the various studies described above. As a result of this effort, 5,427 birds were estimated to have been killed due to the spill. A report of this modeling effort is in the Administrative Record (Ford et al. 2009). This modeling did not include an estimate for injured shorebirds, as they are too small to be collected in sufficient numbers for this modeling approach. The Trustees estimated that half the oiled shorebirds, or 1,422, were also killed, for a total of 6,849 birds.

- **Bird Injury Analysis (Estimation of Lost Bird-Years)**
    - The duration of the impact of the oil spill on the various species' populations was also estimated, taking into account the likely rate at which the remaining populations would reproduce and survive.

- **Bird Restoration Project Benefit Analysis (Estimation of Gained Bird-Years)**
    - The benefits of each restoration project were estimated and quantified in terms of its likely contribution to the bird species' populations. In this way, each project was "scaled" to be appropriate in size to the injury.

4.3.1.2 Summary of Injury

A separate report of estimated seabird and waterfowl mortality (Ford et al. 2009) is attached as Appendix B. That report contains additional details of many of the data collection and study activities summarized above. It estimates mortality for all bird species except shorebirds.

Another report, focusing on shorebird oiling and mortality, is attached as Appendix C. Because of their small size and terrestrial behavior, dead and dying shorebirds are more difficult to find, and are scavenged at a higher rate, than larger birds. Although surveys counted nearly 3,000 oiled shorebirds, only seven individual shorebirds were collected after the spill. The Beached Bird Model employed in Ford et al. (2009) thus was not suitable for estimating shorebird mortality.

4.3.1.3 Large Diving Ducks, Loons

Background

This category includes loons, scoters, Greater Scaup, Red-breasted Merganser, and Long-tailed Duck.

Surf Scoters accounted for 71% of the birds estimated dead from this species group and were the species most impacted, in absolute numbers, by the spill. Surf scoters are diving ducks that feed primarily on bivalves, crabs, and herring roe. This species occurs regularly along the California coast and San Francisco Bay in winter. Large numbers spend their winter in San Francisco Bay. They nest throughout Alaska and northern Canada, on lakes within forested areas. A recent telemetry study has shown that birds wintering in San Francisco Bay originate from these northern regions and migrate through Puget Sound and Southeast Alaska (Takekawa 2005; Figure 4). Greater Scaup, the second most affected species in this group, is also a diving duck that breeds in Alaska and Canada and winters in San Francisco Bay.

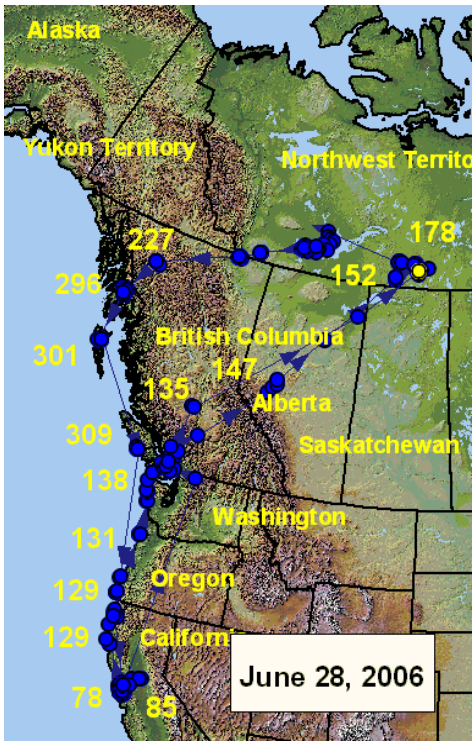


Figure 4: Migration route of Surf Scoter from wintering grounds in San Francisco Bay to nesting grounds in northern Canada. The numbers refer to days.

Loons are duck-like birds that spend most of their lives floating on the water and diving for fish. They nest in very low densities on inland lakes, primarily in Alaska and Canada. Common Loons formerly nested in northeastern California, but have been extirpated for over 50 years. Loons winter in near-shore ocean waters, bays, and (less commonly) at inland lakes within California.

Conservation Issues

All scoter populations are showing declines in various surveys, especially in the West (Brown and Fredrickson 1997; Savard et al. 1998; Conant and Groves 2003). The reasons for these declines are not well understood. Elevated levels of toxic contaminants, particularly metals ingested on the wintering grounds, have been found in most studies of scoters. However, it is difficult to relate these findings to decreases in the population, as the effects of these contaminants levels are not known. Nesting habitats in Alaska and Canada face threats from recreational development and natural gas extraction (e.g. roads and pipelines through breeding habitat). Wintering habitat may also be limited by human disturbance. Finally, research in Puget Sound shows that derelict fishing nets regularly trap and kill hundreds of adult birds each year during migration (Good et al. 2009). Greater Scaup and other waterfowl in this category have similar conservation issues. All waterfowl in this category are also harvested by hunters to some degree.

Loons nest in low densities, often one pair per lake, depending on the size of the water body. They are highly sensitive to human disturbance on their breeding grounds and thus require remote areas for nesting (Russell 2002). Like scoters, they are subject to mortality from derelict fishing nets in winter and in migration.

Injury Assessment

The table below summarizes the injury to these species, in terms of estimated mortality.

Species	**Estimated Mortality**
Common Loon	61
Pacific Loon	17
Red-throated Loon	12
loon, sp.	2
Greater Scaup	260
scaup., sp.	55
White-winged Scoter	43
Surf Scoter	1,147
scoter, sp.	23
Red-breasted Merganser	2
Long-tailed Duck	2
TOTAL	**1,624**

Restoration Alternatives

Restoration options for these species are limited. As of this writing, the Trustees continue to solicit restoration project concepts that will provide tangible benefits to Surf Scoters and other species in this category, either on their breeding grounds, wintering grounds (ideally in San Francisco Bay), or at migration stopover points. The Trustees have researched a variety of projects, but have not selected any projects for the reasons described below. Instead, the Trustees will issue a request for proposals (RFP) soliciting scoter restoration projects.

SELECTED PROJECT	**SPECIES BENEFITS**
Release a request for proposal for a restoration project	**Scoters, large diving ducks**

Other Restoration Projects Considered

The Trustees considered the following projects but did not select them as preferred at this time. They may be reconsidered in the RFP process.

OTHER PROJECTS CONSIDERED	SPECIES BENEFITS
Wetlands or salt pond enhancement around San Francisco Bay	Scoters, other waterbirds
Wintering foraging habitat enhancement	Scoters
Removal of derelict fishing nets in Puget Sound	Scoters, large diving ducks, loons, and large grebes
Removal of derelict fishing nets in SF Bay or elsewhere in California	Scoters, large diving ducks, loons, and large grebes
Disturbance reduction in SF Bay	Scoters, large diving ducks, loons, and large grebes
Rehabilitation of sick and injured scoters	Scoters
Research of scoter mortality	Scoters

Wetlands or salt pond enhancement around San Francisco Bay

The Trustees specifically considered whether maintained salt pond habitat (see proposed projects under Salt Pond Divers) or newly developed wetlands (specifically at Cullinan Ranch in the North Bay) would benefit scoters. Based on extensive research of scoter wintering habits in the Bay (Takekawa et al. 2001, Warnock et al. 2002, Stralberg et al. 2009), scoters are unlikely to use salt pond habitat, including these project sites, in any significant numbers. Loons are similarly unlikely to use these habitats.

Wintering foraging habitat enhancement

This project would enhance foraging habitat for wintering scoters, either in San Francisco Bay or elsewhere on the Pacific Coast (e.g., Puget Sound). Various techniques could be used, including providing substrate for mussels to colonize. This project could potentially benefit scoters (but not loons) if food availability is a limiting factor during winter. This project is not currently selected as a primary project because there is little information regarding the need for improved foraging for wintering scoters, and there are no specific plans regarding project implementation. The Berkeley Pier project will include a small component that should provide additional foraging opportunities for scoters.

Removal of derelict fishing nets in Puget Sound

This project would provide some benefits to scoters and other species at an important migration stop-over location. However, recent efforts have already removed many of the worst-offending nets, and funding was recently received from another source to complete the project. Removal of nets in Canadian waters of Puget Sound and the Strait of Georgia may be considered through the RFP process. However, this project is not currently selected for Canadian waters due to a lack of information on the prevalence of derelict nets and impacts to birds.

Removal of derelict fishing nets in SF Bay or elsewhere in California Due to the nature of the fisheries in San Francisco Bay, derelict nets are not known to be a problem. Derelict fishing gear (e.g. abandoned nets and crab pots) on the outer coast of California has been known to impact wildlife, but not these species in appreciable numbers.

Disturbance reduction in San Francisco Bay
This project would set aside areas of San Francisco Bay, as is done in Richardson Bay, to prohibit boats so that the birds may forage and rest undisturbed. This project is not selected because: (1) there is no strong evidence that disturbance is having a significant effect on scoter populations; and (2) there are feasibility concerns in excluding the public from using navigable waterways.

Rehabilitation of Sick and Injured Scoters
This project would provide funds to existing bird rehabilitation centers to enable greater care for scoters suffering from oiling from chronic sources, gunshots, entanglement in fishing gear, and diseases. It would result in an increase in the number of individuals rehabilitated and released each year.

This project would not fund rehabilitation of birds oiled from future spills—that is already a legal requirement of the responsible parties of the spills. Restoration of non-spill related birds has been implemented as a compensatory restoration project for Brown Pelicans in Florida, where hundreds of pelicans are injured each year by fishing gear.

This project is not currently selected because of uncertainty over the size of the benefits, although it could potentially address a portion of the scoter injury.

Research of Scoter Mortality
This project would provide funds for research assessing other mortality factors (e.g. diseases, parasites, etc.) that are affecting scoters. This could begin with an examination of the 1,800 carcasses collected during the spill. The benefits could be new information on issues affecting scoters, as well as new information that would aid rehabilitation of sick and injured scoters. Because the connection between research and population benefits is indirect at best, in most circumstances the Trustees prefer to fund projects that provide direct benefits to the birds. However, the Trustees do plan on turning over the carcasses to the scientific community for further study.

Scoters and large diving ducks will likely benefit in limited ways from the Berkeley Pier Enhancement Project described in section 4.3.1.6, as it will provide some foraging habitat for these species.

Compliance with relevant environmental laws will be evaluated upon consideration of the project proposals and any required environmental compliance for selected projects will be completed by the Trustees or the project implementer.

4.3.1.4 Large Grebes

Background
Like loons, grebes are aquatic birds that spend most of their lives floating on the water and diving for fish. They nest on inland lakes along marsh edges and winter in near-

shore ocean waters and inland lakes. Unlike loons, many grebes nest in temperate climates, including California.

Figure 5: Western Grebe on nest. Photo by Steve Hampton, CDFG.

Two species, the Western Grebe and the Clark's Grebe, are closely related and often nest in close proximity in dense colonies. These two species are known as *Aechmophorus* grebes. These species occur regularly along the California coast in winter, as well as at large inland lakes. They nest at various lakes throughout the western United States and Canada.

Conservation Issues

Western Grebe populations have declined significantly in the past 25 years. Data from Christmas Bird Counts reveal that total Western Grebe counts have fallen from approximately 80,000 in 1980 to just over 40,000 in recent years. Like loon nests, grebe nests are constructed as small islands of vegetation that sit low, usually floating at the surface of the water. Unlike loons, Western and Clark's Grebes nest in dense colonies (although they are also known to solitarily nest). Of the approximately 5,000 pairs in California, the vast majority of them nest at just four lakes: Eagle Lake in Lassen County, Tule Lake National Wildlife Refuge (NWR) in Siskiyou County, Clear Lake in Lake County, and Lake Almanor in Plumas County.

Nesting grebes are vulnerable to human disturbance. The colonies are so concentrated that a single disturbance event by a boat or personal watercraft could destroy the majority of a colony's breeding attempt in any given year. Grebe nesting colonies in California are subject to several factors that may reduce or eliminate nest productivity in any given year: wave wash from boat wakes, disturbance and direct destruction of nests from boats or personal watercraft (e.g., jet-skis), sudden changes in water levels (Ivey 2004), and potentially reduced food supplies. Recent data from Clear Lake show that grebe colonies have suffered from severe disturbance events (from boats) in 6 of the past 13 years (1992-2004), reducing nest productivity by an average of 80 percent in those years (D. Anderson, pers. comm.).

Injury Assessment

The table below summarizes the injury to these species, in terms of estimated mortality.

Species	**Estimated Mortality**
Western Grebe	769
Clark's Grebe	56
Western/Clark's Grebe	246
TOTAL	**1,071**

Restoration Alternatives

Restoration options for these species on their wintering grounds, such as San Francisco Bay and the outer coast, are limited. This is because there are no identified limitations on these species imposed by wintering ground conditions. However, there are some feasible options for protecting and improving nesting habitat on the breeding grounds. The Trustees have selected the Tule Lake nesting habitat project to compensate for the injuries caused by the oil spill.

SELECTED PROJECT	SPECIES BENEFITS
Creation of grebe nesting habitat at Tule Lake NWR	**Western/Clark's Grebes**

Selected Alternative

Creation of Grebe Nesting Habitat at Tule Lake National Wildlife Refuge

This project is intended to increase grebe nesting habitat at Tule Lake National Wildlife Refuge (NWR). This area is one of four major grebe nesting sites in the state. Furthermore, it is the only one that is free of human disturbance. Western and Clark's Grebes nest here and spend their winter in San Francisco Bay and elsewhere along the Pacific Coast in near shore waters.

Figure 6: Map of Tule Lake NWR.

The primary goal of this project is to lower and manage water levels at a large reservoir known as Sump 1-A to create more emergent vegetation in the form of tule marshes. Grebes build their nests out of aquatic vegetation, essentially constructing a low-lying floating island in which to lay their eggs.

Specifically, the water level will be lowered about two feet, allowing the marsh to grow from 2,500 acres to 3,360 acres. It is estimated that this additional habitat will accommodate up to 500 more pairs of grebes. Currently, about 340 pairs of Western and Clark's Grebes nest at this location each summer, although numbers are highly variable.

This project, which was designed in consultation with Tule Lake NWR staff, includes the following specific tasks:

- Pumping water to lower the level each summer, and then to refill it each fall.
- Installation of additional water control structures (e.g. pumps, gates, etc.)

- Monitoring, or other actions to avoid "take", of fish that may be affected by changed water levels, for at least two years
- Monitoring of grebe nesting for five years

The fish monitoring, and other potential actions, is for a remnant population of Lost River and shortnose suckers, both of which are state and federally endangered species. The monitoring will examine the effects of the reduction in water levels (including potential changes in dissolved oxygen, temperature, and pH) on the survival and movements of the fish.

Affected Environment

This project will be located at Sump 1-A of Tule Lake National Wildlife Refuge. A freshwater marsh with a grebe colony already exists in the southwest corner of this reservoir. This project will lower the water level of the impoundment, increase the vegetated area, and create shallower water throughout. The shallow water and mudflats created by lowering water levels will provide germination conditions for emergent marsh vegetation. This approach is and has been used in other areas of the refuge with success. Such habitat is in keeping with the goals of the refuge. The primary concern is the effect of altered water levels on Lost River and shortnose suckers.

Environmental Consequences (Beneficial and Adverse)

This project is the subject of a separate NEPA review process currently being undertaken by the USFWS; therefore, this DARP/EA will not serve as the final impacts analysis. However, the Trustees note that the project will lead to increased nesting opportunities for Western and Clark's Grebes. Moreover, since this location does not experience human disturbance, such as from personal watercraft that may impact grebe colonies elsewhere, nesting success should be high. This will provide an overall benefit to Western and Clark's Grebes in California. Potential adverse effects on Lost River and shortnose suckers will be closely monitored, and effects will be minimized through adaptive management. Consultation under Section 7 of the ESA is currently underway with the FWS Office in Klamath Falls. The project is being coordinated with Bureau of Reclamation and the Tule Lake Irrigation District.

Probability of Success

Because there is already an established grebe nesting colony at this site, the likelihood of success is high. Because grebes do not exhibit strong nesting site fidelity, grebes that experience problems at other colony sites (e.g. due to human disturbance, inappropriate water levels, lack of forage fish) may rapidly colonize this site. The estimation of project benefits assumes that grebes both immigrate to the site and experience greater productivity.

Performance Criteria and Monitoring

The project includes five years of monitoring. Two measurements will be quantified:

- Total number of nests in Sump 1A for years 1-5 of the project.
- Juvenile/adult ratio during years 3-5 of the project.

Both aerial survey (with digital photography) and boat surveys will be used.

The project goal is to achieve 900 nests at the project site by the final year of water level management, with an average juvenile/adult ratio of at least 0.35 during years three through five.

Evaluation

The Trustees have evaluated this project using the threshold and additional screening criteria developed to select restoration projects and concluded that this project is consistent with and meets the objectives of these selection factors. They believe that this type and scale of project will effectively provide appropriate compensation for large grebes injured as a result of the spills and have therefore selected this project as a preferred alternative.

Other Restoration Projects Considered

The Trustees also considered the following projects but did not select them as preferred at this time.

OTHER PROJECTS CONSIDERED	SPECIES BENEFITS
Removal of derelict fishing nets in Puget Sound	Scoters, large diving ducks, loons, and Western/Clark's Grebes
Removal of derelict fishing nets in San Francisco Bay or elsewhere in California	Scoters, large diving ducks, loons, and Western/Clark's Grebes
Grebe colony protection at northern California lakes	Western/Clark's Grebes
Grebe colony protection at southern California lakes	Western/Clark's Grebes

The derelict fishing net projects listed were not selected for reasons discussed in section 4.3.1.3. Other nonpreferred projects, protecting colonies at northern and southern California lakes, are discussed below.

Grebe colony protection at northern California lakes

This project is described in detail in the Restoration Plans for the *Luckenbach*, *Stuyvesant*, and *Kure* oil spills. It is currently being implemented with funds from the *Kure* and *Stuyvesant* oil spill settlements, and will receive additional funds from the *Luckenbach* case. The *Luckenbach* funds will allow the project to expand to other lakes and grebe colonies, and to continue for approximately ten more years. Thus, the Trustees feel that this project already has sufficient funds.

Grebe colony protection at southern California lakes

This project would address the same issues that are addressed in northern California, as described above. *Aechmophorus* grebes do nest at some lakes in southern California, including Lake Cachuma (Santa Barbara County) and Lake Hodges (San Diego County). Less information is available on southern California lakes than northern California lakes, but disturbance is likely to be less of an issue at nesting sites in southern California (e.g., grebes at Lake Cachuma nest in areas off-limits to humans). In addition, it is unknown whether grebes nesting in southern California could have been present on San Francisco Bay at the time of the spill.

4.3.1.5 Salt Pond Divers (small diving ducks and small grebes)

Background

This category addresses injured species that commonly winter on flooded salt ponds in the San Francisco Bay, as well as in near shore bay waters. These are Lesser Scaup; Bufflehead; Ruddy Duck; and Horned, Eared, and Pied-billed Grebes. Eared Grebes accounted for 49% of the estimated birds killed from this category, and Horned Grebes and Ruddy Ducks accounted for 20% and 18%, respectively.

While these species winter in the Bay, they breed at lakes either inland or far north. Eared Grebes nest primarily at saline and shallow ponds in the interior West.

Conservation Issues

All of these species use low to high-salinity salt ponds in southern San Francisco Bay, and could be affected by the planned restoration of these ponds to tidal salt marsh habitat. Eared Grebes nest at inland marshes primarily in the Great Basin, and migrate to the Pacific Coast and inland Mexico during winter. The majority of Eared Grebes breeding in North America stop at Great Salt Lake or at Mono Lake during migration to feed on predictably abundant brine shrimp (Cullen et al. 1999). While feeding at these migration stopovers, Eared Grebes molt their flight feathers and become flightless. Thus, alteration of important migration stopover sites with predictable food resources could leave Eared Grebes without sufficient food to continue migration, and have disastrous consequences on populations. However, there is currently no evidence that Eared Grebe populations are declining (Cullen et al. 1999).

San Francisco Bay salt ponds may be used both as fall migration stopovers and as wintering habitat. More than 10,000 Eared Grebes typically use the South Bay Salt Ponds (Harvey et al. 1992). Although Eared Grebes have responded to changed management operations, which includes a reduction in salinity of some ponds under the Interim Stewardship Plan of the South Bay Salt Ponds Restoration Project (SBSPRP) by moving to other ponds that continue to be managed for solar salt production by Cargill Salt Company (South Bay Salt Pond Restoration Project 2007).

All birds in this category also nest in wetland habitats, and loss or alteration of wetlands throughout their breeding ranges could limit populations. Many Eared Grebes winter in the Gulf of California, and entanglement in fishing nets there may be an issue (Cullen et al. 1999). It is not known if Eared Grebes that migrate to San Francisco Bay then continue on to the Gulf of California, or remain to winter locally.

Injury Assessment

The table below summarizes the injury to these species, in terms of estimated mortality.

Species	Estimated Mortality
Horned Grebe	153
Eared Grebe	386
Eared/Horned Grebe	17
Pied-billed Grebe	2
Lesser Scaup	52
Bufflehead	16
Ruddy Duck	138
unidentified duck species	16
TOTAL	**780**

Restoration Alternatives

Because these species nest in widely scattered locations and habitats, the Trustees focused on improving wintering habitat as a way to address injuries caused by the spill. Specifically, the Trustees are proposing a component of the South Bay Salt Ponds restoration project specifically designed to benefit these species. This project is part of a much larger endeavor, by multiple agencies, to restore and manage the historic salt ponds in the South San Francisco Bay. This project would fill a gap in current plans by providing habitat for wintering small ducks and grebes.

SELECTED PROJECT	BENEFITS
South Bay Salt Pond restoration project for salt pond divers	**Salt pond divers**

Selected Alternative

South Bay Salt Ponds Restoration Project

The goal of this project is to provide high quality winter foraging habitat for small ducks and grebes within Eden Landing Ecological Reserve (ELER) as part of the overall SBSPRP. It is well documented that these ponds are important to, and highly preferred by, these species (Takekawa et al. 2001, Warnock et al. 2002, Stralberg et al. 2006, Stralberg et al. 2009).

The SBSPRP is a multi-agency, 50-year effort, and is the largest tidal wetland restoration project on the West Coast. The goals of the SBSPRP include restoration actions within 15,100 acres of former industrial salt ponds to restore tidal wetlands and other managed pond habitats. The SBSPRP is located at the southern end of San Francisco Bay, and includes parts of Eden Landing Ecological Reserve which is managed by CDFG, and the Ravenswood and Alviso Complexes (managed by USFWS). An Environmental Impact Statement/Environmental Impact Report (EIS/EIR) and restoration plan was completed in 2008, and the first phase of the project began in 2009. Further details are available at the project's website: http://www.southbayrestoration.org/. Only a small portion of the funds necessary to carry out this full project have currently been identified.

Much of the SBSPRP Phase 1 actions focus on restoring tidal salt marsh habitat in areas that are presently former salt ponds now managed for waterbird habitat. However, one

concern is that many birds, ranging from shorebirds to the salt pond divers listed above, have come to rely on some of these existing salt ponds as important habitat. Extensive research and modeling was employed to understand how different bird species will be impacted by the changes that will occur through the SBSPRP (see, for example, Stralberg et al. 2006). The project selected by the Trustees aims to address an as-yet-unfunded portion of the overall SBSPRP: the maintenance and management of Ponds E6A and E6B for Snowy Plovers in summer and small ducks and grebes in winter.

This selected project will focus on two approximately 350-acre ponds at Eden Landing Ecological Reserve (Ponds E6A and E6B) and will include the following specific tasks:

- Installation of water control structures;
- Annual management of water levels and water quality, pumping, and levee road maintenance, for 12 years;
- Water discharge monitoring for all years and bird monitoring of bird species for the first five years.

Specifically, water will be maintained at very low water depths in the summer, to benefit plover nesting, and maintained at higher levels during the fall through spring for the benefit of the small ducks and grebes. Salinity levels will also be monitored and adjusted through pond operations and management to provide the maximum benefit for these species.

Affected Environment

This project will be a component of the larger SBSPRP. A full discussion of the affected environment can be found in the EIR/EIS for the SBSPRP (South Bay Salt Pond Restoration Project 2007).

Environmental Consequences (Beneficial and Adverse)

As with the affected environment, a full discussion of the environmental consequences can be found in the EIR/EIS for the SBSPRP, which was completed by the project's implementing agencies, three of which are also natural resource Trustees participating in this *Cosco Busan* DARP/EA, and is in full compliance with NEPA and CEQA. Regarding the specific parameters of the project described above, the management of Ponds E6A and E6B is expected to provide benefits to Snowy Plovers in the summer and to the small ducks and grebes in the winter.

Council on Environmental Quality (CEQ) regulations on NEPA recommend the avoidance of repetitive discussions when more than one environmental document addresses the same action (such as is the case for this DARP/EA and the SBSPRP final EIS/EIR). Three of the Trustee agencies for the *Cosco Busan* oil spill are parties to the SBSPRP EIS/EIR. Therefore, the potential environmental impacts of the project have been considered for this DARP/EA as well. The other federal Trustees in this matter have considered the information contained in the SBSPRP EIR/EIS as well and incorporate by reference the analysis of environmental consequences contained in the SBSPRP EIS/EIR.

Probability of Success

The probability of success is high. Bird usage of these ponds has been extensively researched and the trustees believe the ponds will continue to attract and provide valuable habitat for the targeted species.

Performance Criteria and Monitoring

Water discharge quality will be monitored annually, and/or as required by law. Winter usage by small ducks and grebes will be monitored for five years. The goal of this project is to attract 2,240 birds in the winter. This is based upon an average of 7.9 birds/ha described in Takekawa et al. (2001).

Evaluation

The Trustees have evaluated this project using the threshold and additional screening criteria developed to select restoration projects and concluded that this project is consistent with and meets the objectives of these selection factors. They believe that this type and scale of project will effectively provide appropriate compensation for small ducks and grebes injured as a result of the spill and have therefore selected this project as a preferred alternative.

Other Restoration Projects Considered

The Trustees also considered one other project but did not select it as preferred.

OTHER PROJECTS CONSIDERED	BENEFITS
Creation of grebe nesting habitat at Tule Lake NWR	Western/Clark's Grebes

Creation of grebe nesting habitat at Tule Lake NWR

This project is the preferred project to address injuries to Western and Clark's Grebes. The Trustees considered whether this project would simultaneously provide benefits to Eared Grebes, but it was concluded that it would not.

4.3.1.6 Brown Pelicans, Cormorants, and Gulls

Background

This category includes the California Brown Pelican; Brandt's, Double-crested, and Pelagic Cormorants; Bonaparte's, Mew, Western, California, Heermann's, Glaucous-winged, Glaucous-winged x Western, and Glaucous Gulls; and Parasitic Jaeger. Cormorants represent 66% of the estimated mortality in this category, with Brandt's Cormorants being the majority of those. All of these species share several characteristics: they all forage in near-shore waters and in bays, they all spend considerable time out of the water roosting on rocks or other platforms, and they are frequently found roosting and foraging together.

Conservation Issues

At the time of the oil spill, the California Brown Pelican was listed as a State and federal endangered species. It was delisted by the State in June 2009 and by the federal government in December 2009. It nests in Mexico and on islands off southern California. It is a seasonal migrant in the Bay Area during the non-breeding season,

primarily during fall and winter. Brown Pelicans typically forage in relatively shallow coastal waters, feeding almost entirely on surface-schooling fish caught by plunge diving. Brown Pelicans are rarely found away from salt water and do not normally venture more than 32 kilometers (20 miles) out to sea. During the non-breeding season, Brown Pelicans roost communally and these roosting sites are essential habitat. Brown Pelicans have wettable plumage so they must have roost sites to dry after feeding or swimming (Jaques and Anderson 1987). Roost sites are also important for resting and preening. The essential characteristics of roosts include: nearness to adequate food supplies; presence of physical barriers to protect the bird from predation and disturbance; sufficient surface space for individuals to interact normally; and adequate protection from adverse environmental factors such as wind and surf (Jaques and Anderson 1987). Major roosts are found on jetties and other manmade structures, offshore islands and rocks, and beaches at the mouths of estuaries (Jaques and Anderson 1987). In some sections of the coast, such roosting sites are in short supply (Jaques 1994; Jaques and Strong 2002).

Double-crested, Brandt's, and Pelagic Cormorants occur in California year-round. The latter two species are found strictly along the coast, while Double-crested occurs inland as well. The Double-crested Cormorant was formerly listed as a California Species of Special Concern as a result of impacts from DDT in past decades. Like the pelican, these species require disturbance-free roost sites to enable them to rest and dry their plumage after foraging for fish in the water. Likewise, their nesting is limited to disturbance-free areas, typically small offshore rocks and human-made structures (e.g., bridges or abandoned piers).

The Bay Bridge and Richmond-San Rafael Bridge have hosted two of the largest Double-crested Cormorant colonies in the state. However, between 2008 and 2009, there has been a 73% and 36% decline in the number of nests on these two bridges, respectively (PRBO 2009). This decline may be due to changes in fish populations inside the Bay.

Most of the world's Brandt's Cormorants are in California, with central California being the center of their range. Presumably many of the birds killed in the spill came from the colony on Alcatraz Island. This colony formed in 1994 and has grown since then.

Unlike the other two cormorants, Pelagic Cormorants do not form large colonies, but nest at widely scattered locations, primarily outside the Bay but also at Alcatraz Island.

The gull species occur along the coast, and some occur inland as well. The California and Western Gulls breed in California (including the San Francisco Bay area) and are present year-round, while most of the others breed north of California and are present primarily in the winter months. Many of the species nest on offshore rocks and other platforms, frequently in close proximity to cormorants and pelicans.

Pelicans and cormorants need to dive into the water (the pelicans diving from the air) for food, which makes them especially at risk from oil spills. Gulls are able to forage on land as well as in the water.

Injury Assessment

The table below summarizes the injury to these species, in terms of estimated mortality.

Species	Estimated Mortality
Brown Pelican	22
Double-crested Cormorant	135
Brandt's Cormorant	262
Pelagic Cormorant	16
cormorant, sp.	94
Bonaparte's Gull	2
Mew Gull	8
Western Gull	110
California Gull	31
Herring Gull	8
Glaucous-winged (Gl-w) Gull	22
Gl-w x Western Gull	4
Glaucous Gull	2
gull, sp.	47
Parasitic Jaeger	2
TOTAL	**765**

Restoration Alternatives

While pelicans and most of the gulls do not nest in the Bay Area, all of the cormorants do. The pelicans and gulls rely on cormorant nesting sites for roosting and resting. The Trustees focused on projects that would support both cormorant nesting and pelican roosting. The Berkeley Pier enhancement project is selected because it will provide more nesting habitat for cormorants and disturbance free roosting for cormorants and gulls. Additionally, it will provide critical high-tide roosting habitat for shorebirds and may provide limited foraging opportunities for scoters and diving ducks.

SELECTED PROJECT	SPECIES BENEFITS
Berkeley Pier enhancement project	**Pelicans, cormorants, gulls, scoters and diving ducks, shorebirds**

Selected Alternative

Berkeley Pier Enhancement Project

This project will enhance portions of the dilapidated Berkeley Pier to benefit pelicans, cormorants, gulls, scoters and diving ducks, and shorebirds. The Pier itself is an approximately 2.5 mile long structure extending into San Francisco Bay, with only a small, landward portion maintained and accessible to the public. The remainder of the pier is dilapidated and closed to the public for safety reasons. For this project, a platform will be installed on old pilings near the end of the dilapidated pier and will be augmented with special structures to attract nesting cormorants. Pelicans and gulls would use the platform for roosting as well. Another platform will be installed near the base of the dilapidated pier, visible from the publicly accessible part of the pier, as a high tide roosting area for shorebirds. Finally, hawser ropes will be draped from the sides of the near-shore platform, into the water, to create a substrate for mussels, barnacles, and other invertebrates. It is anticipated that this will offer a food source for scoters and diving ducks.

Currently, the derelict portion of the pier consists primarily of pilings and some crossbeams. These have proven popular among the birds, but use is limited by the size of the available platforms. There is limited nesting by Double-crested Cormorants, Western Gulls, and Pigeon Guillemots. Near the base of the pier, shorebirds (primarily Willets, Sanderlings, Western Sandpipers, and Black-bellied Plovers) use available pilings and beams as a high tide roost.

Figure 7: Tip of the derelict portion of the Berekely Pier. Photo by Steve Hampton, CDFG.

This project will expand the usefulness of the derelict portion of the pier for these species. The cost of this project is currently the subject of a feasibility study.

Affected Environment

This project will be located in the central Bay, near the location of the oil spill, and will be constructed within the current footprint of the dilapidated portion of the Berkeley Pier. No new pilings will be used, unless necessary to replace existing ones for the structural integrity of the platforms. The environmental characteristics of this area are described in section 2.0 of this document.

Environmental Consequences (Beneficial and Adverse)

This project will lead to increased nesting opportunities for cormorants, increased roosting for pelicans, gulls, and shorebirds, and increased foraging opportunities for scoters and diving ducks. Moreover, since this location experiences limited human disturbance, nesting success should be high. This will provide an overall benefit to these species. The new platform will shade portions of the Bay, but these areas will be relatively small. There are no eelgrass beds that would be impacted by such shading.

Probability of Success

The probability of success is high. Cormorants, pelicans, gulls, and shorebirds already use the existing derelict pier in modest numbers, the only limitation on which appears to be the amount of space available for use by birds. The site is relatively free of disturbance and very proximate to bird foraging areas. It is reasonable to assume that the birds will quickly take advantage of increased and improved nesting and roosting structures at this site.

Performance Criteria and Monitoring

The pier will be monitored for five years, documenting cormorant nesting, as well as pelican and shorebird roosting, and scoter foraging. The goal of the project is to provide up to 60 cormorant nests and roosting sites for pelicans and shorebirds, and foraging for scoters.

Evaluation

The Trustees have evaluated this project using the threshold and additional screening criteria developed to select restoration projects and concluded that this project is consistent with and meets the objectives of these selection factors. They believe that this type and scale of project will effectively provide appropriate compensation for all pelicans, cormorants, and gulls, as well as some of the shorebirds, injured as a result of the spill and have therefore selected this project as a preferred alternative.

Other Restoration Projects Considered

The Trustees also considered the following projects but did not select them as preferred at this time.

OTHER PROJECTS CONSIDERED	SPECIES BENEFITS
Alcatraz Island human disturbance reduction project	Pelicans, cormorants, gulls
Reduce impacts to pelicans and gulls from fishing waste	Pelicans, gulls
Reduce entanglement and hooking of pelicans and gulls in recreational fishing gear	Pelicans, cormorants, gulls
Seabird habitat restoration on Southeast Farallon Island	Cormorants, gulls
Habitat enhancement for nesting Brandt's Cormorants	Cormorants

The Trustees do not prefer these other projects for the following reasons:

Alcatraz Island human disturbance reduction project

This project would also provide benefits to pelicans, cormorants, and gulls. It would primarily benefit Brandt's and Pelagic Cormorants and Western Gulls that nest on the island, as they are vulnerable to human disturbance. This project was not preferred primarily because the Berkeley Pier project is likely to provide a broader range of benefits and will allow new nests to be established, rather than just protecting existing nests. This project also is more likely to receive funds from other sources (e.g. an expansion of the Seabird Protection Network).

Reduce impacts to pelicans and gulls from fishing waste

Brown Pelicans and various gull species are often attracted to commercial fishing vessels off-loading small fish (e.g., sardines and anchovies) and squid, and to facilities where fish waste is desposited by recreational anglers. These birds may attempt to dive into open bins of fish and may get injured by off-loading machinery and vehicles. In addition, repeated bodily contact with fish and fish oil can lead to a loss of waterproofing on the birds, resulting in hypothermia and other health issues. This project has the potential to decrease mortality of pelicans and gulls, but there is little information available regarding the scope of this problem or methods to minimize impacts to birds. Thus, this project is not currently proposed.

Reduce entanglement and hooking of pelicans and gulls in recreational fishing gear

Brown Pelicans and other seabirds, including cormorants and gulls, are often attracted nearshore areas where schooling bait fish are abundant. If anglers are fishing in these areas (e.g., from coastal piers), seabirds can be inadvertently

hooked or entangled in fishing line. In addition, discarded waste fishing line can entangle seabirds. This project would use outreach to raise public awareness and educate anglers about ways to reduce their chances of hooking birds and what to do if one is hooked. Outreach could include printed materials and/or training of docents. This project is not currently selected due to a lack of information on how the project would be implemented and how the benefits of the project would be scaled.

Seabird habitat restoration on Southeast Farallon Island
This project would help to restore seabird breeding habitat by restoring the native plant community. On Southeast Farallon Island, several species of non-native plants have become dominant and are displacing native plants, including Maritime Goldfield, which is the predominant vegetation that is used for nests of Brandt's Cormorants, Double-crested Cormorants, and Western Gulls. Efforts to control the invasive plants have been ongoing for almost 20 years but large seed stocks have made control difficult. This will be a very intensive effort requiring several years to implement and may include: revised methods to control or eradicate the most invasive non-native plants; methods to control the extensive seedbanks of invasive plants; and methods to restore the native plant community, including propagation and planting of natives. This project is not preferred because it is farther from the spill site and the time to provide benefits is longer than for the preferred project.

Habitat enhancement for nesting Brandt's Cormorants
This project would remove non-native vegetation (especially ice plant) currently covering potential nesting ledges for Brandt's Cormorants in central/northern California. A pilot study was conducted in 2011 along West Cliff Drive in the City of Santa Cruz, showing that nesting cormorants successfully colonized mainland cliff ledges cleared of invasive ice plant. This project would expand habitat restoration for nesting cormorants within Santa Cruz and/or other sites in the region. The project could also potentially benefit nesting Pigeon Guillemots which nest in crevices that may be covered by ice plant. This project is not currently selected due to the greater distance from the spill site compared to the preferred project, and the lack of benefits to pelicans.

4.3.1.7 Shorebirds

Background

A wide variety of shorebird species, including Western Sandpipers, Dunlins, Snowy Plovers, and Willets, are found in the San Francisco Bay area and the adjacent outer coast in November. Some are passing through, migrating further south, and some spend the winter in the Bay Area. While most of these species breed far to the north, such as along the Arctic Slope, a few species breed in this area. These include the Snowy Plover, which breeds at salt ponds in the San Francisco Bay and winters along the coast, such as at Ocean Beach, Crissy Field, and a few other sites. Shorebirds typically forage in intertidal waters for small invertebrates.

Of the 1,422 shorebirds estimated killed by the spill, 56% were Western Sandpipers. These nest in tundra along the Bering Sea and Arctic Ocean, and winter along the coast from Washington State to South America. Large numbers of them spend November in the Bay, which is a key migration stopover point for them.

Conservation Issues

Most of the shorebird species have stable populations, yet they are vulnerable to loss of habitat at migration stop-over points and wintering locations. During these time periods, large numbers of shorebirds, and indeed a large percentage of the world's population for a single species, may concentrate at a single estuary, including San Francisco Bay. In the Bay, extensive mud flats provide foraging opportunities at low tide. However, high tide roost sites away from predators and disturbance are in short supply. During high tides, large numbers of shorebirds will roost on rock walls, old piers and pilings, and whatever infrastructure they can find away from the shoreline disturbances.

The Pacific coast population of the Snowy Plover is listed as "threatened" under the federal Endangered Species Act. The primary threats to it include loss of nesting habitat due to European beachgrass (*Ammophila arenaria*), encroachment from urban development, disturbance from human recreational activities, and predation exacerbated by human disturbance (USFWS 2001). The species is also considered a Species of Special Concern by the State of California and is on the Red List of the National Audubon Society, the most at-risk category. They nest at scattered sites along the California coast, where their population is small and declining.

Injury Assessment

The table below summarizes the injury to shorebird species, in terms of estimated mortality.

Species	**Estimated Mortality**
Black-bellied Plover	116
Snowy Plover	2
Semipalmated Plover	1
Killdeer	14
Black Oystercatcher	4
Black-necked Stilt	10
American Avocet	30
Spotted Sandpiper	3
yellowleg Sp.	3
Willet	127
Whimbrel	2
Long-billed Curlew	6
Marbled Godwit	39
Black Turnstone	9
Sanderling	33
Western Sandpiper	799
Least Sandpiper	30
Dunlin	139
dowitcher spp.	54
shorebird, sp.	1
TOTAL	**1,422**

Because of their special status, the Trustees conducted an extensive study to examine the effects of the spill on Snowy Plovers. That study concluded that 52 Snowy Plovers were oiled during the spill, most of them only lightly. Because Snowy Plovers rarely enter the water, their ability to survive oiling may be greater than for other species. Some of the oiled plovers were previously color-banded, and the Trustees, with the help of PRBO Conservation Science, banded additional birds and tracked 23 oiled and 22 unoiled plovers for over a year after the spill. The survival rate of the two groups was similar. Thus, it is likely that the spill killed fewer than five Snowy Plovers. Further details of the study are provided in Appendix C.

Restoration Alternatives

Shorebirds will benefit from several of the projects identified and described elsewhere in this plan.

- Berkeley Pier Enhancement Project: This project, discussed above, will include a component to provide roosting platforms for shorebirds. High tide roost sites are in short supply in the Bay, and already shorebirds pack onto a wide variety of human-made structures at high tide, including the remnants of the Berkeley Pier. This project includes a platform that will include a substrate attractive to shorebirds and will be located at the base end of the dilapidated pier. This is already their preferred area and will be visible to the public from the tip of the publicly-accessible portion of the pier.

- South Bay Salt Ponds: This project, also discussed above, managing water levels in two 350-acre ponds for small grebes and diving ducks in the winter, will also be managed for Snowy Plover nesting in the summer.

- Aramburu Island: It is anticipated that this project will create improved roosting areas as well as mudflats, which will create additional foraging areas for shorebirds.

There are two additional projects that could benefit shorebirds. They are not selected at this time but will be considered if there are available funds:

- Albany Bulb Jetty Cuts: This project would involve cutting one or more small channels into the small jetties at the tip of the Albany Bulb. This would essentially turn these small jetties into islands. Protected from wandering people and dogs and cats, this would provide a safe high-tide roost for shorebirds, and perhaps safe nesting habitat for Black Oystercatchers.
- Predator Management in the Monterey Bay area for Snowy Plovers: This project entails predator management actions to benefit nesting Snowy Plovers in Monterey and Santa Cruz counties. Some of the plovers oiled by the *Cosco Busan* oil spill nest in the Monterey Bay area. Management of introduced or human-subsidized predators, especially Common Ravens, is essential to ensure plover productivity meets recovery plan goals. Management actions may include symbolic fencing to protect nests, nest exclosures, and predator removal. This project is not preferred as the trustees' selected project to benefit salt pond divers

(i.e., salt pond restoration in San Francisco Bay discussed in section 4.3.1.5) will benefit nesting Snowy Plovers, thus meeting the project selection criterion to provide multiple resource and service benefits.

4.3.1.8 Alcids and Procellarids

Background

This category includes Common Murres, Pigeon Guillemots, Ancient Murrelets, Cassin's Auklets, Rhinoceros Auklets, and Northern Fulmars. Another alcid, the Marbled Murrelet, is not included in this injury category. Because of its threatened status and unique conservation needs, it is treated separately in section 4.3.1.9. Murres represent 70% of the birds estimated to have been killed in this group.

Murres, guillemots, murrelets, and auklets are in the Alcid family and are thus related to puffins. They are small to medium-sized duck-like birds that spend most of their lives at sea, coming ashore on remote islands and coastal rocks to nest. On the West Coast, they generally occur from Alaska to Baja California, with the Farallon Islands hosting the largest nesting colonies south of Alaska for many of these species. They dive from the surface of the water for fish or zooplankton such as krill.

Northern Fulmars are Procellarids, which is the same Order that includes albatross. These birds are also highly pelagic, spending most of their lives far out at sea foraging on fish and zooplankton, coming ashore only to nest. Northern Fulmars wintering off California nest in Alaska.

Conservation Issues

Historically, alcids suffered population declines for several reasons. Some breeding colonies were impacted by human development and disturbance, egg collection (on the Farallones during the Gold Rush), and the introduction of predators such as rats and foxes. Because alcids are long-lived species (living up to 30 years), the loss of adults can severely impact their population. At sea, adults have been killed in large numbers by various oil spills and commercial gill-netting operations. Today, with gill-netting and egging eliminated and oil spills much-reduced from historical rates, murre populations throughout the state are steady or increasing on a long recovery trajectory towards historical levels. Because alcids are among the longest-lived and slowest reproducing of all birds, typically laying only one egg a year (if they nest at all), recovery will continue to take many decades.

Today, the primary conservation concerns are human disturbance and raven predation at nesting colonies. Annual reproduction in alcids is variable and thought to be a function of available prey and oceanic conditions. Changing sea temperatures can thus impact nesting colonies.

There are on-going restoration projects addressing some of these issues in California, especially human disturbance of colonies.

Procellarids around the world face a variety of threats at their breeding grounds and at sea. For many species, over 90 percent of the population nests at a few locations, sometimes on a single island. At these locations, the entire colony may be at risk from predation by introduced non-native species (e.g., rats, cats) or from habitat and ecosystem changes caused by non-native species (e.g., rabbits, goats). Human disturbance and trampling of burrows is also significant at some locations. At sea, Procellarids are at risk from certain commercial fishing practices, such as long-lines and drift nets, although recent changes in fishing practices and methods have reduced the by-catch of some species of seabirds in some regions (e.g., Alaska). Procellarids also suffer mortality from the ingestion of plastic waste floating on the ocean's surface. In contrast, Northern Fulmars, perhaps because of their willingness to scavenge offal from commercial fishing vessels, have increased dramatically in recent years (Hatch and Nettleship 1998). Because of this, they have not been a focus of conservation concern.

Of the Procellarid species that occur locally, the Ashy Storm-Petrel, with its small population and limited range, is probably the most threatened. Approximately half of the world's population breeds on the Farallon Islands, where it has declined (Sydeman et al. 1998).

Injury Assessment

The table below summarizes the injury to these species, in terms of estimated mortality.

Species	**Estimated Mortality**
Northern Fulmar	134
Common Murre	633
Pigeon Guillemot	6
Ancient Murrelet	3
Cassin's Auklet	15
Rhinoceros Auklet	104
alcid, sp.	9
TOTAL	**904**

Restoration Alternatives

Several restoration projects for Common Murres are underway in California, largely funded from settlements from past oil spills. These other projects cover the feasible options for large-scale restoration for this species in central California. However, there is a feasible and urgently needed opportunity to benefit Rhinoceros Auklets, Cassin's Auklets, and Ashy Storm-Petrels on the Farallon Islands, which is the selected project. The Farallon nest site enhancement project is selected because it will address an urgent need and provide tangible benefits. The project is to replace deteriorating nest boxes used by the auklets and create additional rocky crevices for nesting storm-petrels.

SELECTED PROJECT	**SPECIES BENEFITS**
Farallon nest site enhancement project	**Rhinoceros Auklet, Cassin's Auklet, Ashy Storm-Petrel**

Selected Alternative

Farallon Nest Site Enhancement Project

This project aims to provide high quality nesting sites for Rhinoceros Auklets, Cassin's Auklets, and Ashy Storm-Petrels. The first two are burrow nesters and will utilize nest boxes placed in the ground, while the latter nests in rocky crevices.

Currently on Southeast Farallon Island there are 450 Cassin's Auklet and 80 Rhinoceros Auklet nest boxes. These boxes have provided secure nest sites for these burrow-nesting seabirds. However, in recent years, many of the boxes have fallen into disrepair. Furthermore, because of the thin materials and locations of the boxes, they have been subject to overheating. The island has experienced unusually warm days in recent summers and this phenomenon is expected to increase due to climate changes. This has resulted in adult birds dying in their nest boxes due to the heat. This project will replace all of these deficient boxes with higher quality boxes, turning unproductive nest sites that can lead to adult mortality into successful breeding sites. The project includes redesigning the boxes, building new ones with better insulation and more durable materials, and placing them on the island in more protected locations with more soil cover.

The second component of the project is to create nesting habitat for crevice nesting seabirds such as the Ashy Storm Petrel by using old concrete slabs and other old construction materials that have no current use. The materials will be broken up and arranged into rock piles for nesting habitat. Fully half the world's population of Ashy Storm Petrels nest in the rocky crevices on one hillside on Southeast Farallon Island. This project would provide up to 60 additional nesting sites.

This project, which was designed in consultation with Farallon NWR staff, includes the following specific tasks:

- Nest box design and experimentation
- Nest box construction and installation
- Concrete slab removal and re-assembly into rock formations
- Monitoring

Affected Environment

This project will be located at Southeast Farallon Island, which is part of the Farallon NWR. The Farallon Islands are described in section 2.0.

Environmental Consequences (Beneficial and Adverse)

This project is expected to provide benefits, in the form of new and improved nesting sites, to Rhinoceros and Cassin's Auklets, and to Ashy Storm-Petrels, as described above. No adverse effects are anticipated. Jack-hammer use, installation of nest boxes, and any other physical work on the island will be done during the fall when the birds are not present; therefore, the potential impacts are anticipated to be not significant.

Probability of Success

The probability of success is high. While Alcids and Procellarids have very specific nesting requirements, the construction of artificial nest sites for them has been

implemented successfully in the past, at the Farallones and at other sites in California. With each new project, lessons learned from the past are applied, making the new nest sites more successful. Thus, the ornithologists at the Farallones fully expect the birds to occupy these new nest sites and reproduce successfully.

Performance Criteria and Monitoring

This project will include monitoring of the new bird nest boxes and crevices to document the occupancy of these nest sites by the birds and their reproductive rates. The goal of the project is to have these new sites occupied by breeding pairs with a fledging rate equal to or higher than the old nest sites. The goal is to achieve 60 Rhinoceros Auklet and 200 Cassin's Auklet nests in new boxes, and 60 Ashy Storm-Petrel nests in the newly created artificial habitat.

Evaluation

The Trustees have evaluated this project using the threshold and additional screening criteria developed to select restoration projects and concluded that this project is consistent with and meets the objectives of these selection factors. They believe that this type and scale of project will effectively provide appropriate compensation for all Alcids and Procellarids injured as a result of the spill and have therefore selected this project as a preferred alternative.

Other Restoration Projects Considered

The Trustees also considered the following projects but did not select them as preferred at this time.

OTHER PROJECTS CONSIDERED	SPECIES BENEFITS
Removal of derelict crab pots	All alcids
Seabird Protection Network to protect murre colonies	Common Murre
Fortification of the Murre Ledge, Southeast Farallon Island	Common Murre
Bird Island enhancement	Common Murre
Mouse eradication on Southeast Farallon Island	Ashy Storm Petrel
Bird blind to reduce disturbance at Devil's Slide Rock Trail	Common Murre, Pigeon Guillemots

Removal of derelict crab pots in the Gulf of the Farallones

This potential project would fund removal of derelict crab pots that have been abandoned on the ocean floor. While birds may occasionally get trapped and die in the crab pots, the available data suggest this is unusual. Thus, the project would likely provide only minimal benefits to these species.

Seabird Protection Network to protect murre colonies

This project seeks to protect Common Murre colonies from human disturbance e.g., from boats and aircraft. This project is not preferred as it is currently being funded by other sources (i.e., Luckenbach NRD settlement http://www.dfg.ca.gov/ospr/Science/Luckenbach.aspx).

Fortification of the Murre Ledge

The Murre Ledge on Southeast Farallon Island was installed and monitored with funds from the *Command* oil spill settlement to shield an expanding murre colony from researchers walking on a frequently used trail. In the last couple of years,

California sea lions have been climbing into the colony area, causing damage to the unfortified wall. Modifications could be made to the artificial ledges to discourage sea lions from climbing onto them. This project is not preferred as it does not provide as many benefits as the preferred project and may receive funding from other sources.

Bird Island habitat enhancement

In 2008, breeding by murres was documented for the first time on Bird Island, located just north of Point Bonita in the Marin Headlands. For the last two years, murres have only bred underneath the palate-like wooden remains of a former structure on the western facing slope of the rock. This structure provides protection to the small murre colony from predatory Western Gulls, who nest on top of and adjacent to the structure. As the structure is small, the number of murres nesting under it is very limited and appears to be saturated. This structure could be removed, replaced and expanded with long-lasting plastic wood to provide more long-term, protected habitat for Common Murres. With more protected habitat for more murres, the colony could expand beyond the artificial habitat as the rock has enough space to support tens of thousands of murres. While this project could provide some benefits to murres nesting under the structure, it is not certain that benefits would extend beyond the artificial habitat. This project is not preferred as it does not provide as many benefits as the preferred project.

Mouse eradication on Southeast Farallon Island

This project will restore critical seabird nesting habitat by eradicating the introduced non-native House Mouse. These mice are directly and indirectly impacting the breeding success of burrow nesting seabirds, particularly, the Ashy Storm-Petrel. This project is not preferred as it is currently being funded by other sources (i.e., Luckenbach NRD settlement http://www.dfg.ca.gov/ospr/Science/Luckenbach.aspx).

Bird Blind to reduce disturbance at Devil's Slide Rock Interpretive Trail

In late 2012, the Devil's Slide section of Highway 1 between Pacifica and Half Moon Bay will be re-routed through a tunnel. The old road along the cliffs, about 1.5 miles in length, will become a walking and biking trail open to the public. While the trail will offer spectacular views of the cliffs and ocean, it will also subject nesting Common Murres, Pigeon Guillemots, and cormorants to disturbance, which could jeopardize these nesting colonies.

This project would involve building a blind along sections of the recreational trail to protect these birds from disturbance. This project would have multiple benefits: 1) Protect seabirds from human disturbances in an area that is known to be have vulnerable seabird populations; 2) provide hikers and bikers with enhanced viewing opportunities of nesting Common Murres, Pigeon Guillemots, Peregrine Falcons, and other seabirds and marine mammals; and 3) educate visitors about the importance of protecting seabirds from human disturbance.

This project is not currently preferred because of uncertainties associated with the project design and benefits, and because the preferred project likely provides larger benefits.

4.3.1.9 Marbled Murrelets

Background

The Marbled Murrelet is a small seabird in the alcid family found along the Pacific Coast from Alaska to northern California. At sea, it feeds by diving for small fish in near-shore waters, typically within 5 km of the coastline. Unlike most alcids, the Marbled Murrelet nests up to 50 km (most within 30 km) inland in late-successional and old-growth coniferous forests. In California, it nests almost exclusively in redwoods (*Sequoia sempervirens*) 200 years old and older (Nelson 1997). Like most alcids, the Marbled Murrelet is a long-lived slow-reproducing species, laying only one egg per year.

Conservation Issues

The Marbled Murrelet is listed as a "threatened" species under the federal Endangered Species Act and as "endangered" under state law. The North American Waterbird Conservation Plan considers it a species of "high concern," while the National Audubon Society has placed it on its "yellow list" for species that are declining or rare. In California (Figure 8), fewer than 5,000 birds nest in Humboldt and Del Norte Counties (Marbled Murrelet Conservation Zone 4), while a much smaller population of less than 500 birds nests in the Santa Cruz Mountains south of the San Francisco Bay area (Zone 6). There are even fewer murrelets in Zone 5 (Mendocino, Sonoma, and Marin Counties). The Northwest Forest Plan estimated the population for all of Zone 5 at 48 birds, most of which presumably occur from the Gualala River north (USDA and USDI 1994). A DNA study has shown that the Santa Cruz Mountain population is genetically distinct from the others (Hall et al. 2009).

Fig 8: Marbled Murrelet conservation zones

The population of Marbled Murrelets in California is declining. The primary factors affecting murrelet populations throughout California are decreased availability of suitable nesting habitat (old-growth forest) and predation by corvids (USFWS 2009). Nest predation risk appears to be related to proximity to humans (recreation sites and housing), proximity and type of forest edge to the nest, and abundance of avian predators (USFWS 2009). As a consequence of dramatic increases in corvid abundance (i.e., Stellar's Jays and Common Ravens) in California, and especially in the Santa Cruz mountains, high

corvid densities are observed around campgrounds and picnic areas located in or adjacent to murrelet nesting habitat (Peery and Henry 2010). The most recent 5-year review of the species found that the Santa Cruz Mountain population is experiencing near-zero reproduction and declining at 15% per year, consistent with the annual adult mortality rate (USFWS 2009).

Injury Assessment

During the spill, three murrelets were collected oiled and dead. Based on the Ford Report (see Appendix B), which utilized the Beached Bird Model, the trustees estimate that 13 Marbled Murrelets were likely to have been killed by the spill.

During the spill, aerial surveys for Marbled Murrelets and other species were conducted over ocean waters on five different days (November 8, 9, 13, 15, and 21). Murrelets were observed in unusually high numbers off the southern Marin County coast. On the first three dates, only two birds were seen, but the flights were short and covered a small area. More extensive flights on November 15 and 21 counted 20 and 57 murrelets, respectively, as detailed in Table 2 and Figure 9.

Table 2: Results of Marbled Murrelet Aerial Surveys

	Area Surveyed (km^2)	MAMU counted	MAMU/ km^2
Nov 8	6.4	0	0
Nov 9	2.8	2	0.71
Nov 13	6.0	0	0
Nov 15	21.5	20	0.93
Nov 21	44.6	57	1.28

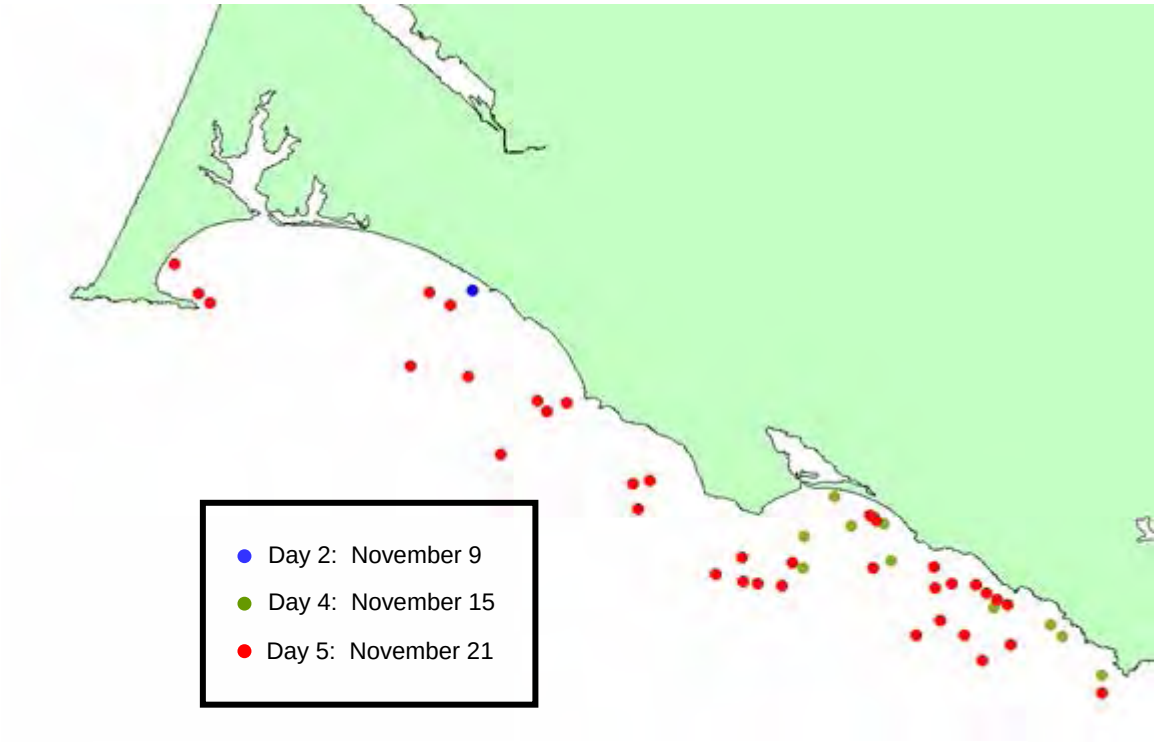


Figure 9: Location of Marbled Murrelets detected on aerial surveys after the spill.

DNA analyses of the three Marbled Murrelets collected during the spill indicate they came from northern California or points further north, and not from the Santa Cruz Mountain population. However, because birds from both populations are known spend the winter in the spill zone, and because birds from the Santa Cruz Mountains would have likely been in such a minority as to be easily missed by the sample size of three birds, the Trustees will assume birds from both populations were present and will consider restoration actions in both areas.

Restoration Alternatives

Traditionally, two types of projects have been employed to benefit the Marbled Murrelet population when it has been impacted by an oil spill: (1) the protection of nesting habitat via acquisition of conservation easements or fee title to old-growth forests in danger of being logged; and (2) management of corvid populations to reduce their numbers around campgrounds in prime murrelet breeding areas to reduce predation on murrelet nests (eggs and chicks).

Recently, however, new research has revealed additional restoration actions that may also provide benefits to Marbled Murrelets and may enhance existing corvid management efforts (see R. Golightly comment http://www.dfg.ca.gov/ospr/Science/cosco_busan_admin.aspx; Z. Peery, pers. comm.). These include conditioned taste aversion (CTA) and jay removal. Both of these measures are essentially new forms of corvid management to protect murrelets and offer the promise of additional reductions in jay predation of murrelet nests. Increasing murrelet productivity in the short-run is vital to sustaining the species (Peery and Henry 2010). Studies and experiments regarding these methods are currently on-going.

Given the dire condition of the Marbled Murrelet population in both the Santa Cruz Mountains and in northern California, and given that new restoration methods may be developed at any time, the Trustee Council is proposing a comprehensive and flexible Marbled Murrelet Restoration Project.

SELECTED PROJECT	SPECIES BENEFITS
Marbled Murrelet Restoration Project	**Marbled Murrelet**

Selected Alternative

Marbled Murrelet Restoration Project

This project is designed to restore Marbled Murrelets using a variety of actions. These actions may be implemented anywhere in California where Marbled Murrelets may benefit (i.e., Zones 4, 5, or 6). The actions most likely to be implemented are described in detail below, and an assessment of their environmental effects is provided. If new restoration methods are developed following release of this Environmental Assessment, additional environmental compliance will be conducted as appropriate.

Nest predation by corvids, especially ravens and jays, is thought to be one of the primary causes for low productivity among Marbled Murrelets in California. Hebert and Golightly (2007) documented murrelet nest depredation by Steller's Jays and Common Ravens and recommended that steps be taken "to minimize anthropogenic activities that may increase

local corvid densities or disturb murrelets during the early incubation period." Corvids are the predators having the greatest impact to Marbled Murrelets (USFWS 2009).

Actions that would be implemented under the preferred project consist of expanding current corvid management efforts to additional areas as well as including additional corvid management measures. The current efforts are designed to increase Marbled Murrelet productivity by managing corvid populations in certain campgrounds where breeding murrelets, human trash and food scraps, and corvids coincide. Reducing human food subsidies is critical to reducing corvid predation pressure on murrelet nests, as these subsidies are a root cause of high corvid abundances. Such projects are already underway in the Santa Cruz Mountains (at Big Basin Redwoods, Butano, and Portola State Parks, and at Memorial and Pescadero Creek County Parks) and at Redwood National and State Parks in Humboldt and Del Norte Counties. Humboldt Redwoods and Grizzly Creek State Parks in Humboldt County meet these conditions but neither park has a dedicated corvid management program.

Current corvid management efforts include:

- education of campers and visitors regarding the effects of human food waste;
- "soft" enforcement of food storage regulations to reduce human food waste;
- improvements to garbage receptacles;
- improvements to food storage lockers; and
- removal of ravens and/or their nests.

While education efforts and improvements to garbage infrastructure have resulted in substantial reductions in relative densities of jays in the Santa Cruz mountain parks since 2003, jay densities are still over 7 times higher than in similar habitats without food subsidies (Suddjian 2010). In Redwood National and State Parks jay numbers in campground areas were 5 times higher than in control areas (Bensen 2008). The Trustees believe additional measures to decrease predation risk to murrelet nests is warranted to restore murrelets.

Under the proposed Marbled Murrelet Restoration Project, the existing efforts described above would be expanded into new areas within Marbled Murrelet Zones 4, 5 and 6 and/or augmented by the new measures listed below:

- conditioned taste aversion (CTA);
- removal of jays and/or their nests; and
- installation of food waste receptacles at water spigots (grates).

These new measures provide additional ways to address predation risk. Installation of food waste receptacles within camping and picnic areas is an additional means to improve infrastructure to reduce the amount of human food subsidies available to corvids; the effects of grates are considered to be similar to and consistent with other measures to improve infrastructure to reduce the amount of food waste in current corvid management efforts. CTA addresses predation risks by jays to murrelet eggs. Jay removal addresses high jay densities to reduce predation risk to murrelet nests (eggs and chicks).

Conditioned taste aversion (CTA) involves training jays to avoid Marbled Murrelet eggs by exposing them to painted chicken eggs (colored to mimic murrelet eggs) that contain carbachol shortly before the start of, and during, the murrelet incubation period. Carbachol is a drug that mimics the action of the neurotransmitter acetylcholine. It causes jays and many other species to experience temporary discomfort, nausea, and possibly vomiting when ingested. In humans, carbachol is used primarily to treat glaucoma (in eye drops) or used in eye surgery. In horses, it is given to treat colic. Treated eggs would be secured with zip-ties to branches >3 meters above the ground. Eggs would be placed in forested areas surrounding the campgrounds and picnic sites and up to 2 km away. The density of eggs placed in the forest would vary depending on jay densities, with average egg densities anticipated to be <2 eggs/ha. Jays that ingest carbachol-treated eggs are expected to associate the unpleasant experience with murrelet eggs such that they modify their behavior and avoid ingesting actual murrelet eggs they encounter in the future.

Recent cage and field studies suggest that it may be possible to safely train a large number of jays in the wild to avoid murrelet eggs (Gabriel and Golightly 2011). Gabriel and Golightly (2011) observed subdued activity, beak wiping, and vomiting in jays ingesting carbachol-treated eggs but did not observe any lasting ill effects. The advantage of this CTA approach is that it is a non-lethal predator management action that has been successfully tested on other predator species (Conover 1990; Avery et al. 1995, Cox et al. 2004). CTA would be implemented in a phased approach, with initial experimental applications to Butano and Portola State Parks and Memorial, Sam McDonald, and Pescadero Creek County Parks (all in San Mateo County), and then Big Basin State Park (San Mateo and Santa Cruz Counties). If effectiveness monitoring (see *Performance Criteria and Monitoring* section below) indicates success and funding is available, CTA may be expanded to other applicable murrelet nesting habitats in Marbled Murrelet Zones 4-6. This measure will be subject to additional environmental review and/or permitting as needed (e.g., Migratory Bird Treaty Act and CEQA).

Jay removal involves the humane trapping and subsequent euthanasia of up to several hundred jays from one or more campgrounds. As jays quickly learn to avoid traps, multiple methods will likely be necessary including baited walk-in traps, noose carpets, mist nets, and bow nets. The goal would be to reduce jay numbers in old-growth forest around campgrounds to more closely resemble jay densities observed in similar habitats without human-food subsidies. The advantage of this approach is that it immediately and directly addresses on-going jay predation pressure on murrelet nests including eggs and chicks. Methods will be consistent with the recommendations of the American Veterinary Medical Association Guidelines on Euthanasia (2007). This measure will be subject to additional environmental review and/or permitting as needed (e.g., Migratory Bird Treaty Act and CEQA).

For all Murrelet Restoration Project measures implemented, corvids and Marbled Murrelets will be monitored (see *Performance Criteria and Monitoring* section below) for the duration of the project and the associated data will be used to inform management decisions and implementation of further project components.

Additional measures may be developed in the future. These measures could augment corvid management, enhance or protect Marbled Murrelet nesting habitat, improve

murrelet foraging at sea, increase murrelet productivity or survival, or perhaps achieve murrelet restoration through other avenues. If the Trustees consider implementing any such measures, the Trustees or project implementer would undertake additional environmental review, including public comment, as appropriate. The environmental assessment here is restricted to the most likely methods, delineated by the bullets above.

Affected Environment

This project would be located in one or more of the campgrounds and surrounding areas described above, or potentially at any campground, picnic area, or similar site near where Marbled Murrelets are likely to nest, in Marbled Murrelet Conservation Zones 4, 5, or 6. These are areas comprised of old growth and large second growth redwood and Douglas fir forests.

Environmental Consequences (Beneficial and Adverse)

This project is intended to improve Marbled Murrelet nest success through a decrease in predation caused by jays and ravens. Any improvement in nest success will help forestall, and potentially help reverse, the decline of the Marbled Murrelet species in California. Sustaining a Marbled Murrelet population through the next few decades will enable future Marbled Murrelets to access increasing amounts of protected old growth forest and second growth forest as they mature into suitable nesting habitat.

The educational components of the project will attempt to teach the public about imbalances in the ecosystem that may be caused as different species respond positively and negatively to human actions. Specifically, the public will learn how seemingly innocuous interactions with wildlife (e.g., feeding jays at a picnic table) or poor housekeeping at a campsite (e.g., leaving a bag of chips on a table) sustains corvid populations at unnaturally high levels, which in turn can have immediate and long-term negative consequences for the Marbled Murrelet. To the extent that humans adjust their behavior favorably to these messages, there may be a corresponding benefit to the environment.

As described below, corvid management measures to reduce human food subsidies to corvids (e.g., education, soft enforcement, improvements to garbage protection and food storage, and installation of food waste receptacles at water spigots) as well as on-going raven removal will have minimal, negative direct impacts on campers or on jays, ravens, and possibly other animals that scavenge food waste at campgrounds. Any adverse impacts are anticipated to be less than significant.

Campers may experience more rules and restrictions upon their food management and may be subject to an enforcement action should they fail to comply. Although this may inconvenience some campers, such measures are already in place, to a degree, in order to avoid attracting bears to the campgrounds. To date there have been no reported complaints regarding the current corvid management efforts described above. Other campers may experience the positive benefit of having a cleaner camping environment and having fewer jays and ravens surrounding their picnic table. The adverse and beneficial effects to campers would therefore be less than significant.

Reducing human food subsidies in and around campgrounds and picnic areas is intended to displace those corvids that have become dependent on human-food subsidies. Returning jay densities in murrelet nesting habitat in the vicinity of the campgrounds to levels present in similar habitat without human food subsidies will reduce nest predation risk for murrelets. The foraging ecology of jays in old growth forest habitat surrounding campgrounds and further removed from campgrounds is currently under investigation in Zones 4 and 6. Preliminary data indicate that jays with territories >1 km from campgrounds do not travel to forage in campgrounds (Will Goldenberg, pers. comm). Steller's Jays are common and a widely distributed species (Alaska, south to Nicaragua). The reduction in human food subsidies in murrelet nesting habitat is a small fraction of the human food subsidy available to jays from other campgrounds and picnic areas outside of murrelet habitat, and sources such as birdfeeders, etc. In addition, the number of jays potentially affected is a small portion of the regional population of jays. Therefore, any adverse impacts to jays that utilize food subsidies at campgrounds are anticipated to be less than significant.

Ravens have much larger home ranges than jays. Current monitoring indicates that the relative abundance of ravens is much lower than jays, so fewer individuals will likely be affected either by reductions in foraging opportunities around campgrounds or by lethal removal actions. Ravens are abundant in California and the small numbers removed from campgrounds will not adversely impact any regional raven populations. The adverse effects to ravens would therefore be less than significant.

In toxic doses, carbachol stimulates all bodily secretions, produces severe gastrointestinal colic, diarrhea and shortness of breath, increases then slows heart rate, and can cause respiratory paralysis or heart block. A recent study found that jays ingesting egg contents treated with 24 mg or 32 mg of carbachol may vomit or experience gastrointestinal discomfort resulting in subdued activity up to several hours, and beak wiping which may last from several minutes, up to an hour (Gabriel and Golightly 2011). Based on an average weight of 115 g for jays, ingestion of the entire 24 mg treated egg would result in an available dose of 209 mg/kg. Most of the jays in the study consumed only a fraction of the available dose. Gabriel and Golightly (2011) reported that there were no jay mortalities at either dose, no observable lasting adverse effects, and all experimentally-dosed jays were later released back into the wild and subsequently re-sighted alive. The toxicity of exposure of birds to carbachol-treated eggs would vary with the dose of carbachol ingested as well as the frequency and duration of the exposure. However, with this aversive 24 mg dose, conditioning is expected such that birds will avoid ingestion of additional treated eggs, limiting their exposure. Therefore, no significant adverse effects are expected for jays ingesting carbachol-treated eggs. Conditioned jays that will no longer ingest murrelet eggs are unlikely to suffer from food deprivation as bird eggs are not a major food source for jays and murrelet eggs are themselves, relatively rare among forest birds.

Other avian egg predators that may be exposed to carbachol-treated eggs include Gray Jays, ravens, and possibly crows. Gray Jays occur in coastal coniferous forests along the coast from Alaska to Mendocino County, California and are uncommon in Redwood National and State Parks near the southern extent of their range. They are smaller than Steller's Jays (75 g vs. 115 g) so ingestion of an entire carbachol-treated egg would result

in a larger dose. However, the dose received by a Gray Jay would be within the range of doses safe for Steller's Jays as determined in Gabriel and Golightly (2011). Therefore, the Trustees anticipate that even if Gray Jays ingested the contents of treated eggs, there would be no significant adverse effect to individuals or regional populations. Ravens and crows are larger than Steller's Jays so they would effectively receive a smaller dose. It is not certain that this dose would induce aversion. If ravens and crows that ingest carbachol-treated eggs are successfully conditioned to avoid murrelet eggs, they are unlikely to suffer from food deprivation because they are omnivores with diverse diets like jays. Murrelet eggs are likely to make up a very small portion of their diet. The Trustees anticipate that any adverse effects to other corvids are less than significant.

In a pilot experiment, 214 carbachol-treated eggs were placed in a systematic grid covering 428 ha (Gabriel and Golightly 2011). In addition to corvids, black bears and small mammals were suspected of predating the eggs in the pilot study. Given the large size of bears, relative to the dose of carbachol, no adverse effects to bears is expected from ingestion of treated eggs and therefore effects are expected to be less than significant.

Raccoons, Virginia opossums, ringtail cats, weasels and mink, fishers, pine martens, spotted skunks, and to a lesser extent striped skunks potentially could encounter and opportunistically ingest treated eggs. The safe and lethal doses are unknown. Raccoons and opossums are common, occurring over a widespread geographical area. Given the limited geographical area in which eggs will be placed and low densities of treated eggs, the number of animals potentially exposed will be small relative to the local and regional population levels. Any adverse impacts are expected to be less than significant for raccoons and opossums.

Dogs, cats, and ferrets are carnivores that respond to known emetics (Andrews and Horn 2006), and it is expected that ringtails, weasels, mink, fishers, pine martens, and skunks also have the ability to vomit. Based on a cited report of nausea and vomiting in dogs dosed with 3 mg/kg carbachol (Naunyn-Schmiedeberg's Archiv fuer Experimentelle Pathologie und Pharmakologie. Vol. 164, Pg. 346, 1932), it is anticipated that ingestion of treated egg contents would cause gastrointestinal stimulation resulting in nausea or vomiting. As vomiting purges the body of toxic substances and reduces exposure, it is unlikely that a lethal dose would be ingested in these wild carnivores. If ingestion of carbachol-treated eggs results in successful conditioning to avoid murrelet eggs, it is unlikely that these carnivores would suffer from food deprivation because eggs are a minor portion of the diet and they are highly unlikely to encounter murrelet nests. Fishers are not present in the Santa Cruz Mountains (i.e., Murrelet Conservation Zone 6) and are rare in Redwood National Park. If present in the project area, it is unlikely that fishers will encounter treated eggs as they forage mostly on the ground. Given the limited geographical area in which eggs will be placed and low densities of treated eggs, the number of animals potentially exposed will be small relative to the regional population levels for these predatory mammals. Therefore, any adverse impacts are expected to be less than significant.

Rodents, such as rats, woodrats, deer mice, house mice, Douglas' squirrel, Northern flying squirrel, Western gray squirrel, and chipmunks also may encounter and ingest

treated eggs. The lethal dose is 40 mg/kg for rats (Journal of Pharmacology and Experimental Therapeutics. Vol. 58, Pg. 337, 1936) and 5 mg/kg for mice (The Merck Index: Encyclopedia of Chemicals, Drugs and Biologicals S. Budavari (ed)., Rahway, NJ, 1989). Mice and rats, and presumably squirrels and chipmunks, are physically unable to rid themselves of toxic substances by vomiting (Andrews and Horn 2006). Partial consumption of treated egg contents for these small rodents species could result in a lethal dose. These rodent species are common in forested habitats. Given the relatively small geographical area in which treated eggs will be available, limited duration of potential egg exposure, the low density of treated eggs, and the limited number of individuals potentially exposed to eggs relative to the rodent population levels, any adverse effects to rodents are expected to be minor, short-term, and less than significant to the local and regional populations.

The minimum lethal human dose for carbachol has not been delineated. However, given that treated eggs will be secured with zip-ties to branches >3 meters above the ground, at very low densities (<2 eggs/ha), and non-depredated eggs will be removed at the end of the murrelet incubation period, it is highly unlikely that humans will encounter, much less ingest, treated eggs.

Jay removal around campgrounds to more quickly reduce jay densities to levels observed in similar habitats without human-food subsidies is expected to benefit murrelets by reducing jay predation on eggs and chicks. Humane trapping methods will minimize adverse impacts to other non-targeted forest birds that will be released if captured. Removal of jays from campground areas may also provide benefits to other forest nesting birds by reducing their predation risk. Jays are common around campgrounds in murrelet habitat, especially in the Santa Cruz Mountains (Suddjian 2010), but the numbers removed will not adversely impact any regional populations. The adverse effects to jays would therefore be less than significant.

Probability of Success

The success of camper education and garbage control relies on several linkages: the link between project tasks and an actual reduction in food waste; the link between a reduction in food waste and an actual reduction in corvid numbers; and the link between a reduction in corvid numbers and an actual reduction in nest predation.

The first two linkages have been demonstrated in the Santa Cruz Mountains, where education and outreach efforts, combined with improved garbage facilities, has led to a substantial drop in relative jay density at the campgrounds (Suddjian 2010).

The final link between corvid numbers and actual nest predation is difficult to measure directly because Marbled Murrelet nests are difficult to find and study. However, experiments with artificial eggs have found that predation pressure declines with decreasing corvid density (Raphael et al. 2002). Thus, the changes to food storage and food waste infrastructure in campgrounds and camper education to reduce human-food subsidies for corvids has a reasonable probability of success over the long-term.

The success of CTA has been demonstrated in a cage study and a pilot field study in Zone 4 (Gabriel and Golightly 2011). It is not known whether a larger-scale

implementation exposing jays to treated mimic eggs will result in concomitant increases in murrelet productivity. Even if CTA is completely successful, if jay densities are high enough, predation pressure on chicks may offset increases in egg survival. Jay removal to reduce jay densities near campgrounds in murrelet nesting habitat is expected to decrease predation pressure on murrelet nests. Preliminary research by Peery (pers. comm. 2011) has found that naïve jays are remarkably easy to capture near campgrounds. There is some uncertainty as to the duration of benefits for both of these projects. Specifically, the duration of conditioning in wild jays is not fully understood. Nor, as to the jay removal component of the project, is the response of non-territorial jays that may backfill into a removal area known. Given these unknowns and uncertainties, the Trustees intend to conduct pilot evaluations in a few selected areas prior to full-scale implementation.

Performance Criteria and Monitoring

Because Marbled Murrelet nests are difficult to find, and nest predation difficult to study directly, the success of the project will be monitored through Marbled Murrelet surveys, corvid surveys, and annual progress reports from the land managers on the implementation of the corvid management tasks. A strong emphasis will be put on post-breeding at-sea surveys for murrelets, as these surveys are the easiest way to monitor murrelets, including juveniles and determine reproductive rates. Monitoring for potential non-target species effects, for example installing cameras focused on mimic eggs to identify predators, will be included as part of conditioned taste aversion implementation.

Evaluation

The Trustees have evaluated this project using the threshold and additional screening criteria developed to select restoration projects and concluded that this project is consistent with and meets the objectives of these selection factors. They believe that this type and scale of project, if successful, will effectively provide appropriate compensation for all Marbled Murrelets injured as a result of the spill and have therefore identified this project as the preferred alternative.

Other Restoration Projects Considered

The Trustees have identified as the preferred project, a project that includes corvid management actions in Zones 4 through 6.

OTHER PROJECTS CONSIDERED	SPECIES BENEFITS
Corvid management at Humboldt Redwoods and Grizzly Creek SPs	Marbled Murrelet
Breeding habitat protection via acquisition or easement (various sites)	Marbled Murrelet

Corvid management at Humboldt Redwoods and Grizzly Creek State Parks

This was the preferred project in the initial version of this section of the Draft DARP. It is retained in this version, but expanded upon to include a broader geographic area and a wider array of murrelet conservation measures. Given the critical condition of the Marbled Murrelet in California, the Trustees believe that greater flexibility in addressing the species' conservation needs is necessary.

Breeding habitat protection via acquisition or easement

This project is not excluded under the current proposed project, but is part of it, should a suitable parcel become available. As land acquisition or conservation

easements may only be undertaken from a willing seller and such opportunities are limited and difficult to predict, the Trustees anticipate that the Murrelet Restoration Project will initially focus on corvid management measures. Any acquisition or easement if undertaken, is not expected to result in any significant adverse impacts; public lands are not under consideration so there would be limited adverse impacts to recreational uses. If a specific parcel(s) is identified, depending on the circumstances, further environmental analysis may be undertaken.

4.3.1.10 Other Bird Species

Background

A variety of other bird species were also impacted by the oil spill. These are mostly wetland species as well as raptors, which most likely became oiled when preying upon injured oiled birds. The vast majority of these wetland birds were American Coots. The table below summarizes the injury to these species, in terms of estimated mortality.

Species	Estimated Mortality
Greater White-fronted Goose	2
Canada Goose	5
Great Blue Heron	4
Black-crowned Night-Heron	4
Red-shouldered Hawk	2
Red-tailed Hawk	4
Common Moorhen	2
American Coot	76
American Crow	5
Fox Sparrow	2
TOTAL	**106**

No specific restoration project is identified for these species, as they will benefit from several of the various habitat projects described in section 4.3.4.

4.3.2 Mammals

Some mammal species are quite vulnerable to oiling, while others are much less so. Marine mammals that rely on their fur to keep them warm while swimming in the ocean are the most vulnerable. These include Northern Fur Seals and Sea Otters. As with birds, oil can destroy these mammals' ability to stay warm, allowing ocean water to penetrate against their skin. They quickly become hypothermic and unable to forage. Other marine mammals, such as California Sea Lions, Harbor Seals, dolphins, porpoises, and whales, rely on their blubber to keep warm. Light oiling thus does not necessarily compromise their ability to keep warm; however, oil can cause injury if it gets around their eyes, nose, or mouth. Researchers also determined from examining marine mammals exposed to oil during the *Exxon Valdez* oil spill that the aerosols released by oil at the sea surface may damage the lung tissue of seals when they surface to breathe.

Also, they are at risk of ingesting oil. Additionally, Harbor Seals oiled during the *Exxon Valdez* spill had higher concentrations of polycyclic aromatic hydrocarbons (PAHs) in blubber than reference samples (Dierauf and Gulland 2001, Loughlin 1994).

Terrestrial mammals, such as Raccoons and River Otters, may forage on land as well as in the water. So, while they still may encounter oil in water and become hypothermic, they can potentially survive by staying out of the water and foraging on land.

In this spill, five mammals were collected oiled during the spill: two Northern Fur Seals, one Harbor Seal, and two Raccoons. There were observations of small amounts of oil on many sea lions and Harbor Seals.

4.3.2.1 Overview of Data Collection and Studies

This list below summarizes the various field studies, data collection tasks, and analyses used for the assessment of mammal injuries.

- **Live and Dead Mammal Intake Data**
  - This data is collected as a normal part of the spill response. It describes the collection of each mammal, with such information as date, location, condition, degree of oiling, etc.

- **Surveys of Pinnipeds at Haul-out Sites**
  - These surveys focused on known haul-out sites for seals and sea lions, assessing the degree of oiling and any other observable impacts to the animals. A minimum of 232 California Sea Lions and Harbor Seals were observed with some oiling on them; although, most of this was very light and did not appear to affect them.

- **Collection of Oiled Mammal Observations**
  - In addition to the surveys conducted above, reports of oiled mammals from the public and other agencies were collected.

- **Oil Sampling at Haul-out Sites**
  - Oil samples from rocks and other substrates were collected from haul-out sites.

- **Tissue Analysis at Intake**
  - Blood and tissue samples were collected from live and dead mammals at intake for analysis. Additionally, necropsies were performed on dead marine mammals.

- **River Otter Scat Analysis at Rodeo Lagoon**
    - Otter scat was collected and analyzed for the presence of oil.

- **Harbor Seal Reproduction Assessment**
    - Harbor Seals were captured to collect blood and tissue samples for assessment and monitoring of reproduction success.

4.3.2.2 Summary of Injury

Background

This category includes both marine and terrestrial mammals. Fur seals, California Sea Lions, Steller Sea Lions, Harbor Seals, dolphins, porpoises, whales, Sea Otters, and River Otters are particularly at risk, potentially foraging and reproducing among the spill-affected waters.

Conservation Issues

Northern Fur Seals are the most vulnerable of these populations. They occur from Alaska to Baja California, but are more rare south of Alaska. Historic population declines occurred in the 18th and 19th centuries, when they were extensively hunted for their fur. More recently, several factors (e.g. loss of prey, entanglement in fishing nets, changes in climate) may have caused further declines. They are now considered "vulnerable" under the Endangered Species Act. In California, they breed on the Farallon Islands in small numbers and at San Miguel Island.

Harbor Seals and California Sea Lions are the most common pinnipeds along the California coast and are commonly seen from shore, but Harbor Seals are the only year round resident pinniped within San Francisco Bay. California Sea Lions mostly breed on the Channel Islands in southern California, but a small number also breed at Año Nuevo Island and at the Farallon Islands. Mostly adult males and some juveniles migrate north and congregate onshore at various haul-out sites in the San Francisco Bay Area, including Pier 39 in San Francisco. Harbor Seals haul-out on many sites within the San Francisco Bay Area, but within the bay they breed at only a few locations, including Castro Rocks and Mowry Slough. Both Harbor Seal and California Sea Lion numbers are stable or increasing in California. In contrast to the rest of the colonies on the coast, the Harbor Seal population within San Francisco Bay has had a mixed recovery, likely due to habitat alteration, disturbance, and pollution (Grigg et al. 2004).

Raccoons are common in riparian and wetland habitats throughout the Bay Area, occurring even in suburban contexts. River Otters occur regularly along waterways, such as streams, rivers and lagoons, and are well documented in Rodeo Lagoon.

Injury Assessment

The only mammals oiled and collected during the spill were Northern Fur Seal, Harbor Seal, and Raccoon. Several Harbor Porpoise were documented swimming at the mouth of San Francisco Bay in the presence of oil slicks. Additionally, California Sea Lions were observed with oil on them at Pier 39, and harbor seals were observed with oil on them at several haul-out locations, including Point Bonita, Yerba Buena Island and

Castro Rocks. River Otters at Rodeo Lagoon prey upon birds on the lagoon. During the spill, some of them consumed oiled birds and oil was detected in their scat.

The table below summarizes the mammals collected with oil during the spill.

Species	Comments
Northern fur seal	1 pup collected alive at Asilomar, died next day; 1 pup collected dead at RCA Beach, Marin County.
Harbor seal	1 collected dead at Fitzgerald Marine Reserve
Raccoon	2 collected dead along the East Bay

Necropsies performed on the three seals suggested that the oil on them was not likely the primary cause of death.

Figure 10. A harbor seal with a patch of oil. Photo by Brent Stewart.

During routine field surveys of sea lion and Harbor Seal haul out sites within San Francisco Bay, few California Sea Lions or Harbor Seals were identified as oiled. Most oiling was light, including a light sheen or a few spots, and only three California sea lions were observed "heavily oiled" with tar. Additionally, oil was detected on the haul-out site at Yerba Buena Island and was observed in the surrounding waters of Point Bonita. Seals may have been oiled while they rested onshore at these sites.

Reproduction of Harbor Seals at sites within San Francisco Bay during the following breeding season in 2008 appeared normal (Flynn et al. 2009). However, there was one notable exception. A young Harbor Seal, less than three days old, was found stranded and rescued on April 14, 2008 in Sausalito (Harris et al. 2011). It was deformed, with brain-like tissue growing from its mouth. This condition, called congenital neuroglial heterotopia, had never before been documented in a wildlife species (only rarely in humans and once in a kitten). Because the pup could not survive, it was euthanized. The animal was tested for contaminants and was found to have elevated levels of polycyclic aromatic hydrocarbons (PAHs), which are associated with oil. Based on an analysis of the oil fingerprint and the nature of the deformity, researchers concluded that the mother may have been exposed to a large amount of oil, which was not run-off from vehicle or industrial use, during pregnancy. While researchers could not definitively link the rare deformity to the *Cosco Busan* spill, that spill occurred during the late first trimester to early second trimester of the pup's gestation. The researchers are confident this was an isolated case, as a survey of pups revealed no other deformities or signs of poor health.

River otters within Rodeo Lagoon were observed eating oiled birds, and oiled scat from river otters was collected (see also Salman 2007). While previous studies suggest that otters may be affected by ingestion of oil (Ben-David et al. 2001 and Ormseth and Ben-

David 2000), in this case, no dead or sick river otters were observed. River Otters continue to be seen regularly at Rodeo Lagoon, apparently without adverse impacts.

The studies described above showed that, while sea lions, seals, and River Otters were exposed to oil, there is no evidence to suggest significant injuries to them. The animals under surveillance continued to behave normally during and after the spill, and there was no evidence of reproductive impacts to harbor seals or to river otters.

Restoration Alternatives

Because injury is likely minimal, the Trustees are not proposing a specific restoration project to address any particular mammal species.

Nevertheless, it is likely that marine and terrestrial animals will benefit indirectly from restoration of habitat in wetlands, as wetlands restoration may enhance prey opportunities. Any restoration of spawning Pacific Herring will also benefit all marine mammals because herring that spawn in San Francisco Bay are important prey for seals, sea lions and cetaceans such as Harbor Porpoise and Humpback Whales. Seals may also benefit indirectly from any protection of seabird colonies from human disturbance because seals often haul out in similar habitat.

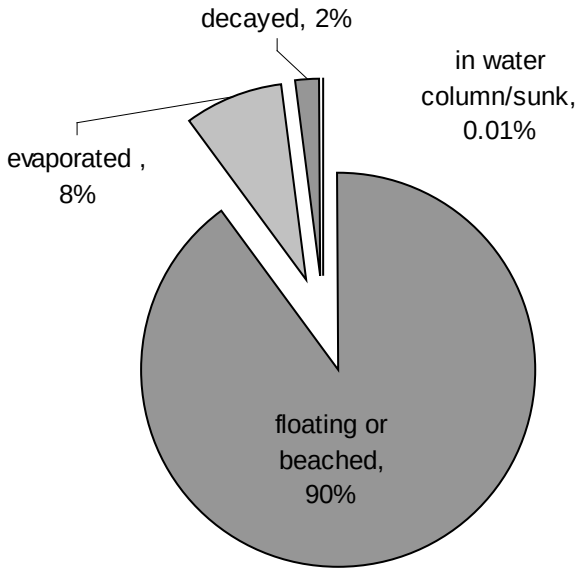
4.3.3 Fish and other Aquatic Organisms

All bay and ocean waters affected by the *Cosco Busan* oil spill are formally designated as essential fish habitat (EFH) and portions are designated as habitat areas of particular concern under the federal Magnuson-Stevens Fishery Conservation and Management Act. The Bay is also designated critical habitat for endangered Sacramento River winter run Chinook salmon and threatened Central Valley spring run Chinook salmon, Central California Coast steelhead trout and Central Valley steelhead trout, under the Endangered Species Act.

In the initial days and weeks after the spill the Trustees investigated the potential for injuries to several species of fish, crabs, and other aquatic fauna from the *Cosco Busan* oil spill. These animals may be harmed by oil spills if they are exposed directly to the oil, or to a fraction of the oil that may dissolve into the water, or if they eat contaminated prey.

The type of fuel oil spilled, IFO-380, is a thick black oil with a specific gravity less than that of seawater or bay water, making it unlikely that significant amounts of oil would be found submerged. Past experience and scientific models (e.g. California Type A Model from Applied Science Associates) suggest that a week after the spill approximately 90% of the *Cosco Busan* oil remaining in the environment (i.e., that which was not recovered during cleanup operations) was either still floating on the surface of the water or concentrated in nearshore intertidal areas (i.e., beached), 8% had evaporated, 2% had decayed, and less than 0.01% was in the water column.

Figure 11: Fate of IFO-380 after one week



During the response, the Incident Command and the Trustees conducted several studies to explore whether significant amounts of oil sank and had the potential to harm aquatic organisms in deeper water. These investigations did not find submerged oil. For example, water was sampled and analyzed from subsurface water intakes at the Aquarium by the Bay in San Francisco and the Romberg Tiburon Center; neither water sample contained *Cosco Busan* oil. Other assessment efforts surveying for submerged oil (described below) did not reveal evidence of subsurface oiling impacts. Therefore, the Trustees determined that it was unlikely that the *Cosco Busan* oil spill had measurable impacts on fish or other organisms inhabiting the *subsurface* waters of the bay and ocean and did not pursue further studies in these areas.

Despite this, there were still potential impacts to fish and other aquatic organisms along the shorelines, where wave action and sediments can mix the oil into the water column. The initial investigations for submerged oil did not address whether some of the oil along shorelines sank, stranded, and dissolved or mixed into the water and sediments, posing a risk to near shore species that occupy shallow areas along the shore. To examine this issue, five species were the subject of further assessment efforts.

- **Pacific herring**
  - Pacific herring spawn in near shore habitats in San Francisco Bay typically from late November to March, soon after the *Cosco Busan* spill. Herring spawn was observed in subtidal and intertidal locations where surface water and shoreline oiling was observed. Herring eggs are known to be very sensitive to the toxic effects of oil.

- **Tidewater goby**
  - Tidewater goby is a small resident fish that inhabits the shallow waters of Rodeo lagoon (Marin County) where some oiling occurred. It is federally listed as an endangered species.

- **California grunion**
    - The California grunion is more common to southern California coastal waters, but late spring, early summer spawning along some San Francisco Bay beaches has been observed in recent years. Some of these beaches were oiled following the spill.

- **Coho salmon**
    - Spawning and juvenile Coho salmon are known to pass through shallow near shore environments where surface water and shoreline oiling was observed.

- **Dungeness crab**
    - Dungeness crab (i.e., from 4 months to 1.5 years old) are known to inhabit shallow to deep subtidal regions where surface water and shoreline oiling was observed in San Francisco Bay, as well as along the outer Pacific coastline.

The Trustees' focus on Pacific herring was renewed after a field study conducted in February 2008 showed high rates of mortality and deformities in herring eggs collected from mid to low intertidal areas within the oil spill zone. Studies of the other target species did not suggest spill-related impacts. Herring became the focus of several follow-up studies, all of which are described below. Documentation for these studies is contained in the Administrative Record for this case. In addition, an overall herring injury report is included in Appendix D.

4.3.3.1 Overview of Data Collection and Studies

The list below summarizes the various field studies, data collection tasks, and analyses used for the assessment of fish injuries. It also summarizes the results of each task.

- **Report on the Safety of Consuming Fish and Shellfish from Areas Impacted by the M/V *Cosco Busan* Oil Spill in San Francisco Bay, California**
    - On November 13, 2007, California Governor Schwarzenegger issued an executive order suspending all fishing for human consumption in a five county area and ordered the Office of Environmental Health Hazard Assessment in conjunction with the Department of Public Health to issue a consumption advisory and conduct an assessment of potential human health risks from consuming marine life caught from areas affected by the spill. Several species of commonly caught fish and shellfish were collected and analyzed to determine levels of contamination and safety of human consumption. A report was prepared by California Environmental Protection Agency. The report concluded that consumption advisories should be lifted for all species and areas with the exception of mussels collected from Berkeley Marina and Rodeo Beach, because mussels

collected from these two locations exceeded the human health concentration limit of concern for benzo[a]pyrene equivalents.

- **Herring Spawning Locations Assessment**
  - Historical spawning data were obtained and analyzed, to compare with areas impacted by oil. A map was created that overlays recent herring spawning locations with shoreline cleanup and assessment team (SCAT) data on oiled shorelines and tar ball collections. The map layers indicated that herring were likely to spawn in several areas where shorelines had been oiled by the spill.

- **Herring Spawning Site Water Sampling**
  - Water from oiled herring spawning sites and non-oiled control sites were collected and analyzed for polycyclic aromatic hydrocarbons (PAHs). PAHs are a suite of chemical components found in petroleum products. All oil sources display a "fingerprint" of the unique proportions of the different PAHs that allow for confirmation of the source(s) by forensic analysis. PAHs found in a nearshore water sample collected on November 30, 2007, near Tiburon in Keil Cove (which had been moderately to heavily oiled) were determined to be a probable match with the *Cosco Busan* source oil.

- **Submerged Oil Screening Survey**
  - A rapid assessment survey was conducted by the Unified Command with the involvement of the NRDA Trustees to determine whether there were significant amounts of submerged oil present in San Francisco Bay. Pompoms were dragged by boat and deployed in eelgrass beds where submerged oil was most likely to be found. Pompoms were all found to be clean and it was concluded, based on this study and the properties of the spilled oil, that no significant amounts of oil were found in the water column or on the bottom of the bay.

- **Redwood Creek Salmon Data Analysis**
  - Salmon spawning data from Redwood Creek in Marin County were compared with data from other creeks and NOAA and CDFG salmon researchers were consulted to determine whether the complete absence of any returning Coho salmon in Redwood Creek in early 2008 might be attributable to the *Cosco Busan* oil spill. The Trustees determined that the absence of Coho salmon in Redwood Creek was not related to the spill; rather, it was due most likely to oceanic conditions, prior year droughts and floods, and other factors. Salmon spawning was severely depressed in all regional streams, not just Redwood Creek.

- **Tidewater Goby Habitat Assessment**
  - Water and sediment samples from Rodeo Lagoon were collected and analyzed to determine the risk to resident Tidewater Gobies, an endangered species. Based on the water column and sediment PAH data

collected in oiled and non-oiled areas of the lagoon, no significant risks to Tidewater Gobies were anticipated.

- **Tidewater Goby Surveys**
  - Detailed surveys of Tidewater Gobies in Rodeo Lagoon in Marin County were conducted and results compared to numbers from previous surveys. November 2008 and 2009 Tidewater Goby surveys performed by the National Park Service did not find a significant change (i.e., decrease) in estimated goby numbers in the lagoon or amongst lagoon zones exposed to different oiling levels and cleanup actions.

- **Dungeness Crab Analysis**
  - San Francisco and San Pablo Bays are important nursery areas for Dungeness crab. Crabs of the year enter the Bay complex during May and June and leave by August or September the following year. Young crabs (i.e., the instar stages) may spend a portion of their life span in shallow subtidal habitats. For example, bay surveys conducted by California Department of Fish and Game in the 1970's found that maximum dispersion of crabs-of-the-year was apparent from September through December. Crabs were found to concentrate along subtidal shorelines near piers, jetties, marinas, boat launching ramps, and other sites offering protection. However, they were conspicuously absent from the shallow mud flats that dominate much of south San Francisco Bay, the eastern portion of central San Francisco Bay, and north and west San Pablo Bay (DFG Bulletin 172, 1983). Based on this information, the Submerged Oil Screening Survey, and observations made on the more sensitive herring eggs in the subtidal zone (see below), the Trustees concluded that it was highly unlikely one could demonstrate injuries to Dungeness crabs at the juvenile life stage as a result of this spill.

    Even though there was no evidence of submerged oil on the ocean floor, adult crabs were also examined for potential exposure to oil. Samples of crab tissues from two different collections in January and February 2008 were analyzed for PAHs after 1) a crab fisherman reported retrieving dead crabs in pots deployed off Point Bolinas in January 2008 and 2) another crab fisherman reported seeing black things come out of a previously frozen crab being cooked. PAH concentrations were generally low and did not match *Cosco Busan* source oil. Pathological examination of Bolinas crabs showed evidence of disease (Hematovianum). Based on these investigations and the lack of submerged oil, it is unlikely that adult Dungeness crabs were exposed to *Cosco Busan* oil.

    The commercial crab fishery was closed, not because the crabs were being oiled on the ocean floor, but because the fishery uses surface water to keep the crabs fresh on board their vessels after harvesting them. This surface water potentially included floating oil, which would have contaminated the crabs on board the vessels.

- **California Grunion Assessment**
  - California Grunion are planktivorous fish that school in near shore environments. They live up to four years and spawn from March to August by stranding themselves on the beach to deposit their eggs in the moist sand. The known range of grunion extends from Baja California to Tomales Bay (Roberts et al. 2007), but only small populations are known to occur north of Point Conception. Grunion may have been first observed in San Francisco Bay in 1860 but there are no known records of their presence in the Bay until they were observed in 2001 by CDFG (Roberts et al. 2007). Small numbers of juvenile and adult grunion were identified in monthly midwater trawls in San Francisco Bay from 2001 to 2007, as reported by the CDFG San Francisco Bay Study and the Interagency Ecology Program for the San Francisco Estuary (pers. comm. K. Hieb). The total survey catch, consisting predominately of age-0 fish, was six in 2001, reaching a peak in 2005 at 284, and declining in 2006 and 2007 (47 and 58, respectively). Since 2008, grunion have been absent from monthly trawls, except for one adult collected to date in 2010. A similar pattern was observed in an annual May to August survey of dropped prey at the Alameda Point Least Tern colony (pers. comm. Elliott; Elliott 2008; Jahn and Jolliffe 2004). In 2000, three grunion were first observed, numbers were higher from 2002 to 2007 (ranging from 35 to 63), then declined to four in 2008 and zero in 2009 and 2010.Grunion were first observed spawning in San Francisco Bay in 2005 to a limited extent on sandy beaches (Johnson et al. 2009).

    There have been some concerns raised to the Trustees that the current absence of grunion in San Francisco Bay may be related to the November 2007 *Cosco Busan* oil spill. However, the Trustees did not find evidence that *Cosco Busan* oil caused this change in abundance. Following the spill, and as part of the Trustees' Herring Spawning Site Water Sampling and the Tidewater Goby Habitat Assessment, surface water samples were collected and analyzed by the Trustees. During both assessments, surface water collected approximately 6 inches beneath floating oil contained low parts per billion concentrations (<2.4 µg/l) of PAHs. Similar to conclusions drawn during the Tidewater Goby Habitat Assessment, these concentrations were unlikely to be acutely toxic to grunion, based on comparison to a variety of toxicity benchmarks. The critical target lipid body burden model (McGrath and DiToro 2009) predicts that the measured concentrations were two to three orders of magnitude below levels that would be lethal to inland silversides and sheepshead minnows, two laboratory test species similar to grunion. Levels of one of the PAHs, benzo(a)pyrene (<1 ng/l), were well below levels shown to impair reproduction or respiration in grunion (Winkler et al. 1983; Hose and Puffer 1984). Finally, comparison to acute toxicity benchmarks for individual PAHs (Suter and Tsao 1996; US EPA 2003) also indicate concentrations were orders of magnitude below toxic levels. Nevertheless, some lethality resulting from direct exposure of grunion

embyros to *Cosco Busan* oil during spawning on beaches may have occurred.

To evaluate this possibility, the Trustees also assessed the potential for California grunion to be exposed to *Cosco Busan* oil if they spawned along San Francisco Bay sandy beaches in the spring/summer of 2008. Grunion experts were consulted and maps were generated showing locations of recent grunion spawning runs in San Francisco Bay. Monitoring was conducted during the expected spawning season but no grunion spawning was observed in San Francisco Bay in 2008, 2009 or 2010. Coincidentally, although survey efforts were variable, no grunion spawning was observed in Monterey Bay or Tomales Bay in 2010 (pers. comm. R. Lea, D. Roberts). The recorded absence of juveniles, adults and spawning events since 2008 in San Francisco Bay may be due to changes in oceanic conditions. Roberts et al. (2007) reported that the observed increase in occurrence of grunion in the northernmost portion of their range in 2005 may have been due to anomalously warm sea surface temperatures. Relatively warm ocean conditions were observed in 2002 and continued until 2007 when cooler ocean conditions were reported that have continued through 2009 (McClatchie et al. 2009). This temperature regime corresponds to the grunion abundance pattern, such that warmer temperatures in the tidally influenced San Francisco Bay may have provided suitable conditions for the grunion until the pattern of cooler water temperatures returned. Johnson et al. (2009) hypothesized that San Francisco Bay may not support a viable population of grunion over the long term and that their persistence in the Bay may depend on continuous northern migration from southern California. While ocean conditions may play a dominant role in the abundance of grunion in San Francisco Bay, limited survey data with adequate taxonomic identification, and the presence of multiple stressors in San Francisco Bay, complicates the ability to make conclusive statements about the causes for the recent observed reduction in grunion abundance.

- **2007/08 Herring Spawning Studies**
  - **Herring Spawn Collection and Developmental Assessment**

    In early 2008, natural and artificially spawned herring eggs were collected from locations both inside and outside the spill zone and examined for pre-hatch mortality, hatching rates and embryo-larval deformities. The result was that naturally spawned herring eggs collected from mid to low intertidal areas inside the spill zone suffered very high levels of mortality, embryo-larval deformities, and poor hatching rates, while those from outside the spill zone were largely normal. Results were not as dramatic for artificially spawned herring placed in cages in deeper, subtidal water, leading to a hypothesis that the more dramatic effects found in the natural spawn collected from shallows may have been a result of phototoxicity.

- **PEMD and Sediment Study**

  At the same time as the 2007/08 Herring Spawn Collection and Developmental Assessment, polyethylene membrane devices (PEMDs) were deployed in the water column alongside cages with artificially spawned herring eggs, as sentinels of contaminants present in water at these sites. In addition, sediments were collected adjacent to each cage and natural spawn sampling location.

  The PEMDs were analyzed to determine whether they revealed a presence of PAHs in the water at the various subtidal sites where cages were deployed, and whether the patterns of PAHs varied between the sites. PEMDs were not deployed where natural spawn was collected, and so only reflected conditions at the deeper caged sites where herring embryo effects were more subtle than at shallower natural spawn sites. As expected, analysis of the PEMDs indicated that the water contained detectable concentrations of both typically urban (pyrogenic), and oil spill derived (petrogenic) PAHs at each of the sampled sites. While the Trustees detected an elevated petrogenic to pyrogenic PAH ratio in PEMDs collected from one oiled sampling location (Keil Cove), analytical issues prevented the Trustees from drawing more conclusive information from these sampling devices.

  Composited sediment samples collected from all sites were analyzed for PAHs at the request of the Responsible Party. The Trustees did not consider these samples to be a strong line of evidence, given the likely heterogeneous nature of subtidal and intertidal oiling in sediments at the time of collection and the compositing of the samples. Forensic analyses of sediment samples revealed that 1 sample collected from the intertidal zone at the Keil Cove site contained a PAH fingerprint that was interpreted as a probable match to *Cosco Busan* oil; remaining samples from all sites were either indeterminate (i.e., not possible to tell whether they did or did not match the source oil) or did not match. The Trustees did not pursue further chemistry and biomarker interpretive work, which could have been undertaken to attempt to draw more conclusive evidence for indeterminate sediment samples. The Trustees concluded that herring embryos were exposed to oil, or at least to trace levels of constituents of *Cosco Busan* oil, and used this as the basis of their claim for herring injury - thereby rendering this additional work unnecessary. As stated in the Summary of Injury below, there were other sampling events that provided continuity in evidence of the presence of *Cosco Busan* oil at at least one oiled spawning site that both pre-dated and post-dated the herring spawning season.

- **Herring Tissue PAH Study**

  Herring egg tissues from the 2007/08 Herring Spawn Collection and Developmental Assessment were subjected to forensic analysis. Ovaries from donor adults were also analyzed for potential maternal contributions of contaminants and effects. Analytical chemistry revealed indications of

slightly elevated PAHs associated with petroleum hydrocarbons in herring egg tissues at most of the oiled sites, but not in reference sites or in donor ovaries. Because of the difficulty fingerprinting petroleum signatures in biological tissues (organisms show differential rates of chemical uptake and metabolism compared to non-living environmental media), the confounding influence of urban inputs of PAHs, and analytical issues that prevented the Trustees from quantifying some petroleum-related PAHs, the unambiguous identification of a *Cosco Busan* oil fingerprint in naturally spawned eggs was not possible.

- **2009 Laboratory Herring Injury Studies**
  - A study testing hypotheses about *Cosco Busan* bunker oil toxicity and phototoxicity to herring eggs was conducted by NOAA's Northwest Fisheries Science Center and the University of California Bodega Bay Marine Laboratory. An array of flow-through oiled gravel columns were prepared to generate various concentrations of dissolved oil constituents in seawater in order to evaluate the relative toxicity of *Cosco Busan* oil under various environmental conditions. The gravel columns included replicates of clean gravel, typical urban gravel, and three doses each of *Cosco Busan* bunker oil and Alaska North Slope crude oil (the latter being a type of oil that has been extensively studied for contaminant effects since the 1989 *Exxon Valdez* oil spill and provides a useful comparison with bunker oil). Half of the columns were exposed to ultraviolet light (UV) from natural sunlight and half were UV shaded. Endpoints of embryonic and larval development and hatching success were measured, and concentrations of PAHs were analyzed in eggs and water. At the request of the RP, an additional study also was conducted to examine potential effects on developing herring embryos from different salinities of water. Results and more detailed information on these studies are provided below (Section 4.3.3.2) and further discussed in Appendix D.

- **2009 Herring Natural Spawn Collection and Analysis**
  - In 2009 there were no significant mid to low intertidal spawning events in locations previously oiled by the *Cosco Busan* spill; no herring eggs could be collected for further study.

- **2010 Herring Spawning Study**
  - In 2010 herring eggs were collected from mid to low intertidal areas in the vicinity of two of the 2007/08 sample sites, Sausalito and Keil Cove, and from Paradise Cove, a site that was not oiled after the spill. Suitable spawning did not occur at appropriate depths for collection at the other prior 2007/08 sample sites. Nevertheless, examination of herring spawn from the Sausalito and Keil Cove sites to determine degrees of pre-hatch mortality, abnormalities, and hatching rates found no evidence of phototoxic effects from the spill on the 2010 spawn.

- **Herring Injury Quantification**
    - The degree of impacts to herring was estimated using spawning and biomass surveyed by CDFG, spatial coincidence of spawning with shorelines known to have been oiled, estimates of mortality based on data from 2007/8 Herring Spawn Collection and Developmental Assessment (above), and records of locations, density, and depths of spawning. The estimated percentage of the total 2007/08 spawn that was impacted was calculated.

See Appendix D for further details regarding the herring injury studies.

4.3.3.2 Summary of Injury

Due to the physical properties of the *Cosco Busan* oil, the Trustees concluded that exposure of aquatic organisms to the oil – and, accordingly, injury – was most likely to occur in nearshore areas where oil stranded along shorelines. Since nearshore areas are also the primary spawning location for herring, the Trustees conducted an in-depth assessment of the potential for injuries to spawning Pacific herring. Because of their spawning behavior and high sensitivity to oil toxicity, the Trustees considered herring to be a reasonable proxy for near shore spawning species of fish in San Francisco Bay at risk for exposure from the spill (see Appendix D). Furthermore, restoration activities focused on herring also will benefit other near shore spawning species.

Sampling and photographs documented the presence of *Cosco Busan* oil at several locations where Pacific herring typically spawn in San Francisco Bay. Sediments sampled in November 2007 in Keil Cove as part of the eelgrass assessment were analyzed and forensically interpreted to be probable matches with the source oil. Although the cleanup of several such areas in December 2007 is likely to have significantly reduced the exposure of herring embryos to oil, there was documented oil, including multiple tarball stranding events, along the shoreline in at least one spawning location (Keil Cove) as late as January 2010. Continued shoreline surveys by the U.S. Geological Survey subsequent to herring spawning documented continued presence of stranded tar in Keil Cove (R. Rosenbauer, personal communication, May 24, 2011). The Trustees also were concerned that cleanup activities would not likely address oil that was entrained in the nearshore water column and sediments due to churning wave action in shoreline areas (as suggested by the November 30 water sample discussed above under "Herring Spawning Site Water Sampling" and the samples discussed above under "PEMD and Sediment Study").

During the first spawning event after the spill (in February 2008), the Trustees were able to collect naturally spawned herring eggs at three sites along the southern Marin County coast that were oiled (Keil Cove, Sausalito, Peninsula Point), and from one unoiled site along the northern Marin County coast (i.e., San Rafael Bridge). These samples were examined and dramatic differences were observed in the developing embryos collected from oiled and unoiled sites. Eggs collected from oiled sites had a high proportion of mortality in late term embryonic development and poor hatching outcomes, while eggs collected from the unoiled site developed and hatched normally. Significantly, the effects identified in naturally spawned herring embryos from the oiled sites were generally not

the type normally associated with chronic exposure to PAHs (e.g., cardiac edema). Rather, these embryos exhibited gross deformities, such as the body axis defects shown in Figure 12.

Figure 12. Comparative photographs of herring eggs/ larvae collected from shallow water in areas affected and unaffected by the *Cosco Busan* oil spill.

In addition to collecting and examining naturally spawned herring eggs, the Trustees placed artificially spawned herring eggs in small cages at selected locations to ensure that data would be obtained from a sufficient variety of conditions. The cages were placed at six locations, four within the oiled zone and two outside the oiled zone, along with specially designed PEMDs that provided a means for detecting PAHs in the water column. Herring typically spawn in a wide range of water depths, and these caged herring eggs were placed at a somewhat greater water depth than where the natural spawn were collected.

Developing embryos collected from cages placed at oiled sites were examined and found to have elevated occurrences of altered cardiac function, a more subtle effect associated with chronic oil exposure than what was observed in naturally spawned eggs collected from shallower areas at oiled sites. This condition occurred to a significantly greater degree in caged eggs from most of the oiled sites than it did in caged eggs from the unoiled sites.

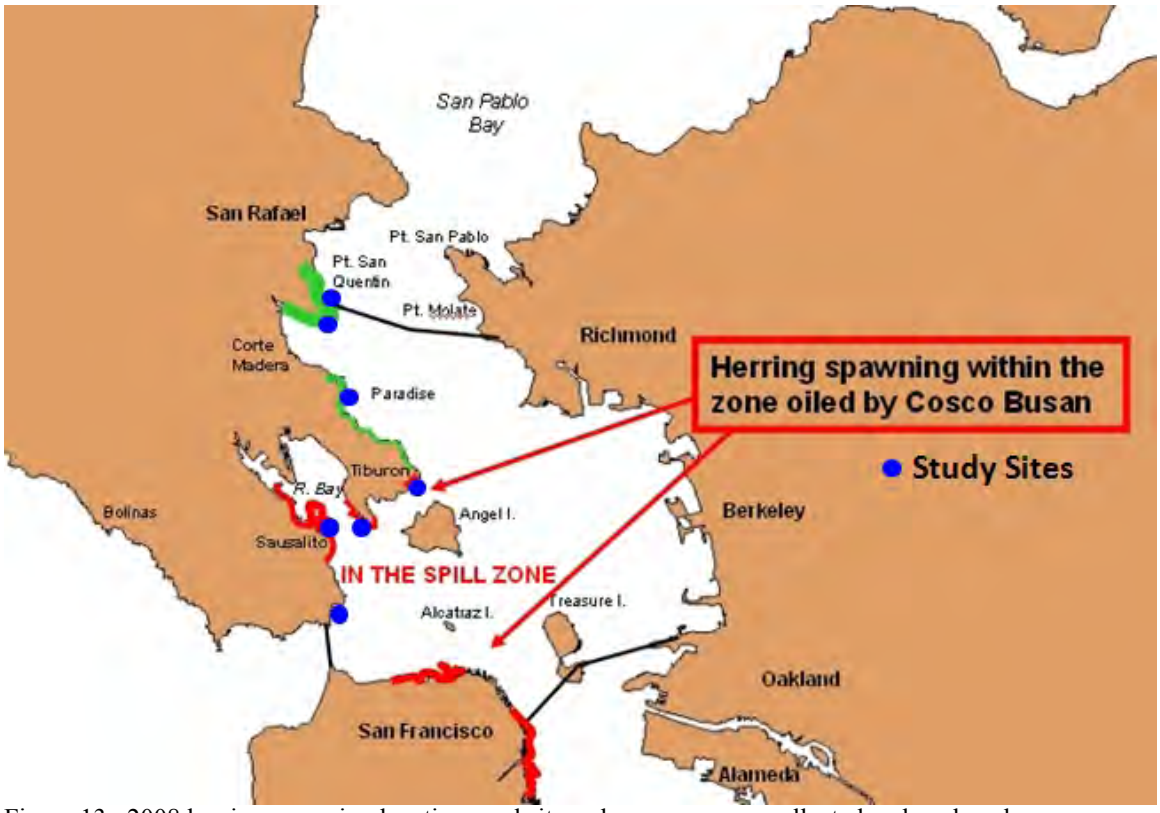


Figure 13. 2008 herring spawning locations and sites where eggs were collected and analyzed.

Based on historical toxicity research, the greater severity of abnormal development in herring eggs collected in shallow oiled areas compared to deeper oiled areas suggested that exposure to daylight (UV radiation) may magnify the toxicity of the oil. This hypothesis was tested the following year (2009) in a controlled laboratory study conducted at UC Davis Bodega Marine Laboratory. Artificially spawned eggs from Pacific herring collected in San Francisco Bay were incubated in several different treatments of seawater, both clean and contaminated, and under both UV exposed and UV shaded conditions. Despite the presence of certain "lab artifacts" (e.g., increased temperatures, algal blooms) that were observed at various times during the studies in both the treatment and control groups, Trustee scientists made a consistent and unambiguous observation over the course of multiple runs of the experiment with multiple replicates in each run: the greatest occurrence of late term mortality occurred in herring eggs exposed to both *Cosco Busan* oil and sunlight. This phototoxic effect occurred to a significantly greater degree in eggs exposed to *Cosco Busan* oil than it did in eggs exposed to a similar mass of a typical crude oil under identical conditions. This observation, in addition to the nature of the injuries found in naturally spawned eggs collected in the oiled zone, which were not the type normally associated with exposure to PAHs, led the Trustees to hypothesize that this mortality was caused by some non-PAH component of the chemically complex bunker oil.

The Trustees also investigated other possible factors in the environment that could explain why high degrees of mortality were only observed in herring eggs collected from oiled sites. Possible explanations include the presence of other contaminants, differences in physical conditions such as temperature and salinity, differences in the spawning

suitability of different schools of spawning adults, and a sewage spill that occurred in southern Marin County several weeks before herring spawning in 2008. The Trustees found no evidence to support these other potential explanations for the herring embryo losses observed at oiled sites in southern Marin County. These alternative explanations were either refuted or not supported when specific details about them were compiled and examined (see Appendix D).

The Trustees returned to herring spawning sites in the 2009 and 2010 spawning seasons to see if late-stage embryonic mortality or developmental abnormalities reoccurred. In 2009 the amount of herring spawning in San Francisco Bay was extremely low (for reasons not believed to be associated with the spill) and it was not possible to collect eggs from any of the oiled sites. Spawning was better in 2010 and herring eggs were collected from two previously oiled sites and one unoiled site to determine whether any effects persisted. No phototoxic effects of *Cosco Busan* oil were observed, suggesting that the injuries to developing herring were likely limited to the first spawning season that followed the oil spill.

Given the evidence derived from the field and laboratory studies, the Trustees concluded that the *Cosco Busan* bunker oil caused injuries to developing herring embryos. Field studies showed that elevated levels of mortality and, specifically, the types of deformities discussed above, occurred only at oiled sites, not at reference sites. Subsequent laboratory studies confirmed that Cosco Busan oil was highy phototoxic – far more so than crude oil – even at concentrations so low that the presence of the oil may be difficult or impossible to fingerprint or detect above background levels. The Trustees considered chemical analyses of the eggs, PEMDs, and sediments collected in 2008 that did not show a strong spatial pattern of differences in measured concentations of PAHs. However, the Trustees ultimately concluded that the evidence from the field and laboratory studies persuasively demonstrated injury, particularly since this evidence suggested significant toxicity from non-PAH components of the Cosco Busan oil. This conclusion was borne out by the lack of similar injuries in the 2010 spawning season, after *Cosco Busan* oil levels had nearly two years to decrease.

The RP for the *Cosco Busan* oil spill cooperated with the Trustees in carrying out this assessment of fish injuries. However, their technical consultants do not agree with the Trustees' conclusions about the herring injury data and have investigated other possible explanations for the developmental abnormalities found in herring embryos from oiled sites. Additional information on the responsible party's conclusions regarding the herring assessment may be found in the Trustees' Administrative Record.

Injury Assessment

The Trustees used the data on effects to herring eggs described above, and long term herring monitoring data, to estimate the scale or magnitude of the injuries and the amount of restoration that would compensate for the estimated losses of natural resource services.

CDFG has monitored herring populations and spawning in San Francisco Bay every year since 1979. Monitoring data include identification of the locations and estimated size of each spawning event. These data, overlaid with SCAT data on shoreline oiling, were used to estimate the amount of herring spawn that occurred in the presence of residual oiling.

Based upon these data, approximately 50% of the herring eggs in the 2007/08 spawning season were deposited outside the spill zone. Due to depth of the spawn and the proximity to observed oil, only a proportion of the remaining 50% of the eggs were expected to be subject to abnormalities and mortality associated with the *Cosco Busan* spill. The Trustees estimate that between 14% and 29% of the 2007/08 spawn deposition were subject to deleterious effects associated with *Cosco Busan* oil.

Examination of herring spawn in 2009/10 have not shown evidence of continuing phototoxic impacts, thus the Trustees concluded that this direct impact to the development of herring embryos was limited to one season.

In the year prior to the *Cosco Busan* oil spill, herring spawning biomass in San Francisco Bay dropped to well below the historical average of 40,000 tons. The 2008/09 herring spawning biomass was the lowest on record and prompted the California Fish and Game Commission to close the commercial herring season for 2009/10.

There are many environmental factors that affect the development and growth of herring eggs. Historical data show high variability in the annual spawning biomass of herring in San Francisco Bay, which can be affected by oceanographic conditions, drought and El Niño events, changes in predator and prey availability, and other factors. Spawning location and substrate quality also appear to influence rates of productivity. For instance, herring eggs may become desiccated and subject to greater rates of predation by birds and marine mammals when deposited higher in the intertidal zone. These considerations were utilized by the Trustees in evaluating both the magnitude of injuries caused by the spill and the benefits of restoration projects that expand the availability of good spawning habitat.

Restoration Alternatives

To compensate for spill injuries, the Trustees evaluated restoration projects expected to enhance the successful production of early life stages of herring and other near shore spawning fish. The Trustees have selected a program to restore eelgrass around San Francisco Bay.

SELECTED PROJECT	BENEFITS
Eelgrass restoration in San Francisco Bay	**herring, eelgrass**

$2.5 million from the settlement has been allocated to implement the project selected below.

Selected Alternative

Eelgrass Restoration in San Francisco Bay

Eelgrass beds provide important habitat in San Francisco Bay and are key nurseries for shellfish, herring, and other species of fish. The goal of the project is to create 70 new acres of eelgrass over nine years. Thirty-six of those acres will be directly planted (four acres per year for nine years), while the remainder is expected to expand naturally from the planted acres.

To achieve the most effective and efficient restoration, each individual project site should be able to maintain itself with little additional human intervention over time. This means that restored plants will persist over time, spread clonally, and establish extensive rhizome systems, flower, and contribute seed. They must also be resilient to storms, herbivory, and other damages each year as well as be resilient to changes that occur in climate and human uses of the bay.

Criteria for site selection include local conditions such as depth profile, sediment type, waves and currents, salinity patterns, and turbidity. In addition, sites were chosen because they were nearest the spill zone and are in locations particularly suitable for use by spawning herring, as they are adjacent to deepwater habitat and near known herring spawning areas.

Based on the recommendations found within the San Francisco Bay Subtidal Habitat Goals Report (San Francisco Bay Subtidal Habitat Goals Project 2011) and the criteria set in this document, multiple sites within the central bay are preferred. These are:

- San Rafael Bay at the Marin Rod and Gun Club and moving southward toward areas along Corte Madera;
- several locations within Richardson Bay;
- the entrance to San Francisco Bay at Horseshoe Cove;

Additional locations along the eastern shore line within the East Bay Regional Park District and some sites outside of the Bay are also available for restoration and will be considered if herring utilize these areas.

This restoration project will rely on taking seedstock from existing eelgrass beds and transplanting them at the restoration sites. Due to the current depleted state of eelgrass habitat in San Francisco Bay, only a limited amount of seedstock can be taken, limiting active restoration to a maximum of four acres each year. However, the newly restored areas are expected to expand over time. Thus, the restoration will directly create 36 new acres of eelgrass (four acres x nine years of transplanting), but another 34 acres are expected to generate from the newly-created beds during that time.

Based on comments received on the Draft DARP/EA, additional eelgrass restoration projects were identified. These include removing objects from eelgrass beds that are either inhibiting or impacting the growth of the beds. These projects include:

1) Abandoned vessel removal in Richardson Bay

This project involves the removal of abandoned vessels that may be affecting 3.3 acres of eelgrass. Currently this project is moving forward with necessary partnerships between the Richardson Bay Regulatory Authority, the San Francisco Bay Conservation and Development Commission (BCDC) and the Regional Water Quality Control Board. Permits are being acquired. However, only partial funding exists for the removal. This project may be reconsidered once all regulatory approvals have been met and if restoration funds remain available.

2) Mooring chain replacement in Richardson Bay

Currently there are non-permitted live-aboard vessels anchored within Richardson Bay. Some of these non-permitted vessels are anchored with long iron chains that drag and swivel along the bottom of the bay tearing out eelgrass. These could be replaced with elostmere floating chains to avoid impacting eelgrass. However, these currently non-permitted vessels would need to obtain BCDC permits for chain replacement to occur. This project may be reconsidered if the permitting issues are resolved and restoration funds remain available.

Affected Environment

This project will be located at several locations in San Francisco Bay. This area is described in section 2.0.

Environmental Consequences (Beneficial and Adverse)

The over-harvesting of seedstock from donor beds could result in adverse impacts to the donor beds; however, the project has been designed so as to avoid such impacts. The restoration of eelgrass beds from conservation measures such as the removal of marine debris and/or the removal or replacement of moorings may have some temporary impacts. However the benefits to eelgrass and other subtidal habitats would be immediate. These projects are expected to provide benefits, in the form of new and expanded eelgrass beds, to a variety of fish and other species as described above.

The techniques proposed for restoring eelgrass are anticipated to have *de minimis* adverse environmental consequences. The technical approach commonly employed by resource managers in San Francisco Bay, i.e., deployment of seed buoys to promote recruitment of new plants at suitable sites, does not involve significant physical disturbances. Since unvegetated soft-bottom substrates predominate the subtidal zone of San Francisco Bay, the expansion of vegetated habitats will not adversely affect species that utilize unvegetated subtidal areas. These project would provide incremental progress toward a long term resource management goal of increasing the presence of eelgrass in the bay.

Probability of Success

The probability of success is high for all projects suggested. These projects will use techniques recently developed and demonstrated to be successful in restoring eelgrass beds.

Performance Criteria and Monitoring

This project will include monitoring of the new eelgrass beds to document their expansion over time as well as the utilization and success of herring spawn within newly restored areas. The goal of the project is to create 70 new acres of eelgrass over nine years. Thirty-six of those acres will be directly planted (four acres per year for nine years), while the remainder is expected to expand naturally from the planted acres or from areas that will no longer be impacted by marine debris. In addition, any other eelgrass restoration projects will also be monitored for success of both eelgrass and herring.

Evaluation

The Trustees have evaluated this project using the threshold and additional screening criteria developed to select restoration projects and concluded that this project is consistent with and meets the objectives of these selection factors. They believe that this type and scale of project will effectively provide appropriate compensation for all fish and eelgrass injured as a result of the spill and have therefore selected this project as a preferred alternative.

Other Restoration Projects Considered

The Trustees also considered the following projects but did not select them as preferred at this time.

OTHER PROJECTS CONSIDERED	BENEFITS
Herring hatchery	herring
Pier piling replacement for herring spawning	herring

The eelgrass restoration program is the preferred alternative because of cost effectiveness, benefits to multiple species, and because it may benefit otherwise uncompensated spill injuries.

The other two restoration alternatives are considered non-preferred for the following reasons:

Herring hatchery

Hatcheries have been utilized as a means for enhancing production of certain fish species around the world, and the Trustees investigated the potential application of this approach for the San Francisco Bay herring population. Development of such a facility would be very expensive, take several years for planning, pilot studies, and full scale development, and could potentially introduce unintended adverse consequences on the natural population of herring. Also, this project would only benefit herring and those species that forage on herring. Thus, this project is not currently proposed.

Pier piling replacement

Since herring spawn in San Francisco Bay on man-made hard structures such as pier pilings, this concept entails replacement of a number of creosote pilings in areas of San Francisco Bay where herring spawn with new concrete pilings in an effort to improve the degree of success of herring spawning on these pilings. An alternative, less costly strategy would be to “wrap” existing creosote pilings with non-toxic material rather than completely replacing the pilings. Both approaches have been previously implemented in San Francisco Bay. The piling replacement project is not preferred by the Trustees because the potential for greater scale of benefits from the eelgrass restoration program, given the greater subtidal spawning surface area that eelgrass habitat expansion would create.

4.3.4 Habitats

San Francisco Bay is the largest estuary on the Pacific Coast of North America. Shoreline habitats ring the bay and line the coast outside the Bay providing an unbroken chain of vital habitat in which myriads of species live and move in, around, and through.
The *Cosco Busan* oil spill spread throughout the central San Francisco Bay and outside the Bay, and oiled over 100 miles of shoreline habitat from Pt. Reyes to the north and Half Moon Bay to the south.

The shoreline along the Pacific Coast and in San Francisco Bay includes a wide variety of coastal habitats. For the purposes of injury assessment, separate analyses were conducted for sand and gravel beaches, marsh wetlands, mud and sand tidal flats, rocky intertidal habitats (natural bedrock and artificial riprap), and eelgrass beds.

The habitat assessment relied upon data collected to examine effects of the spill on shoreline habitats, as well as a variety of literature sources which document the effects of oil on flora and fauna. Injuries to the various habitats were quantified according to the maximum degree of oiling and other available data when scaling potential restoration actions for each habitat type. Four million dollars from the settlement has been allocated to habitat restoration projects. This does not include restoration for eelgrass, which will be covered by the funds allocated for eelgrass restoration discussed in section 4.3.3.2 above.

4.3.4.1 Overview of Data Collection and Studies

The list below summarizes the data collection tasks, various field studies, and analyses used for the assessment of habitat injuries.

- **Response Information Compilation of Oiled Shoreline Data**
    - Immediately after and throughout the duration of the spill, Shoreline Cleanup and Assessment Teams (SCAT) were dispatched to document the location and severity of shoreline oiling and to develop cleanup recommendations. These response teams reported on details concerning the approximate location, thickness, and percent cover of oil on intertidal habitats throughout San Francisco Bay and the outer coast shoreline. This information is primarily collected to assist response crews in prioritizing cleanup decisions. However, the Trustees also used this information during their injury assessment for gaining an understanding of the severity of oiling along the different shoreline segments over time.

- **Supplemental Information Compilation of Oiled Shoreline Data**
    - Additional observations regarding the presence and degree of oiling were used to supplement the SCAT data in cases where information pre-dated SCAT reports or where shorelines were unsurveyed by response teams. This information was collected from sources including Trustee NRDA field teams, BeachWatch surveyors, as well as well-documented observations from other individuals and organizations.

- **Extent of Oiling Quantification and Mapping**
    - The SCAT data and supplemental information described above were compiled to create maps showing the geographical extent and maximum observed degree of oiling along each shoreline segment (Figure 14). The oiling of shoreline habitats was quantified in terms of linear extent (meters of shoreline) and degree of oiling using SCAT descriptions (e.g. heavy, moderate, light, very light) and mapped according to shoreline type (rocky intertidal, beach, marsh, etc.). The area of affected shoreline, in acres, was calculated for each oiling category and each habitat type. The width of impacted habitat used in the calculations varied by habitat type from the width of the oil band only to the width of the entire intertidal zone.

- **Quantification and Delineation of Tidal Flats and Eelgrass Beds At Risk**
    - Utilizing information from the San Francisco Estuary Institute (SFEI), NOAA's Environmental Sensitivity Index (ESI), and Merkel & Associates, tidal flats and eelgrass beds within the area of interest were delineated and quantified. Because SCAT teams do not survey degree of oiling on mud/sand flats or eelgrass beds, the degree of oiling on directly adjacent shorelines was used to estimate the likely severity of oil exposure to these intertidal habitats.

- **Oil Sample Collection and Analysis**
    - Polycyclic aromatic hydrocarbons (PAHs) are a suite of chemical components found in petroleum products, and all oil sources display a "fingerprint" of the unique proportions of the different PAHs that allow for confirmation of the source(s). Tarballs, sediments and oiled vegetation were collected from a variety of locations for analysis of PAHs, particularly on the outer reaches of the spill, in order to confirm the presence of *Cosco Busan* oil, and to assist in delineating the overall footprint of the spill.

- **Ephemeral Sample Collection and Analysis**
    - Invertebrate samples (clams, mussels, oysters, and various arthropods) were collected from a wide variety of locations within the spill zone and were analyzed for PAHs and other components of oil to fingerprint the sample to the spill source. Samples were collected in relation to the severity of oiling of the shoreline and over time, to confirm and provide estimates of degree and duration of exposure to shoreline fauna (Figure 15). In addition to using PAHs to determine source of oil, these compounds are toxic to organisms, and thus bivalve body burden concentrations were compared to toxicology literature values as an indicator for potential health effects to marine invertebrates (Appendix E).

- **Rocky Shoreline Flora and Fauna Community Structure Surveys**
    - Study sites established by the University of California, Santa Cruz, for monitoring long-term habitat and community changes in intertidal flora and fauna were examined immediately after the spill and again a year later

in order to document changes to community composition. Study sites within the spill zone showed community changes, as compared to unoiled sites, indicative of oil-related impacts.

- **Native Oyster Health and Survival Analysis**
  - Native oyster bed study sites established by the University of California, Davis, were monitored several times post-spill for increased mortality or other oil-related impacts. Several oyster beds within the spill zone showed increased mortality post-spill, though results were inconclusive as to the cause.

- **Clapper Rail Surveys**
  - The California Clapper Rail is an endangered species and a resident in marshes impacted with *Cosco Busan* oil. Surveys for Clapper Rails were carried out as part of ongoing Bay-wide monitoring. Surveys included spill impacted marshes, such as Emeryville Crescent and Stege Marsh, and results were used to compare with previous years findings. The nature of the surveys did not allow for visual inspections of birds for oiling, but rather for approximate numbers inhabiting and demonstrating nesting behaviors. Nesting pairs were identified in all survey sites within the spill zone, with no readily obvious reduction in population sizes from pre-spill numbers.

- **Eelgrass Side Scan Sonar Surveys**
  - Side scan sonar surveys were conducted at several sites throughout the Bay to measure the density of eelgrass beds and to look for any anomalies that may have occurred during response activities. Results were inconclusive for impacts specific to oiled beds vs. unoiled beds. However, sonar surveys were helpful in documenting watercraft injuries to eelgrass resulting from response actions at Keil Cove, near Tiburon.

- **Eelgrass Health, Growth and Reproduction Surveys**
  - Eelgrass beds were evaluated at several sites throughout the Bay and measurements of photosynthetic activity, rhizome node production, and phenolic compound analysis were conducted. Results were inconclusive for impacts specific to oiled beds vs. unoiled beds.

- **Eelgrass Invertebrates Species Diversity Analysis**
  - Invertebrates were collected from within eelgrass beds and species were identified and enumerated. Epibenthic and benthic invertebrates were examined for population density changes between and within spill zone eelgrass beds. Results were inconclusive for impacts specific to oiled beds vs. unoiled beds.

- **Injury Quantification (Estimation of Lost Acre-Years)**
  - All salt marshes, tidal flats, rocky shorelines and beaches within the spill area were quantified in terms of acreages impacted by the spill. Degree of

injury to the ecological services of each habitat, and duration of injury until full recovery, were estimated based on strength of evidence from collected data, inputs from scientific literature, and consultation with regional ecologists. Details are provided below and in Appendices E and K.

- **Project Benefit Analysis (Estimation of Gained Acre-Years)**
  - The benefits of potential restoration projects were estimated and quantified in terms of their likely long-term ecological benefits. In this way, each project was "scaled" to be appropriate in size to the injury incurred by each habitat type.

Generally, there are three different mechanisms by which an oil spill impacts shoreline ecosystems:

1) Direct smothering of organisms from oil;
2) Effects on organisms exposed through direct contact or ingestion of oily water, sediment, and prey items; and
3) Direct impact to habitat through clean-up activities; such as removal of beach wrack (vegetation washed up on the beach), hot water treatment of oiled rocky shores, and marsh vegetation trampling or removal.

Oil in the environment can affect organisms by physical fouling of skin, fur and feathers, clogging of mouthparts and other filtering appendages, or through injury via toxic effects associated with dissolved oil. In general, lighter oils have greater acute toxicity due to inhalation and ingestion risks, while heavy oils are more apt to cause physical fouling and chronic toxicity from exposure to persistent oil residues. The fuel oil spilled in this incident is considered to be heavier oil so physical effects would be expected to predominate. Nevertheless, potential water column exposure and acute toxicity to certain organism was also a concern.

The degree of oiling in the habitats was classified based on descriptors used by the SCAT Teams. These descriptor categories: Heavy, Moderate, Light, and Very Light oiling, are based on a combination of width of "oiled band", percent of oil distribution across the band, and thickness of the oil. This terminology was used by the Unified Command to help prioritize and direct clean-up actions. These categories were not developed to characterize injury to habitats, and thus they provide only information on oiling in a given shoreline segment relative to other areas, at a specific time. Most shoreline segments were characterized with one of these oiling levels at least once during the response in order to inform the Incident Command Center regarding the level of clean-up required. However, some shorelines were never characterized because they were inaccessible, while others were characterized after some clean-up operations were performed, or after tides had significantly altered the location of the oil. In some situations where there was additional supplemental information (e.g. photographs, field notes from Trustee representatives), shoreline segments were re-characterized from their SCAT designation for purposes of the injury assessment. The Trustees compiled the known SCAT information, along with supplemental oiling data, into a "maximum

observed oiling" map (Figure 14), in order to delineate the degree of known exposure to the various habitats (Figure 15).

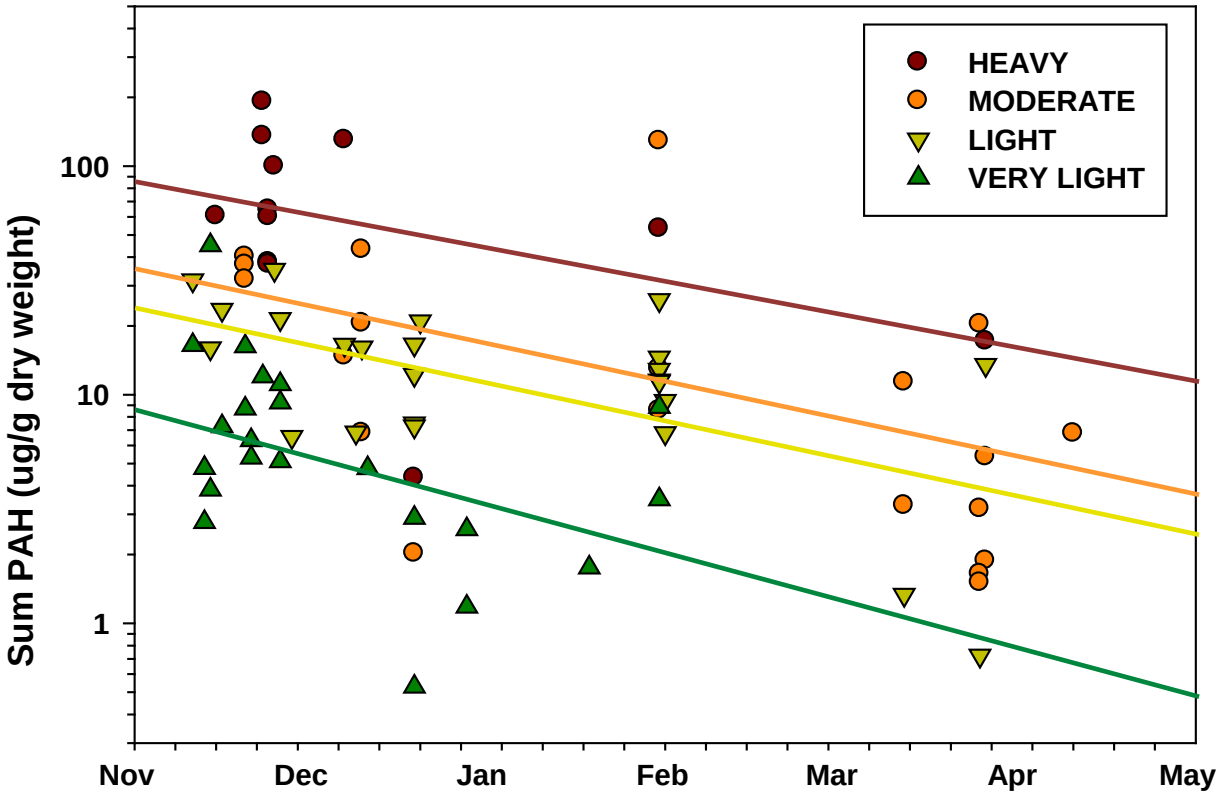
Figure 14. Maximum observed oiling map showing degree of oiling along outer and inner San Francisco Bay shoreline.

As mentioned in section 4.1.1 above, the HEA method was used to estimate the injury for each of these shoreline habitats. For the injury assessment, inputs to the HEA are the areas of impact or acres of shoreline habitat impacted, initial injury or the reduction in ecological services as a result of the spill, and time for recovery or the return to baseline. The general concepts and information used to assess the shoreline habitat injury are described below.

> **Area of Impact**. The area of affected shoreline, in acres, was calculated for each oiling category and each habitat type. The width of impacted habitat used in the calculations varied by habitat type from the width of the oil band only to the width of the entire intertidal zone.

Baseline Conditions. Baseline is the ecological services that would be present but for the oil spill, including abundance, diversity, and age class. Information used to determine baseline conditions included, if available: rocky intertidal survey data collected prior to the spill, any other data regarding occurrence and abundance of organisms by habitat type and location, as well as background PAH concentrations in bivalves collected prior to the spill or outside the spill footprint.

Initial Injury. Injury to intertidal habitats resulted from both the oiling and the associated cleanup activities. Information used to assess injury included scientific literature on oil-related impacts from previous spills or from laboratory studies, PAH tissue concentrations in field-collected bivalves, direct observations of mortality or injury, and field assessments regarding effects to populations and communities. In general, the degree of injury was determined to be related to the degree of oiling (see Figure 15), and thus was quantified based on the maximum observed oiling for that segment.



Degree of Oiling	Avg. (1st Month)	Min. (1st Month)	Max. (1st Month)
	Total PAH ug/g dry weight		
Heavy	85.8	37.2	191.0
Moderate	36.4	31.9	40.1
Light	22.4	6.5	35.3
Very Light	11.0	2.8	45.0

Figure 15. Total PAH (ug/g dry weight) concentrations from bivalve samples collected up to 6 months post-spill. Samples were assigned to the appropriate shoreline oiling level designated during the spill response.

Recovery. Recovery to baseline is considered to be the attainment of 100% of the ecological services that would be present but for the oil spill, including abundance, diversity, and age classes of organisms in the affected habitats. Recovery was assumed to begin after the initial cleanup actions have ceased, although ongoing cleanup activities and re-oiling events were considered in specific locations and habitats. Time to recovery was based on the life histories of the specific flora and fauna present in each habitat type, and relative to the degree of initial injury.

4.3.4.2 Sandy Beaches

Background

Beaches are an important resource along the Bay's shoreline, and the importance that these environments play towards providing habitat is critical. Beaches are typically dominated by very different species than those found in rocky shorelines or marsh habitats. The dominant fauna on sand beaches include amphipods and flies, coleopteran beetles, and isopods and mole crabs (*Emerita*) (see Appendix K). These invertebrates all present a vital food source for the multitude of marine and avian species found along this intertidal habitat. In addition, two species of concern, the California Least Tern and the Western Snowy Plover, typically require open, unvegetated or sparsely vegetated sand or gravel areas near open water (bars, flats, beaches) for foraging, roosting and nesting habitat (Thompson et al. 1997). Both the tern and plover utilize the sand beach environments within the San Francisco Bay and the outer coast.

In addition, the inland sand beaches within the San Francisco Bay provide a unique environment that helps to support a diminished high marsh and beach flora and fauna found specifically in these inland, protected environments. There are currently only about seven miles of interior beaches within San Francisco Bay. These beaches are mostly "pocket beaches" which have either regenerated in different locations or have been emplaced by humans. The shores of the Central Bay (Berkeley, Albany, Richmond, San Francisco, etc.) are the main centers of beach locations and have seen the elimination of most of these beaches due to urbanization and emplacement of riprap shorelines.

Injury Assessment

Oil from the *Cosco Busan* spill washed over and stranded on the Bay Area beaches, smothering and fouling invertebrates and other fauna using the habitat, and rendering it impaired for use by fish, birds and other wildlife. The entire tidal zone is impacted by the oil, as it travels back and forth with individual waves throughout the tidal cycle, until it either washes back out to sea or is stranded on the shore by the receding tides. Interstitial and suspended detritus is a major food source for the masses of invertebrates living in the intertidal zone, and is easily fouled by adherence with oil particles. In addition, the beach wrack was often oiled and is generally removed as part of clean-up operations. This wrack is of prime importance as habitat to a variety of micro and macroinvertebrate species that are a critical food source for higher trophic level organisms, including shorebirds, fish and crabs.

The movement of sand on beaches along the coast of California is very dynamic and affects the final disposition of the oil. The beach cycle of erosion and deposition of sand on beaches of the West Coast is driven by the passage of storms, particularly in the winter. During storms, large, short-period waves suspend the sand and carry it offshore, creating a flat beach profile. Within days after a storm, smaller, long-period waves transport sand back onto the beach, building depositional berms at the high-tide level. (See Appendix K for more detailed information.) Any oil deposited on the beach will follow this same pattern of suspension, transport offshore, and re-deposition and burial on the beach. The next erosion event releases the oil again to be transported back and forth across the beach. Oil which permeates the surface sand and is buried by the processes described may result in chronic exposure to oil. Coarse sand and gravelly beaches are particularly prone to burial of oil. For example, at Rodeo Beach on the outer Marin peninsula, so much oil was buried that surf washing by cleanup crews was still being conducted in late November (see Figure 16). Furthermore, buried oil continued to be encountered for several months, with reports of visitors (including children) getting oiled while digging in the sand on March 14, April 7, May 6, and June 9, 2008. Surfers reported oil on their surfboards and booties over the period June 2-11, 2008, and it is likely there were other unreported incidents. This oil would have continued to foul organisms which live in or pass through the intertidal zone for months after the initial incident.

The injury assessment for sandy beaches was based on field observations and the literature, which together describe how the habitat functions, how the oiling and clean-up affected it, and how it recovers. A summary of acres impacted and duration to recovery is shown in Table 4.

Area of Impact. The entire intertidal zone was determined to be impacted due to oil movement with the tides, the movement of motile organisms up and down with the tide for foraging, and the movement and mixing of the sand itself with waves and storm surges, particularly in the winter storm season.

Baseline Conditions. Information used to assess baseline sandy beach conditions included BeachWatch data on occurrence and abundance of beach wrack, and the collection and chemical analysis of biological samples outside of the spill zone.

Initial Injury. Fouling and removal of beach wrack, impacts to the associated invertebrate communities, and oil exposure to benthic invertebrate populations figured prominently in the injury to beaches. Treatment options for oiled wrack are limited. Oiling of wrack results in invertebrate mortality and contaminated forage for birds. The complete removal of wrack material from the beach removes a potential exposure mechanism, but has long term effects on forage options for birds due to reduced invertebrate community replenishment (Dugan et al. 2009, Beeler 2009). Both of these occurred in the aftermath of the *Cosco Busan* spill as oiled wrack was generally collected and removed from the more heavily oiled beaches, but remained in place on lighter oiled or unvisited stretches. In addition, PAH matches to *Cosco Busan* oil in mole crabs collected from oiled beaches were used to confirm oil exposure to these important prey

items. These crustaceans migrate with the tides while feeding, and are at prime risk for being fouled by particulate oil in the splash zone.

Recovery. The recovery periods reflect the time to restore to pre-spill age class distributions of the most long-lived key species. Dominant species on sand beaches include amphipods and flies (<1 year life span), Coleopteran beetles (2 year life span), and isopods and mole crabs (2-3 year life span). Tarball stranding and re-oiling events along the outer coast sand beaches continued into June 2008, approximately 7 months after the spill.

Table 4: Summary of Sandy Beach Injury

Habitat/Category	Acres Injured	Time to full recovery (years)
Entire intertidal zone - Heavy	4.26	3
Entire intertidal zone - Moderate	5.43	3
Entire intertidal zone - Light	147.21	0.5
Entire intertidal zone -Very Light	491.30	0.5
Total	***648.20***	***0.5 - 3***

A total of 648.2 acres of sandy beach habitat was exposed to and injured by the oil spill. Appendix E provides additional information on the injury assessment and quantification of sandy beach habitat injuries.

Figure 16. Oiling across surf zone at Rodeo Beach.

Restoration Alternatives
Projects in this category will benefit sandy beach ecosystems and may also provide benefits to Snowy Plovers, endangered plants, and grunion spawning. The Trustees have selected the following preferred projects to compensate for the injuries caused by the oil spill. The trustees also considered additional sandy beach restoration projects and may reconsider them if funding becomes available.

SELECTED PROJECTS	SUB-REGION	BENEFITS
Muir Beach dune enhancement	**Outer Coast**	**dune habitat**
Albany Beach restoration	**East Bay**	**dune and beach habitat**

Selected Alternative

Muir Beach Dune Enhancement

The goal of this project is to enhance dune habitat at Muir Beach by installing protective fencing and diversifying the native plant assemblage. Fencing is needed to protect dunes from visitor trampling and encourage dunes to develop in a position in the landscape that is supported by natural processes (Aeolian sand supply).

Trampling has eliminated all but a trace of low foredune vegetation along the central segment of Muir Beach and has contributed to delivery of sand into Redwood Creek. Backdunes have been described as artificially overinflated due to excessive delivery of sand landward through the funnel shaped pedestrian pathway that bisects the dunes. Dune enhancement activities will include a number of actions to reduce the effects of trampling, including re-routing the existing pedestrian traffic.

The foredune zone will be re-vegetated incrementally in annual phases. Driftwood will be strategically placed in shallow pits to help trap sand. The locked-in driftwood will naturally accumulate sand while simultaneously serving to obstruct unauthorized foot traffic through the dunes. Native dune plants will be planted into the area to further accelerate dune development and diversify the plant assemblage. Non-native vegetation will be removed from the dunes. Fencing will be installed around the perimeter of the dunes to further deter trampling by humans and dogs.

This project includes the following specific tasks:

- The existing pedestrian access route through the dunes will be re-routed.
- Non-native vegetation will be removed from the dunes.
- Native dune plants will be planted to accelerate dune development and enhance the existing plant assemblage.
- Fencing will be installed to protect dunes from trampling

Affected Environment

The project is located at Muir Beach on the coast of Marin County, where Redwood Creek drains into the Pacific Ocean. The project area includes Muir Beach, an intermittent tidal lagoon at the beach, and the wetland and creek area extending from just downstream of Highway 1 to the beach. Wetlands and waters under the jurisdiction of the U.S. Army Corps of Engineers extend over most of the site, with about 26.5 acres of jurisdictional wetlands and about 2.6 acres of jurisdictional waters. The San Francisco

Zen Center owns about 15 acres of the site over which the National Park Service has a conservation easement, and Marin County owns and manages the Pacific Way road and bridge which are included in the project area. The National Park Service (NPS) owns the beach as well as the remainder of the site.

Environmental Consequences (Beneficial and Adverse)

The selected dune project is part of a much larger watershed restoration project that includes the restoration of Big Lagoon, Redwood Creek and associated wetlands. The description of dune restoration is based on actions proposed in the Final EIS/EIR titled Wetland and Creek Restoration at Big Lagoon, Muir Beach Final EIS/EIR (http://parkplanning.nps.gov/document.cfm?parkID=303&projectId=12126&documentID=21520) and issued for public review and comment in December 2007. Dune enhancement will, in part, result from the natural lowering of the water table following excavation of the new creek channel to the tidal lagoon, combined with wind activity to develop dunes from newly dry and erodible sands. New fencing will be installed to allow reestablishment of foredunes, to the ocean-side of the existing back dune lobes. With establishment of native foredune vegetation, the foredunes are anticipated to capture fine sand, thereby reducing the sand washed or blown into the new channel. Overall, project actions will increase the extent and the quality of dune habitats at Muir Beach and reduce the transport of sand into the creek.

Under the selected alternative, all actions will improve the potential for coastal dune formation and dune formation will not have significant adverse impacts. Vegetation restoration associated with dune creation will also not have significant adverse impacts on the environment and will have beneficial outcomes to the site, by reducing the transport of sand into Redwood Creek, diversifying the native plant assemblage, reducing invasive species, and providing habitat for rare dune species. In particular, the restoration plant palette for Muir Beach may include pink sand verbena, which is regionally scarce and comprised of small, unstable population sizes in this region.

Probability of Success

The probability of success is for this project is high, as established techniques will be used for the project.

Performance Criteria and Monitoring

A variety of monitoring elements for the dune restoration and other components of the Wetland and Creek Restoration at Big Lagoon, Muir Beach, Marin County are outlined in a post-implementation monitoring and assessment plan designed to evaluate project success relative to the original project objectives (Ward 2009).

Evaluation

Overall, the Muir Beach EIS/EIR concluded that the selected action would have short-term impacts but that the overall benefits for natural resources were long-term.

The Trustees have evaluated this project using the threshold and screening criteria developed to select restoration projects and concluded that this project is consistent with and meets the objectives of these selection factors. They believe that this type and scale

of project will effectively provide appropriate compensation for beach habitat injured as a result of the spills and have therefore selected this project as a preferred alternative.

Selected Alternative

Albany Beach Restoration

The selected project will enhance and expand Albany Beach, a highly visited and eroding beach within the Eastshore State Park, adjacent to Golden Gate Fields in the city of Albany (Figure 17).

Figure 17. Albany Beach showing beach shoreline slated for improvement by sand replenishment.

Coastal beach and dune complexes have been virtually eliminated along the East Bay shoreline, and along with them, the flora and fauna unique to these habitats. Many special-status plants historically occurred only in such areas, but are presently absent from the East Bay. The Albany Beach restoration effort will expand beach and dune habitat. It will be accomplished through removal of existing debris and non-native vegetation, importation of sand to expand the existing beach and adjacent dune complex, and replanting with native dune vegetation. (Figure 18).

- This project includes the following specific tasks: Enhance Sandy Beach – To maintain a broad sandy beach similar to the existing conditions at the site, one-time placement of a large volume of sand will occur at the beach area. This will provide enhanced and expanded foraging habitat for shorebirds.

- Enhance and Expand Dunes and Wetlands - Non-native invasive plant species, as well as deleterious materials including creosote timbers and inorganic debris, will be removed from the dune and seasonal wetland area. Dunes will be expanded

through an integrated plan to establish a wide and high beach. Sand fences and/or other structures will be installed to capture and retain sand at desired locations within the dune system. Dune and wetland areas will be re-vegetated with appropriate native plant species to stabilize dunes and provide improved refuge and forage zones for native wildlife.

Other elements of this project may include:

- Comprehensive Shoreline Stabilization and Enhancement – Rocky shoreline will be improved by removing debris, including large rubble (concrete and asphalt) and hazardous objects, and non-native vegetation. Rock clusters/groins will be placed to create a more topographically diverse intertidal shoreline and anchor pocket beaches. Native plants will be planted at appropriate locations along the slope to stabilize soils and to establish transitional habitats between shoreline and upland zones.

Affected Environment

This project is located at Albany Beach, on the east shore of the central San Francisco Bay. This beach is heavily used by the public. Albany Beach experienced heavy oiling during the spill event, which closed the beach for several weeks, as well as tarball re-oiling events into the summer of 2008.

Environmental Consequences (Beneficial and Adverse)

Under the selected alternative, inland dune formation and native plant revegetation will not have significant adverse impacts. The dunes will be designed to expand onto a paved area currently used for parking. Dune and native plant revegetation design will be integrated to benefit wildlife function and physical sustainability of the dunes. This integrated approach will ensure that dunes also provide water quality benefits to the area. Soil disturbance from replacing non-native vegetation with native plants will not have significant adverse impacts on the environment. Successful re-establishment of native beach and dune plant communities on site will benefit dune stability and benefit species by providing high value habitat.

Probability of Success

The probability of success is high. The East Bay Regional Park District, which would implement this project on lands it manages, views this project as a high priority, and has made significant efforts in the development of site plans. In addition, established techniques for sand replenishment and native plant revegetation will be used for the project.


Figure 18. Dune habitat at Albany Beach showing extensive invasion of non-native vegetation.

Performance Criteria and Monitoring

The Albany Beach project will be monitored by the project implementer to ensure completion of the project and restoration of beach and dune habitats, including establishment of native vegetation. This will include reports regarding project success.

Evaluation

The Trustees have evaluated this project using the threshold and additional screening criteria developed to select restoration projects and concluded that this project is consistent with and meets the objectives of these selection factors. They believe that this type and scale of project will effectively provide appropriate compensation for sandy beach habitat injured as a result of the spills and have therefore selected this project as a preferred alternative.

Other Restoration Projects Considered

The Trustees also considered the following projects but did not select them as preferred at this time. All of the proposed projects would contribute towards restoring coastal dune habitat by removal of invasive plant species and sand replenishment measures, necessary to restore the resiliency of the dune systems to persist as a habitat and ecological feature within the seashore. These projects may be reconsidered if sufficient funding becomes available.

OTHER PROJECTS CONSIDERED	SUB-REGION	BENEFITS
Radio Beach expansion	East Bay	beach and dune habitat
Limantour Beach dune enhancement	Outer Coast	dune habitat, Snowy Plovers
Ocean Beach invasive plant removal and dune enhancement	Outer Coast	beach and dune habitat, Snowy Plovers

Radio Beach expansion. This project was similar in location and type of restoration to the Albany Beach project, but the oil exposure and subsequent injury at Albany Beach were more extensive than at Radio Beach. Also, the Albany Beach Restoration plan is already being developed by the East Bay Regional Park District and the project will likely be implemented and provide benefits sooner than a project at Radio Beach. Thus the Albany Beach project is prioritized as a selected alternative.

Limantour Beach dune enhancement. Both this project and the Muir Beach dunes project benefit outer coast beaches within the spill zone. The oil exposure and subsequent injury at Muir Beach was more extensive than at Limantour Beach, and restoration at that beach was therefore prioritized as a selected alternative.

Ocean Beach invasive plant removal and dune enhancement. Both this project and the Muir Beach dunes project benefit outer coast beaches within the spill zone. The Muir Beach project was preferred over the Ocean Beach project because the Trustees felt that the overall ecological benefits from the restoration project would be greater at the Muir Beach site.

4.3.4.3 Marsh Wetlands and Tidal Flats

The Trustees evaluated restoration projects for marshes and tidal flats together and therefore these two habitat types are discussed together.

Marsh Background

Marshes and tidal flats impacted by the spill included significant areas of Bolinas Lagoon along the northern outer coast, and several areas inside central San Francisco Bay along the Richmond/Emeryville/Oakland shoreline.

Crustaceans and gastropods are the dominant epifauna in salt marshes. These species are motile and cross from marsh to tidal flats and channels to feed, increasing their exposure to the oiled marsh fringe as mentioned above. Salt marshes in the Bay are also home to a variety of birds which feed and live in the salt marshes. Of particular concern is the federally endangered California Clapper Rail, a year-round resident in marshes throughout the Bay Area that forages through the networks of small channels and sloughs at the vegetation edge. The Clapper Rail nests and overwinters in Central Bay salt marshes including Emeryville crescent and Stege marsh both oiled in the oil spill. Other marshes oiled in the spill include the marsh at Bolinas Lagoon and the marsh along Alameda (Elsie Rohmer Bird Sanctuary).

Marsh Injury Assessment

Due to their environmentally sensitive nature, spill responders are often specifically tasked with protecting marsh habitats from oiling, via the specific placement of deflection and containment booms. While much care was put on protecting these environments during the *Cosco Busan* spill, several locations were oiled to varying degrees. These locations include the Emeryville Crescent, Stege Marsh and Albany Marsh, and Bolinas Lagoon.

The basis for determining injury to the impacted marshes was based on field observations, previous scientific investigations on habitat functions, effect of oiling and clean-up actions on the habitat, and recovery. A summary of marsh acres impacted and duration to recovery is shown in Table 3.

Area of Impact. Areas included in this assessment were based on segments identified as marsh vegetation under the SCAT shoreline designation. The area impacted was considered to be the stranded oil band within the marsh habitats as described in the SCAT data.

Baseline Conditions. Information used to assess baseline conditions included historical ecological investigations conducted pre-spill, and PAH concentrations in bivalve tissues collected prior to the spill.

Initial Injury. Oil from the *Cosco Busan* affected a band of vegetation several meters wide, beginning at the outer fringe of the marshes, as well as channels leading into the marshes. This band of oiled vegetation impacted the fauna using the edges and channel borders of this habitat and the fauna which crosses the marsh edge interface for feeding and protection. The degree of oiling affected the extent and types of impacts. Heavy and moderate oiling smothered flora and fauna, rendering it unsuitable for use by fish, invertebrates, and wildlife such as birds. Light and very light oiling adhered to vegetation and sediment surfaces, primarily impacting motile species which cross the oiled zones. Cleanup methods included clipping and removing oiled vegetation at two oiled locations. Data on PAH tissue concentrations and PAH patterns that matched the *Cosco Busan* oil signature in Ribbed Mussels was also evaluated.

Recovery. Oil in the salt marshes was bio-available to fauna from the initial spill and from at least one significant re-oiling event in January 2008 in east San Francisco Bay. The Trustees expect reduced recovery of affected fauna during the less reproductively active winter period, extending the duration of the injury. Recovery periods reflected the time required to reach pre-spill age class distributions of key long-lived species, including crustaceans and gastropods with life spans of more than five years.

Table 5: Summary of Impacted Marsh Acreages

Habitat/Category	Acres Injured	Time to full recovery (years)
Stranded Oil Band - Heavy	0.1	5
Stranded Oil Band - Moderate	0.6	3
Stranded Oil Band - Light	5.0	3
Stranded Oil Band -Very Light	12.4	1
Total	***18.1***	***1 - 5***

A total of 18.1 acres of marsh habitat was exposed to and injured by the oil spill. Appendix E provides additional details on the injury assessment and quantification of salt marsh habitat injuries.

Tidal Flats Background

Dominant species on tidal flats include mollusks (*Gemma, Nutricola, Venerupis, Cryptomya*), worms (annelids and polychaetes) and small crustaceans (amphipods and copepods; Brusati 2004; Neira et al. 2005). Many of these species are filter feeders, making them susceptible to exposure to particulate oil and oil components suspended in the water column. Further, thousands of shorebirds daily utilize these flats during low tides as forage sites, as they probe into the sediments for the variety of invertebrates. In addition, benthic bacteria create significant biofilms along tidal flats, which have been found to account for up to half the total diet of Western Sandpipers (Kuwae et al. 2008). Oil products are likely to have a significant effect on the bacteria and microfauna existing on the surface of these sediments.

Tidal Flats Injury Assessment

The injury assessment for tidal flats was based on an understanding of the literature and field observations which describe how the habitat functions, how the oiling and clean-up affected it, and how it recovers. (See Appendix K for more information.) A summary of tidal flats acres impacted and duration to recovery is shown in Table 6.

Area of Impact. SCAT teams did not assess oiling within tidal flats due to accessibility issues and the limited likelihood of recoverable oil occurring there. Degree of tidal flat oiling was considered to be proportional to the degree of oiling of the adjacent shoreline (i.e., more oil would be moving across tidal flats next to more heavily oiled shorelines). Therefore, for the purposes of NRDA, tidal flats were categorized based on the SCAT oiling categories of the adjacent shoreline habitats. The size and locations of the tidal flat habitat segments were determined from the ESI maps.

Baseline Conditions. Information used to assess baseline conditions included life history information of the tidal flat biota and pre-existing PAH tissue concentrations in bivalves.

Initial Injury. Oil at the surface of the water and particulate and dissolved oil within the water column move across tidal flats with the tides. Although the entire tidal flat is likely exposed to oil, potential injury may be highest in the areas

nearest the shoreline where oil temporarily strands and re-mobilizes, and where the flats are exposed most frequently during the tidal cycle. No cleanup actions were conducted within tidal flats. Information used to assess injury included direct observations of oil within the tidal flats both during the initial spill response, aerial overflight observations of oil on the water near shore, and PAH tissue concentrations and patterns that matched the *Cosco Busan* oil signature in bivalves within (clams collected from sediments) and adjacent to tidal flats (mussels, oysters and clams collected from rocky shores and marsh vegetation).

Recovery. The recovery times are based on the assumption that most of the affected species, particularly invertebrates, would have successfully reproduced during the next reproductive period.

Table 6: Summary of Impacted Tidal Flat Acreages

Habitat/Category	Acres Injured	Time to full recovery (years)
Adjacent to Heavy	4.18	1
Adjacent to Moderate	239.41	0.5
Adjacent to Light	227.43	0.17
Adjacent to Very Light	905.9	0.17
Total	***1376.9***	***0.17 - 1***

A total of 1376.9 acres of sandy beach habitat was exposed to and injured by the oil spill. Appendix E provides additional details on the injury assessment and quantification of tidal flat habitat injuries.

Restoration Alternatives

The Trustees have selected the following project to compensate for the injuries to salt marsh and tidal flats.

SELECTED PROJECT	BENEFITS
Aramburu Island restoration	**salt marsh habitat**

Selected Alternative

Aramburu Island Restoration

This project seeks to restore tidal marsh and shoreline habitat on Aramburu Island in Richardson Bay. The island is currently owned by Marin County and managed as a nature preserve. Richardson Bay historically provided a rich assortment of ecological benefits to wildlife and human communities. In 1987, a channel was cut between the developed and undeveloped portions of the Richardson Bay peninsula, forming what is now the 17-acre Aramburu Island (Figure 19). The channel was cut to provide a buffer of open water between the wildlife that were using the island and the human community on Strawberry Point. In addition, a beach area was constructed on the north end of the island to provide additional harbor seal haul-out habitat. However, the island currently offers only marginal habitat for wildlife. The upland areas of the island are dominated by non-native plants, and the eastern shore of the island is subject to high wave energy that has caused a steep, wave-cut erosional shoreline to develop.

There are several distinct opportunities for enhancing the habitat. The island is located along the western border of the 900-acre Richardson Bay Audubon Sanctuary, which protects important habitats including mudflats, native oyster beds, and eelgrass beds that support fish and wintering waterbirds, among other species. The following four habitat types are available for restoration on Aramburu Island: 1) beach and sand flat areas, 2) tidal marsh, 3) coastal grassland, and 4) seasonal wetlands.

Figure 19. Aramburu Island, located within Richardson Bay.

This project includes the following specific tasks:

1. Rehabilitate existing tidal marsh and grassland habitats, rehabilitate tidal flat and shoreline habitats, and establish gradual transition zones (ecotones) that support diverse native vegetation and optimum wildlife habitats for shorebirds, waterfowl, marine mammals, and native plant species and oysters.

2. Expand existing sand and gravel spit areas as shorebird roosting habitats and reduce wave erosion and shoreline retreat by replenishment of bay sand and gravel beach sediments.

3. Maintain varied topography on the island to facilitate gradual movement of wetland habitats.

4. Establish additional roost habitat for herons and egrets by placement of large woody debris and snags on the island.

Affected Environment

This project will be located on Aramburu Island, which is located in the central arm of Richardson Bay.

Environmental Consequences (Beneficial and Adverse)

The appropriate permits and clearances have been obtained by the project implementers. This project will restore tidal marsh and tidal flat habitat to benefit affected resources in the long term and has the potential to result in a few temporary negative impacts. However, the project implementers have proposed measures to avoid harm to terrestrial and aquatic organisms and to minimize impacts to habitats during construction. Beach and groin construction activities and associated vessel traffic are expected to disturb bay sediments and result in minor, localized, and short-term increased in turbidity. However, increased turbidity levels created by this project are expected to be considerably less than the thresholds cited to cause potential behavioral or physical impacts, and will be minimized through the use of silt fencing and turbidity curtains and other appropriate measures. Construction activities which could impact nesting birds, in particular the California Clapper Rail, will be mitigated by monitoring for presence as well as constructing outside of nesting season (February through August). Although, it should be noted that California Clapper Rails have not been documented nesting at the island. Eelgrass may be directly damaged by vessels via grounding, direct damage from propellers, and anchor scour, or may be indirectly affected via reduced light from shade created from anchored vessels or turbidity plumes. However, any damage would be small scale and temporary, and measures are in place for barge and boat use, to minimize any potential impacts.

The project is located within an area identified as Essential Fish Habitat for various life stages of fish species managed under the Magnuson-Stevens Fishery Conservation and Management Act. However, the proposed actions contain adequate measures to avoid, minimize, mitigate, or otherwise offset the adverse effects. Potential impacts to listed species will be mitigated below the threshold of significance by adjusting construction schedules, establishing disturbance boundaries, and monitoring for and relocating species of concern. Both NOAA and USFWS have evaluated the project plans, and have determined that the project is not likely to adversely affect listed species of concern, nor designated critical habitat.

Probability of Success

The probability of success is high. As the landowner, the County of Marin established the Aramburu Nature Preserve in 2005, and is managed by Marin County Parks. The Audubon Society has been steward of the adjacent Richardson Bay Audubon Sanctuary for 53 years, and plans to continue this stewardship into the future, as evidenced by the recent renewal of a 50-year lease on the portion of Sanctuary. Further, The Audubon Society is committed to achieving the goal of a restored and enhanced coastal habitat on Aramburu Island, and the County of Marin shares a commitment to this vision. The first phase of this project is completed and is already performing as expected.

Performance Criteria and Monitoring

Audubon volunteers and staff members were involved in pre-restoration monitoring, including surveys of birds and plants on the island, fish use of the eelgrass and mudflat

areas adjacent to the island, and native oyster densities along the margins of the island and in the larger Richardson Bay area. Volunteers will continue to play a substantial role in monitoring post-restoration. The proposed monitoring plan can be found at http://www.tiburonaudubon.org/docs/aramburuEnhancementPlan20100420.pdf and includes separate performance targets for beach nourishment, salt marsh vegetation, coastal grasslands and seasonal wetlands.

Evaluation

The Trustees have evaluated this project using the threshold and additional screening criteria developed to select restoration projects and concluded that this project is consistent with and meets the objectives of these selection factors. They believe that this type and scale of project will effectively provide appropriate compensation for tidal flat and marsh habitats injured as a result of the spill and have therefore selected this project as the selected alternative.

Other Restoration Projects Considered

The Trustees also considered the following projects but did not select them as preferred at this time. All of the proposed projects would contribute towards restoring salt marsh and tidal flat habitat and may be re-visited at a later date if sufficient funding remains.

OTHER PROJECTS CONSIDERED	BENEFITS
Schoolhouse Creek daylighting project	stream mouth habitat
Invasive Spartina control	salt marsh habitat
Strawberry Creek enhancement	stream mouth habitat
Quartermaster Reach wetland restoration	stream mouth habitat
Bolinas Lagoon restoration	salt marsh habitat

Schoolhouse Creek daylighting project. The Schoolhouse Creek project site is located between the frontage road west of I-80 and the Berkeley North Basin. The restoration project would reconstruct the dynamics and structure of the historic local stream mouth morphology and habitat. However, the project is still in the very early development phase and cannot be implemented as soon as the other alternatives.

Invasive Spartina control project. The project is part of a long-term control program conducted by the State Coastal Conservancy. Although efforts are conducted bay wide, the vast majority of the restoration work occurs in the South Bay, outside of the spill zone.

Strawberry Creek enhancement. The proposed project will enhance the historic mouth of Strawberry Creek into San Francisco Bay, located on the south side of University Avenue, in Berkeley, CA. The project would call for removal of non native vegetation and inorganic debris from the banks of Strawberry Creek, and land restructuring. However, the project is still in the very early development phase and cannot be implemented as soon as the other alternatives.

Quartermaster Reach wetland restoration. The Quartermaster Reach project will restore an approximately 6 acre site in the northeastern portion of the Presidio. The project would daylight a stream, currently flowing underground in a

storm drain which ultimately discharges to the Crissy Field Marsh. A diversity of habitats will be restored including salt marsh, brackish marsh, dune swales, riparian forest, and upland scrub vegetation. However, the Aramburu Project will provide a greater degree of multiple resource and service benefits and will provide benefits sooner than the Quartermaster Reach project.

Bolinas Lagoon restoration. This project involves restoration of ecological functions of the lagoon, by way of large-scale invasive species removal from an island located near the mouth of the lagoon. The removal of non-native trees and other vegetation from the island, would allow the natural hydrologic processes to erode the island sediments, thereby providing better tidal flow into and out of the lagoon. This project has recently received grant funding for the first five years of the 10-year project. Funding is not currently needed, but will be needed in years 6-10 to continue monitoring and removal of non-native vegetation, which would increase the likelihood of the success of this project.

4.3.4.4 Rocky Intertidal Habitat

Background

The rocky intertidal habitat within the area affected by the *Cosco Busan* spill includes a variety of natural and artificial rocky substrates, both within the San Francisco Bay and the outer coast. These habitat types include boulder fields, bedrock outcrop and benches, riprap, seawalls, and mixed cobble beaches. Along the open coast, many of the rocky intertidal environments are located in high energy environments especially along headland areas (e.g., Marin Headlands). Within the Bay, much of the rocky intertidal shoreline contains artificial substrates including rock riprap and seawalls, yet also are habitat to the native oyster, a species that occurs within the oiled area and is a species being restored by local groups. A wide variety of attached algae, invertebrates, and fish use rocky intertidal habitats. In terms of species diversity, hard substrates within San Francisco Bay support the greatest diversity of macroalgae (Silva 1979).

Injury Assessment

Impacts to rocky intertidal habitat were assessed through a number of field studies. Similar to the other shoreline habitats, the degree of oiling was classified based on descriptors used in the SCAT data. In additional to several field studies conducted after the oil spill, the Trustees also relied on other monitoring programs (e.g., through the Multi-Agency Rocky Intertidal Network and the National Park Service) that had pre-existing sample sites. In addition, the Trustees conducted analyses of pre- and post-spill photographs, field notes (e.g., from Jepson Herbarium at UC Berkeley), and species data from other projects (e.g., Moss Landing Laboratory Aquatic Invasives Study). Detailed information is available in Appendix F as well as in reports available in the administrative record (Raimondi et al. 2009, Zabin et al. 2009).

Area of Impact. Acres impacted were quantified using the SCAT data as described above. Injury categories were subdivided based on regional differences in biota and exposure and by differences between more natural rocky substrates and rip-rap as described below.

By Region. Rocky intertidal habitat was separated into outer coast sites and sites within San Francisco Bay ("in-bay") because the composition of the intertidal communities differed between the two (Silva 1979, Raimondi et al. 2009). In addition, the duration of oil exposure and impacts differed between the two regions.

By Sub-Habitat Type. Injury was considered separately for rocky (Boulder, Bedrock, Seawall, and Mixed Cobble) and rip-rap shorelines, based on habitat structure and oiling. Most of the oil deposited in the mid, high and splash intertidal zones of rocky shores such that the degree of impacts and recovery differ between the stranded zone and the non-stranded, lower intertidal zone. For all non-rip-rap rocky intertidal habitats (both In-Bay and Outer Coast sites), the area of the oiled footprint (determined from the length of the segment multiplied by the oil band width recorded on the SCAT datasheet) was used as the stranded oil band area. The intertidal habitat below the stranded oil band was evaluated separately as the "rest of intertidal" zone. Rip-rap habitats were not separated into a stranded oil band and lower intertidal zone due to the three-dimensional nature of rip-rap and the oiling within the interstitial spaces. For rip-rap, oil dispersed within the crevices between rocks and in some areas, pooled oil was present and likely re-mobilized during tides and storm events, contributing to oiling throughout the intertidal zone.

Figure 20. Close-up of algae (*Gymnogongrus sp.*) with oiled portions (black base), normal tissue (brownish-red), and bleached (white) at Rodeo Beach-Bird Island (Fort Cronkhite, Marin Co.). (Photo: Darren Fong, January 17, 2008)

Baseline Conditions. Limited pre-spill data are available that provide a quantitative description of rocky intertidal biota within the bay. Most of the pre-spill monitoring data are available for sites along the outer coast or are in-bay sites strongly influenced by marine conditions (e.g., Alcatraz) (Fong 2009). These sites are mapped at http://www.marine.gov/About/StudyArea.html#northerncalifornia. In-bay baseline data were available for native oyster monitoring sites maintained by UC Davis/Smithsonian.

Initial Injury. Injuries were a result of direct oil smothering/fouling of individuals, tissue necrosis and bleaching from oil contact (Figure 20), sublethal effects from exposure to petroleum, and trampling and physical cleaning of rocky intertidal habitats (Figures 21-22). Injury quantification was based on field survey data, PAH tissue concentrations in mussels, and supplemented with scientific literature. Sites that were cleaned with high pressure hot water or were subject to rock removal and replacement had different impacts and recoveries than sites without this "heavy" cleaning. The degree of impacts associated with manual cleaning varied according with the amount of oiling (e.g., sites with "moderate" oiling have more cleaning related impacts than "lightly" oiled).

Figure 21. Bag of oiled *Fucus gardneri* (including holdfasts) from cleaning activities at Pt. Blunt, Angel Island. (Photo: Dan Richards, Nov 21, 2007)

Recovery. Recovery times from a UC Santa Cruz disturbance study were used to estimate recovery times for oil spill impacts. The recovery periods reflect the time needed for the affected areas to attain 100% of ecological services that would be present but for the oil spill. Recovery may be delayed by re-oiling events. The recovery time for this habitat was estimated based upon the recovery time of key intertidal assemblages (fucoid, barnacle, mussel, and mid-intertidal red algae) following disturbance. Lower intertidal recovery trajectory were developed using relevant scientific literature for affected taxa.

Figure 22. Manual clean-up actions at Pt. Blunt, Angel Island (Photo: Dan Richards, Nov 21, 2007)

Table 7: Summary of Rocky Intertidal Injury (In-Bay)

Habitat/Category	Acres Injured	Time to full recovery (years)
Heavy clean-up (e.g. hot water rinse or rock replacement)	5.8	5.4
Riprap - Heavy	0.9	5.4
Riprap - Moderate	5.8	5.4
Riprap - Light	21.3	5
Riprap - Very Light	49.6	5
Stranded Oil Band - Heavy	0.5	5.4
Stranded Oil Band - Moderate	0.8	5.4
Stranded Oil Band - Light	4.4	5
Stranded Oil Band -Very Light	3.2	5
Rest of Intertidal - Heavy	1.1	4
Rest of Intertidal - Moderate	4.7	2
Rest of Intertidal - Light	29.4	1
Rest of Intertidal - Very Light	30.6	0.08
Bay Subtotal	**158.1**	**0.08 – 5.4**

Table 8: Summary of Rocky Intertidal Injury (Outer Coast)

Habitat/Category	Acres Injured	Time to full recovery (years)
Stranded Oil Band - Heavy	0.6	5.4
Stranded Oil Band - Moderate	0.9	5.4
Stranded Oil Band - Light	2.4	5
Stranded Oil Band - Very Light	18.3	5
Rest of Intertidal - Heavy	0.7	3
Rest of Intertidal - Moderate	3.7	1
Rest of Intertidal - Light	37.2	0.25
Rest of Intertidal - Very Light	162.5	0.08
Outer Coast Subtotal	**226.2**	**0.08 – 5.4**

A total of 384.3 acres of rocky intertidal habitat was exposed to and injured by the oil spill. Appendix F provides additional information on the injury assessment and quantification of rocky intertidal habitat injuries.

Restoration Alternatives

The Trustees are selecting the projects described below to compensate for injuries to rocky intertidal communities caused by the oil spill (Tables 7 and 8).

SELECTED PROJECTS	BENEFITS
Native oyster restoration	**rocky intertidal habitat**
Rockweed restoration	**rocky intertidal habitat**

Selected Alternative

Native oyster (*Ostrea lurida*) restoration and enhancement projects

The goal of this project is to provide suitable natural hard substrate to enhance oyster larvae settlement and recruitment. This project will compensate for the lost services to natural rock and rip rap intertidal habitats.

Oyster reefs are key marine habitats (Jackson et al. 2001), and create biological diversity (Posey et al 1999, Breitburg et al. 2000). Oysters are responsible for higher densities of macro invertebrate species for crabs and predatory fish species than unstructured mud (Summerson and Peterson 1984, Lenihan and Peterson 1998).

Macroinvertebrate density and species richness are positively correlated with structural complexity (Crowder and Cooper 1982, Diehl 1988, Diehl 1992). Enhanced habitat structure increases prey for crabs and predatory fish survival (Heck and Thoman 1981, Crowder and Cooper 1982, Schriver et al. 1995, Beukers and Jones 1997, Grabowski 2004). Oyster beds made of disarticulated shell (versus mud) increased resident fish, bivalve, and decapod crustacean populations (Plunket and La Peyre 2005).

Naturally occurring populations of native oysters can be found throughout San Francisco Bay from Pt. Pinole to south of the Dumbarton Bridge on natural and artificial hard substrate. In the intertidal zone, oysters can be found in highest abundances (80 per m^2)

in the Central Bay, but lower densities and scattered live individuals are found over a wider extent. Based on measurements of oyster densities around the Bay in 2006, Grosholz et al. (2007) estimated that there are 300,000 living oysters in the intertidal zone in San Francisco Bay.

Oysters require hard substrate for attachment. The increase in sediment in the Bay that has occurred as a result of human activities has likely resulted in the burial of smaller, naturally occurring substrates oysters once were able to use and necessitates the addition of larger substrate. Hard substrate also appears to be limited below the zero tide line in many locations where it is present in the intertidal zone.

Specifically, the project will involve the placement of substrate (i.e., cleaned and dried Pacific oyster shells, reef balls, and rock structures) at various locations suitable for native oyster restoration within the Central Bay. Potential priority sites include Angel Island, Richardson Bay, San Rafael Shoreline from Marin Rod & Gun Club to south of canal area, Marin Islands, Point Isabel and Albany Dog Park, Berkeley Shorebird Park, Ashby Spit to Emeryville Crescent, San Leandro Marina and nearby shoreline. Other areas outside of the Central Bay region that are suitable for oyster restoration may also be considered.

Affected Environment

This project will be located at various locations within the Central Bay where predation is minimal and salinities are within the range for oyster recruitment and survival.

Environmental Consequences (Beneficial and Adverse)

While Olympia oysters do not make reefs, there is evidence that even small-scale physical structure increases biodiversity (Kimbro & Grosholz 2006). In Louisiana, as in San Francisco Bay, oysters are present in beds not reefs. Despite lacking this, oyster beds have been shown to be a valuable refuge and foraging habitat for fish and decapod crustaceans (Plunket et al 2005). The primary negative impacts include loss of soft substrate within these locations. This impact would be insignificant based on the size of the reefs relative to the area of soft substrate covered.

Probability of Success

Native oyster restoration techniques have worked relatively well for recruiting and maintaining native oyster populations in the various locations in the bay. In addition, techniques to increase larval success by seeding cultch could also be employed.

Performance Criteria and Monitoring

The following table is used to guide restoration success of native oyster beds.

Table 9: Modified Matrix for Measuring Restoration Success

Goal	Measurements	Methodology	Timing
Increase/improve habitat for native oysters	Acreage or linear feet of hard substrate	Snorkeling/wading measurements of perimeter	During construction phase and immediately following construction phase, determine that substrate configuration is holding
Self-sustaining populations of native oysters	Oyster density	Counts of live oysters per unit area; compare to reference site	At least annually, for 3-5 years after construction.
	Size class structure	Measurements of oysters in above counts: compare to reference site	At least quarterly, for 3-5 years after construction.
	Recruitment	Number of spat on samples of material used for restoration; compare to reference site	At least annually, for 3-5 years after construction. If recruitment is low over 2-3 years, consider seeding

Source: Zabin et al. 2010.

Evaluation

The Trustees have evaluated this project using the threshold and additional screening criteria developed to select restoration projects and concluded that this project is consistent with and meets the objectives of these selection factors. They believe that this type and scale of project will effectively provide appropriate compensation for injured rocky intertidal habitat as a result of the spill and have therefore selected this project as a preferred alternative.

Selected Alternative

Rockweed (*Fucus gardneri*) Restoration

The primary goal of this project is to increase the amount of vegetative cover of a key mid-high intertidal alga in areas that were directly impacted by the *Cosco Busan* oil spill.

During the *Cosco Busan* oil spill several rocky intertidal areas, such as at Berkeley Marina and Treasure Island, were directly impacted by clean-up activities. Some areas were heavily cleaned with hot water or had rocky intertidal habitat physically removed. Additionally, oiled *Fucus* was removed from rocky shorelines during cleanup efforts. This project is intended to increase the amount of rockweed within the Central Bay at several locations. These sites include riprap shorelines that were heavily cleaned with hot water. The primary goal of this project is to increase the amount of vegetative cover of a key mid-high intertidal alga in areas that were directly impacted by the spill.

This project includes the following specific tasks:

- Map existing distribution of *Fucus* within the Central Bay to determine viable donor sites
- Establish potential donor sites and the maximum percentage of algae that could be harvested for the two techniques (listed below).

- Create 2,000 lineal meters of new *Fucus* habitat through two techniques: (1) use of seed bags with fertile tips of Fucus blades in areas with filamentous algae and (2) use of transplanted *Fucus* (minimum 10-20 cm length, with holdfast intact) either individuals harvested from boulders or through transplant of cobbles with plants attached
- Monitoring of new *Fucus* establishment areas and control sites for five years over a 10-year monitoring period.

Affected Environment

This project will occur on pre-existing rocky shorelines with minimal to non-existent *Fucus* cover. Many of these shorelines are artificial riprap which has been cleaned using hot water during the spill. Donor sites will come from areas within Central Bay that have large and healthy stands of *Fucus*.

Environmental Consequences (Beneficial and Adverse)

Planting of riprap shorelines, particularly those that have been impacted by hotwash activities would increase the amount of algal cover in the mid-intertidal zone. The development of a *Fucus* canopy would benefit long-term establishment of understory species that need protection from desiccation. Adverse impacts could be associated with donor site impacts, should a high percentage of *Fucus* be removed from one site and transplanted at another. Such impacts would be minimized below the threshold of significance by only harvesting small numbers of *Fucus* from several sites with high abundance. This would be accomplished in preliminary tasks, by mapping the existing distribution of *Fucus* within the Central Bay to determine viable donor sites).

Probability of Success

The proposed "planting" activities have been tried with a similar species, *Silvetia compressa*, with good success with planted juveniles on a medium scale (100m x 20 m area; Whitaker 2009). Work in Alaska associated with the *Exxon Valdez* spill indicated that *Fucus* establishment in restoration plots associated with moist conditions provided either by adults or by artificial coconut fiber mats (Stekoll and Deysher 1996).

Performance Criteria and Monitoring

Various criteria measures may include assessments of: survivorship of transplanted adults relative to reference adults, recruitment of new individuals relative to reference areas, Fucus cover over time in transplant areas, recruitment of new individuals relative to reference areas, and expansion of Fucus cover over time in transplant areas.

Evaluation

The Trustees have evaluated this project using the threshold and additional screening criteria developed to select restoration projects and concluded that this project is consistent with and meets the objectives of these selection factors. They believe that this type and scale of project will effectively provide appropriate compensation for rocky intertidal habitat injured as a result of the spill and have therefore selected this project as a preferred alternative.

Other Restoration Projects Considered

The Trustees also considered the following project but did not select it as preferred. This project may be reconsidered if sufficient funding becomes available.

OTHER PROJECTS CONSIDERED	BENEFITS
Albany Bulb rocky shoreline restoration	rocky intertidal habitat

Albany Bulb Rocky Shoreline Restoration

The Albany Bulb Rocky Shoreline Restoration project was considered as part of the larger Albany Beach restoration project (see project details described under section 4.3.3.3). Improvements to the South Albany Neck will create and enhance rocky intertidal habitat and stabilize an eroding shoreline and thereby limit sedimentation and degradation of sensitive habitats. This component of the project could be considered in the future.

4.3.4.5 Eelgrass Beds

Background

Areas vegetated by eelgrass and other seagrasses are recognized as important ecological communities in shallow bays and estuaries because of their multiple biological and physical values (reviewed in Kenworthy et al. 2006). Habitat provided by these submarine plants functions as an important structural environment for resident bay and estuarine species, offering a predation refuge, a food source and a nursery area for many commercially and recreational important finfish and shellfish species, including those that are resident within bays and estuaries, as well as oceanic species that enter estuaries to breed or spawn. Herring use eelgrass beds for spawning in San Francisco Bay.

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

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

Injury Assessment

SCAT teams did not assess oiling within eelgrass beds due to accessibility and limited likelihood of recoverable oil occurring there. Degree of tidal flat oiling was considered by the Trustees to be proportional to the degree of oiling of the adjacent shoreline (e.g., more oil would be moving across eelgrass beds next to more heavily oiling shorelines). Therefore, for the purposes of NRDA, tidal flats were categorized based on the oiling categories of the adjacent shoreline habitats. The areas of eelgrass beds were determined

from maps previously developed (Merkel and Associates 2005). The eel grass beds were divided into intertidal and subtidal areas based on the depth of the beds as provided by NOAA: intertidal (0-4 ft.) and subtidal (greater than 4 ft.). The intertidal beds were assigned a degree of oiling equivalent to the most prominent maximum oiling observed on the closest adjacent shoreline to the intertidal bed. The subtidal beds were assigned an oiling one degree lighter than the oiling assigned to the adjacent intertidal beds.

The studies conducted investigating oiling effects on eelgrass beds showed that, while many eelgrass beds were exposed to oil, there is little evidence to suggest serious injuries to them. In the metrics quantified, the beds under study showed few changes that could be attributed directly to the oil.

Table 10: Summary of Acres of Eelgrass Beds Exposed to Oil

Eelgrass Beds (based on oiling category of adjacent shoreline)	**Acres**
Very lightly oiled	789
Lightly oiled	119
Moderately oiled	14.3
Heavily oiled	17.6
TOTAL	**939.9**

A total of 939.9 acres of eelgrass bed habitat was exposed to the oil spill.

In addition, clean-up operations resulted in impacts to the eelgrass bed at Keil Cove, Marin County. Impacts from vessel groundings on seagrass beds are not uncommon during oil spills. Groundings are when a vessel hits bottom, displacing sediments and uprooting seagrasses. Another injury feature, known as a "blowhole" is formed from the concentrated force of propeller wash, either from the grounded vessel attempting to power off the bank or the propeller wash of the salvage vessel pulling the grounded vessel off the bank. The depth and area of the blowholes also vary depending on the size of the vessel, extent of power used to remove the vessel, and type of seagrass bed substrate. Berms, another common seagrass injury feature, are produced from the sand, mud, coral fragments, and other substrates excavated during the creation of prop scars and blowholes that typically accumulate around the perimeter of the impact, thereby burying healthy seagrasses (Fonseca et al. 2002).
The injuries sustained to the eelgrass bed at Keil Cove are from a combination of prop scars and vessel grounding. In reviewing side scan and single beam images taken in November 2007 and April/May 2008, the images map multiple features that can be correlated with clean-up activities at the site. The vessel *Allied Mariner* was used to transport and haul away oiled rock and carry in new rock and clean-up equipment to the shoreline of Keil Cove. As the vessel moved in and out of the cove, several large scars (approximately 0.19 acres) were formed through an eelgrass bed that has persisted at this site for more than 85 years (Setchell 1927, 1929).

A complete survey of the site for eelgrass was conducted using sidescan sonar (Figure 23). A January 2008 survey revealed a large scar-like impression located at the east end of the cove and running perpendicular to the shore as well as two crescent shaped scars in the

deeper bed. A fourth scar appeared in May after additional clean-up activities were being completed (Figure 23). These scars did not appear in the November 2007 scan.

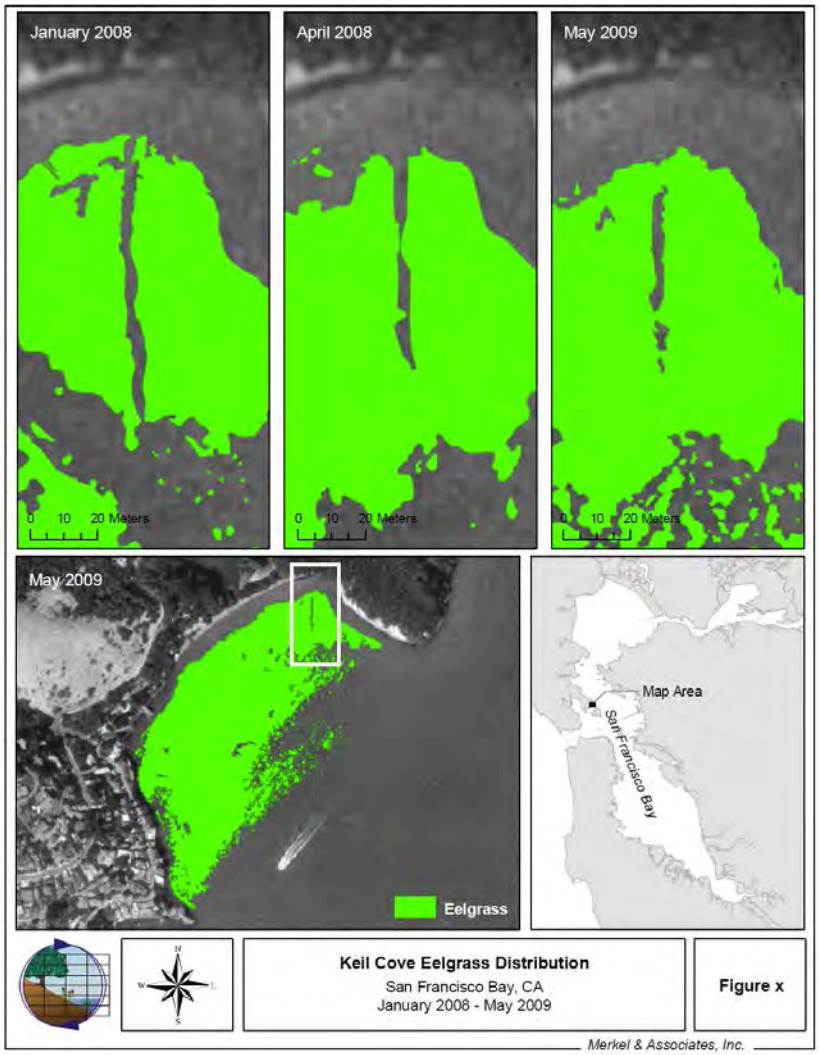


Figure 23. Side-scan sonar data were collected operating at 600 kHz scanning out 20 meters on both the starboard and port channels for a 40-meter wide swath. All data were projected in meters (NAD 83) in the Universal Transverse Mercator (UTM) system and plotted on a geo-rectified aerial image of the study area.

In discussions with seagrass restoration specialists, emergency restoration of the scar by filling and or transplanting was not recommended. Subsequent side scan sonar images revealed the scar maybe recovering on its own (Figure 23). Nevertheless, the scar will be monitored for the next three years.

Restoration Alternatives

Projects conducted under this category will benefit eelgrass habitat, herring and other fish spawn, and invertebrate communities.

SELECTED PROJECT	BENEFITS
Eelgrass restoration in San Francisco Bay	Eelgrass, herring

Selected Alternative

Eelgrass restoration in San Francisco Bay

Specifics of the eelgrass restoration project are discussed in fish section above (section 4.3.3). No other alternatives were considered in regards to eelgrass restoration. The Trustees determined that any injuries sustained by eelgrass habitats would be duly compensated by the same eelgrass project intended to compensate for injuries to herring and other fish. A percentage of the funding for eelgrass restoration will be set aside for monitoring of the eelgrass scar at Keil Cove.

4.3.5 Human Recreational Uses

The San Francisco Bay area includes many national, state, regional, and local parks with rich natural resources providing exceptional recreational opportunities in a major metropolitan area. The people in the region engage in a wide variety of recreational activities along the coast and inside the Bay. These range from general beach use, jogging, and dog-walking, to more specialized activities such as fishing, boating, surfing, wind-surfing, and kite-boarding.

During the spill, a large number of beaches were completely closed or subject to access limitations, on-water activities were curtailed, and fishing of all types was prohibited across an eight-county area (Figure 24). Recreation use was impacted across a wide geographic range of the spill, which limited the number and availability of potential substitute recreational locations. Extensive media coverage of the spill and of the numerous closures and limitations prolonged the depressed public usage, even after beaches and shorelines had been reopened.

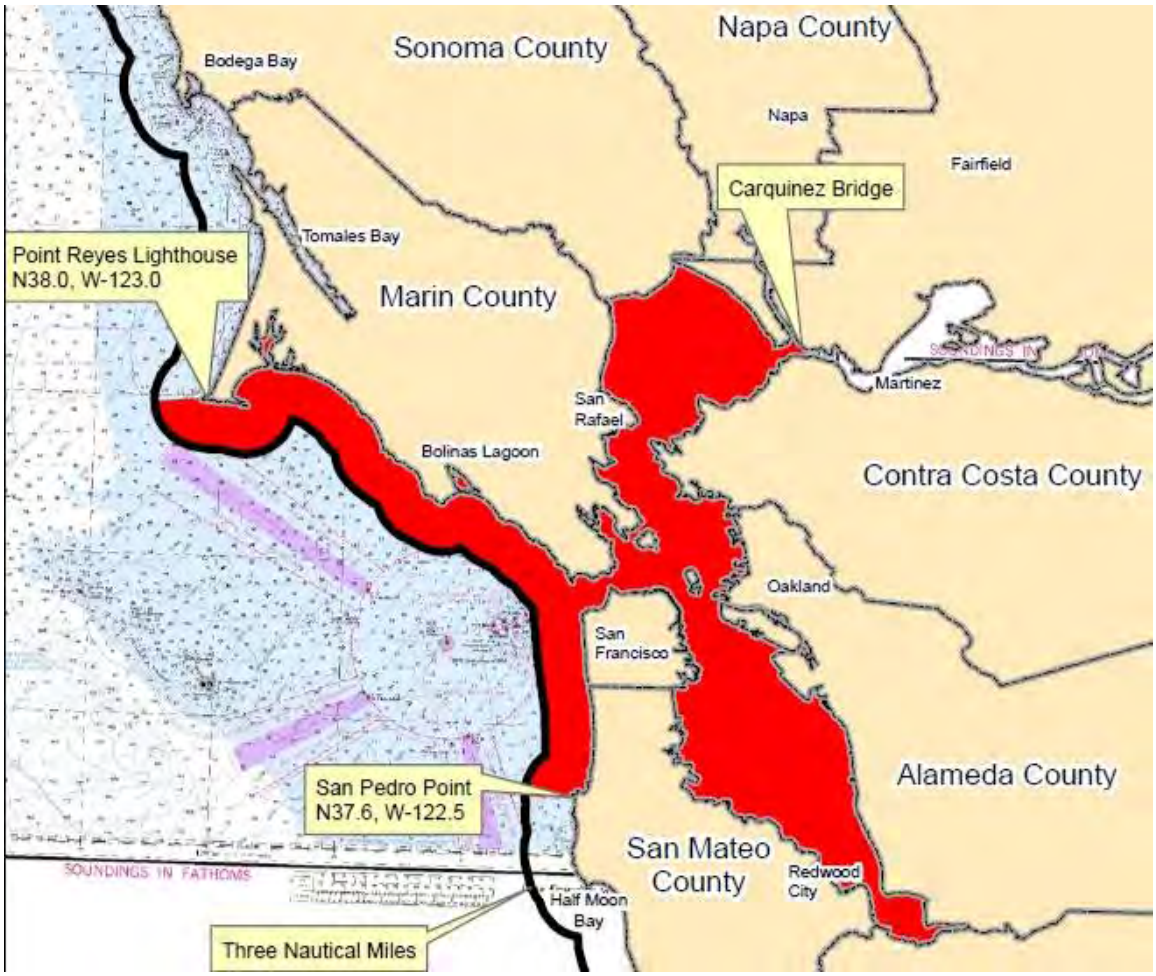


Figure 24: Map showing the closure of all recreational and commercial fishing, which was in effect from November 14-29.

This assessment and plan is limited to recreational use impacts on the public and does not include private claims for losses to commercial fishing or recreation-based concessionaires. Impacts to commercial activities and other private party claims may be addressed through third party claims procedures under OPA or in private civil litigation.

4.3.5.1 Overview of Data Collection and Studies

State and federal Trustees coordinated with the City and County of San Francisco (CCSF) and the East Bay Regional Parks District (EBRPD) in developing a claim for damages for lost human recreational use values. The list below summarizes the various field studies, data collection tasks, and analyses used for the assessment of recreational use impacts.

- **Documentation of Closures and Impacted Activities**
    - A list of impacted sites, groups, and events was compiled, including all closures and restrictions by date and activity, and all public announcements. Additionally, data from affected recreation businesses (e.g. fishing, kayak rentals) were collected.

- **November 2007 Visitor Surveys**
    - A survey of visitors to Golden Gate National Recreation Area (GGNRA) and one East Bay site was conducted during the response phase of the oil spill to document whether the spill affected outdoor recreation in and around San Francisco Bay. The results indicate that 62% of the visitors said their recreation activities were affected by the spill. Information was also collected on how far people traveled to visit selected bay-front locations, along with their modes of transportation (e.g., car, foot, bicycle) used to reach each site. The results of the survey were used to design follow-up studies to assess baseline recreational use around the bay.

- **Compilation and Evaluation of Existing Data Related to Baseline Use**
    - Historical use data from various sites were compiled and assessed for their usefulness. This included car-counter data, recreational fishing data, web cam photographs, and other estimates of human use at shorelines and other sites. Gaps in historical data were also identified.

- **November 2008 Visitor Surveys and Baseline Recreational Use Estimates**
    - Extensive surveys were conducted during the week of the anniversary of the spill in order to estimate baseline use. These were conducted both inside the Bay and on the outer coast, at beaches, marinas, and other sites, counting people by both site and activity, and interviewing a sub-sample of them. The level of use was correlated with the day of the week and weather conditions. A summary of the baseline use at many Bay Area locations is provided in Appendix G.

- **Analysis of Recreational Fishing Losses**
    - Historical data from the California Recreational Fishing Survey was compared to spill year data across shore-based and boat-based fishing modes to estimate lost use across the region. Pre-existing literature on recreational fishing values was examined. These values were multiplied by the number of lost fishing trips to estimate the total lost value for those activities. See Appendix H.

- **Analysis of Recreational Boating Losses**
    - Onsite surveys were used to estimate baseline use and destinations of trips from selected marinas around the bay. These provided the basis for calculating the number of lost boat trips due to the spill. After evaluating pre-existing economic literature on the value of a recreational boating trip,

the number of lost trips was multiplied by a value per trip to estimate spill-related losses associated with boating activities. See Appendix I.

- **Telephone Survey and Analysis of General Shoreline Recreation Losses**
    - A region-wide telephone survey was conducted to estimate the number of lost trips associated with the spill and the associated loss in value. The survey results were used to develop a multi-site travel cost model, which estimates losses over time. This analysis excludes recreational fishing and boating and is calibrated to the baseline use estimates conducted on site. See Appendix J.

4.3.5.2 Summary of Injury

For the purposes of this assessment, recreational use was divided into the following categories:

- General shoreline use (including dog-walking, surfing, kite-boarding, etc.)
- Fishing (including both shore-based fishing and fishing from vessels)
- Boating (including both motorized and non-motorized boating)

Lost use for these categories was quantified in the following geographic regions:

- East Bay (Alameda and Contra Costa counties)
- Marin County (both inside the Bay and along the outer coast)
- San Francisco County (both inside the Bay and along the outer coast)
- San Mateo County (both inside the Bay and along the outer coast)
- Other Areas (Santa Clara, Solano, Sonoma counties)

Affected Use

In the wake of an oil spill, some individuals decide not to visit the shoreline. Others choose to visit alternative sites. Some visit affected shorelines but experience reduced enjoyment as a result of the incident. These all represent impacts associated with the spill.

Beach and shoreline closures and other limitations on activities varied from location to location, as closures and advisories are based on site specific conditions and are implemented by local, regional, state and federal land management agencies that have jurisdiction, not by the oil spill Incident Command Center. While many affected areas were closed for fewer than seven days, Rodeo Beach in Marin County and Albany Beach in Alameda County, for example, were closed for more than five weeks. In both of these locations, tarballs fingerprinted to the *Cosco Busan* were still appearing in summer 2008.

Table 10 summarizes the estimated number of lost trips across three general activities. These represent the number of trips that did not occur at affected sites as a result of the spill.

Table 10: Lost Trips by Activity

	Lost Trips
General Shoreline Use	983,800
Fishing	69,500
Boating	26,600
TOTAL	**1,079,900**

The estimate of lost boating trips focuses on impacts at marinas and yacht clubs, where the highest density of trips occurs. It does not include lost boat trips derived from private residences around the San Francisco Bay.

The most significant impacts occurred in November. However, there were significant ongoing impacts in December, consistent with the continued closures and clean-up activities at various locations. Lost use impacts tapered off over the following months. For general shoreline use, attendance levels did not return to normal until July 2008 at some locations.

Figure 25: Ocean Beach as seen from the web cam atop the Cliff House, one year after the spill.

Value of Affected Use

The value of a lost user day is the value that a trip brings to that individual. Economists refer to this as that individual's "consumer surplus" or willingness-to-pay for that activity, even though use of that location may be free (except for parking, travel costs, and equipment). A wide range of economic analyses have been conducted to estimate the value of recreational activities. In this case, a Travel Cost Analysis specific to the Bay Area and this oil spill was conducted to estimate the value of general beach use. This general beach use category includes a wide range of activities and corresponding consumer surplus value, ranging from dog-walking, jogging, and picnicking to more specialized activities such as surfing and kite-boarding. The value associated with lost trips varied across time, depending on the number of available substitute destinations and/or activities. For boating and fishing, values from other studies conducted elsewhere were used (i.e., the Benefits Transfer Method). The results are as follows:

- General shoreline use: a value ranging from $8.28 to $22.65 per lost trip was utilized, depending primarily on the number and location of available substitutes. Immediately after the spill, when most beaches were closed, the value was highest. The value generally declined over time as more beaches opened and more substitutes were available.
- Boating: $78 per trip for most trips, $52 per trip for dragon boating.
- Fishing: $50 per trip for boat-based fishing, $38 for shore-based fishing.

The state and federal Trustees, along with their local and regional government agency partners recovered $18,800,000 from the responsible parties to fund projects that will compensate the public for lost recreational use resulting from the spill. The following table contains the allocation of recreational use damages among the three categories of activities discussed above:

Table 11: Value of Lost Trips by Activity

General Shoreline Use	$15,000,000
Fishing	$2,400,000
Boating	$1,400,000
TOTAL	**$18,800,000**

The Trustees recognize that the amounts in the table are less than the damage estimates derived from the data and methodologies set forth above. The differences reflect uncertainties in the relevant data and analysis.

Restoration

The Trustees, working with local and regional governmental agencies, intend to select a suite of restoration projects to compensate the public for lost use of the recreational resources caused by the spill. These projects may include improvements or enhancements to public piers, parks, bike paths, boat ramps, fishing areas, or other infrastructure in order to increase the value of recreational experiences involving beach use, boating, and/or fishing. Specific examples include, but are not limited to: beach and waterfront access; boardwalk construction and improvements; fishing pier and dock improvements; beach sand management and replacement; beach fire rings; beach shower and restroom improvements; picnic facilities; San Francisco Bay Area Water Trail improvements; Bay Trail and Coastal Trail improvements; public access components of large ecological restoration projects; interpretive, educational, and wildlife viewing facilities.

It is a goal of the Trustees to select projects spanning the geographic area of the spill and to address the various types of activities (e.g. boating, fishing, other uses) that were impacted by the spill. To that end, and to the extent feasible, funds will be allocated among the regions affected by the spill according to the relative magnitude of the spill impacts, as described below:

- East Bay: 26%
- Marin County: 17%
- San Francisco County: 45%
- San Mateo County: 11%
- Other Areas: 1%

These percentages reflect the approximate estimated distribution of losses across the spill zone.

Compliance with environmental and other applicable laws will be the responsibility of the implementing agency for each selected project.

Administration and Allocation

The $18.8 million in damages recovered for lost recreational value will be administered as follows:

- Trustees
  - The DOI will administer $9.746 million of the settlement amount for projects to be selected by the Trustees to primarily benefit recreational activities associated with units of the National Park Service (NPS) located in San Francisco and Marin counties. The Trustees will work cooperatively with CCSF to identify appropriate restoration projects within the City and County of San Francisco.
  - For more information on the allocation of these funds, contact Daphne Hatch of the National Park Service at daphne_hatch@nps.gov.

- State Trustees
  - The State Trustees (California Department of Fish and Game and the California State Lands Commission) will administer $7.260 million to fund projects to be selected by the Trustees to primarily benefit recreational activities in the East Bay, San Mateo County and portions of Marin County, to compensate for recreational losses not addressed by projects selected pursuant to the preceding and following two paragraphs. The Trustees will work cooperatively with EBRPD, San Mateo and Marin counties, local cities, and other public and private organizations to identify a suite of potential projects according to the relative magnitude of the spill impacts. Projects will then be selected for funding using a competitive grant process, until all funds are spent.
  - For more information on this grant process, see www.nfwf.org/coscobusanrec.

- City and County of San Francisco
  - The City and County of San Francisco (CCSF) will administer $1.125 million to fund projects primarily benefiting recreational activities associated with non-NPS lands located within the City and County of San Francisco. CCSF will work cooperatively with the Trustees to identify appropriate restoration projects.
  - For more information on the allocation of these funds, contact Don Margolis at don.margolis@sfgov.org or Tom Lakritz at tom.lakritz@sfgov.org.

- City of Richmond
  - The City of Richmond will administer $669,000 to fund projects that benefit recreational activities associated with lands in and around the City of Richmond. Richmond will work cooperatively with the Trustees to identify appropriate restoration projects.
  - For more information on the allocation of these funds, contact Bill Lindsay of the City of Richmond at bill_lindsay@ci.richmond.ca.us.

4.4 "No Action" Alternative

NEPA requires the Trustees to consider a "no action" alternative, and the OPA regulations require consideration of a roughly equivalent "natural recovery" alternative. Under this alternative, the Trustees would take no direct action to restore injured natural resources or to compensate for lost services. Instead, the Trustees would rely on natural processes for recovery of the injured natural resources.

The principal advantages of the natural recovery approach are the ease of implementation and the absence of monetary costs. However, while natural recovery may occur over time for many of the injured resources, the interim losses suffered by those resources would not be compensated under the "no action" alternative. OPA clearly establishes Trustee authority to seek compensation for interim losses pending recovery of natural resources. Losses were, and continue to be, suffered during the period of recovery from the spill, including the loss of an estimated 6,849 birds including special status species, the loss of an estimated 14 to 29% of the winter 2007-8 herring spawn, degradation of 3,367 acres of various shoreline habitats, and the loss of human recreational uses estimated at 1,079,900 user-days. Furthermore, technically feasible project alternatives exist to compensate for these losses. Thus, the Trustees reject the "no action" alternative and instead have selected the appropriately scaled restoration projects described above as the preferred alternatives.

4.5 Cumulative Impacts

The Trustees examined a variety of alternatives to restore resources and/or services lost as a result of the *Cosco Busan* oil spill. Anticipated environmental consequences arising from each of the selected projects are provided in section 4.3. As required by NEPA, this section addresses the potential overall cumulative impacts of implementing this restoration plan.

Cumulative impacts are impacts that result from an action along with other past, present, and reasonably foreseeable near-term future actions taken together. Significant cumulative impacts can result from a combination of actions that do not have significant impacts individually. Taken collectively, the effects of several actions may be additive, countervailing, or synergistic. Impacts are considered regardless of the agencies or parties involved. Thus, in considering cumulative impacts, this analysis is not limited to the actions of this case but also considers other projects in the region.

Overall, the Trustees' selected restoration projects for the *Cosco Busan* NRDA will result in long-term net improvement in fish and wildlife habitat, restoration of ecological balance in areas where disturbances have led to adverse impacts on sensitive native species, and improvement in the natural resource services provided by fish and wildlife in the region. Cumulative impact analysis is nonetheless performed to evaluate whether there are specific components of the proposed actions that, when considered in combination with other closely related past, present, and future actions in the affected area, have potentially significant cumulative adverse effects.

The Trustees evaluated the restoration projects selected in this DARP/EA in conjunction with other known past, proposed or foreseeable closely related projects that could potentially add to or interact with the these projects within the affected area to determine whether significant cumulative impacts may occur. All of the selected projects to restore ecological services to compensate for injuries from the oil spill to birds, fish, and habitats are consistent with and in some cases a part of ongoing regional environmental restoration efforts described in plans such as the San Francisco Baylands Ecosystem Goals Project (Goals Project 1999) and the San Francisco Bay Subtidal Goals project (Subtidal Habitat Goals Report 2011). While one of the selected projects, the Tule Lake Grebe habitat project, would take place outside of the San Francisco Bay area, it is designed to function as a component of a comprehensive and adaptive resource management plan as implemented by Tule Lake National Wildlife Refuge. Other restoration projects to be selected later to compensate for lost recreational uses and to benefit surf scoters and other large diving ducks, will be subject to further environmental analysis, including a cumulative effects analysis, and public review once sufficient information is developed to provide for that analysis.

Cumulatively, natural resource improvement projects in the area are expected to result in similar environmental effects (beneficial and adverse) as the projects selected in this DARP/EA. In the long-term, the overall water quality effects of the selected habitat improvement projects and other past and reasonably foreseeable restoration projects is expected to be beneficial, since they are generally acknowledged to provide favorable water quality improvement and enhanced biological activity. Construction for some of the projects could cause temporary water quality impacts; however, these impacts would be limited in scope and duration, would be mitigated by use of best management practices, and are unlikely to contribute to cumulative water quality impacts in San Francisco Bay.

All of the past and proposed wetlands and subtidal habitat enhancement efforts for this region are part of a long-term strategy to recreate a complex mosaic of wetlands and subtidal habitats in the greater San Francisco Bay area. The projects described in this document, considered along with other restoration projects, will result in cumulatively beneficial impacts to plants and wildlife, including special-status species, providing additional habitat to support recovery of these sensitive communities and resulting in greater habitat complexity, diversity, and productivity. These projects will cumulatively increase the availability and quality of marsh and shallow water aquatic habitats throughout the region. The wetlands restoration projects described in this document involve enhancement of existing degraded site conditions rather than conversion of uplands or diked baylands to tidal marsh or mudflat. The eelgrass restoration project entails the gradual conversion of unvegetated shallow subtidal habitat to vegetated habitat resulting in a shift in biological communities from those that occupy unvegetated shallows to those that utilize vegetated shallows. Similarly, native oyster restoration entails gradual introduction and expansion of oyster beds beyond areas where they currently occur. The subtidal habitats of San Francisco Bay are approximately 120,000 hectares or 300,000 acres at mean sea level. More than 90% of the subtidal environment in the Bay is composed of soft-bottom habitats while eelgrass comprises only about 1% of the total estuarine area (Subtidal Habitat Goals Report 2011). Impacts from eelgrass restoration within this plan, even when considered along with changes anticipated as

other similar projects are implemented throughout San Francisco Bay, will be minimal to soft bottom habitats of the bay and will only enhance habitat complexity at sites in which eelgrass restoration will occur. Similarly, the acreage of subtidal habitat affected by native oyster restoration to be performed under this plan, when considered along with other reasonably foreseeable oyster restoration efforts, is *de-minimis* compared to the available suitable subtidal habitat.

Another potential cumulative impact from multiple tidal habitat restoration projects is the potential for invasion of aggressive non-native plant species, such as certain cordgrass species (*Spartina alterniflora and Spartina densiflora*). The number of restoration projects planned in the region increases the availability of suitable habitat for colonization by these species, and in the past, several restoration projects along the shores of San Francisco and San Pablo bays have been degraded because of non-native cordgrass out-competing native California cordgrass. The ability to control the cumulative effects and spread of exotic species of cordgrass and other plants requires a regional effort and the willingness of resource agencies to fund estuary-wide control programs. Applicable restoration projects, including the one in this plan (the Aramburu Island project) that has the potential to support non-native wetland plant species, require monitoring and control of exotic pest plant species within restored marsh areas, and coordination with the Invasive Spartina Project (a regional program to control non-native *Spartina* in the San Francisco estuary).

Projects to enhance public recreation in areas affected by the spill (i.e., improvements to public piers, parks, bike paths, boat ramps, fishing areas, or other infrastructure that increase the value of recreational experiences involving beach use, boating, and fishing) will have minor short-term impacts on air quality, water quality, and traffic that will be mitigated during the construction phase of such projects. The cumulative long term beneficial effects and public use trade-offs of the recreational projects to be implemented under this restoration plan, along with similar foreseeable development projects throughout the San Francisco Bay region, are potentially significant; however, considerations for monitoring and mitigating potentially significant cumulative impacts on a regional scale are already addressed in existing NEPA and CEQA documents addressing local, county, and region-wide planning referenced below.

For further detailed discussion of cumulative impacts, the reader is directed to documentation for the following projects and plans provided in the references section: Joint Management Plan and Final Environmental Impact Statement for the Cordell Bank, Gulf of the Farallones, and Monterey Bay National Marine Sanctuaries (NOAA 2008); Marin Headlands and Fort Baker Transportation and Infrastructure Management Plan Final Environmental Impact Statement (NPS 2009); South Bay Salt Ponds Final EIS/EIR (EDAW et al. 2007); San Francisco Baylands Ecosystem Habitat Goals (Goals Project 1999); California Outdoor Recreation Plan (California State Parks 2009); San Francisco Bay Plan (San Francisco Bay Conservation and Development Commission 2008). Additional city and county general plans addressing impacts of development projects on a regional scale are accessible through the web site of the University of California Berkeley Library at www.lib.berkeley.edu/ENVI/genplans.html including: Marin Countywide Plan (Marin CDA 2007); and the San Francisco General Plan (San Francisco Planning Department 2009).

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8.0 Appendices

Appendix A: Resource Equivalency Analysis

Appendix B: Acute seabird and waterfowl mortality resulting from the *M/V Cosco Busan* oil spill, November 7, 2007 (Ford et al. 2009)

Appendix C: Shorebird Injury Assessment

Appendix D: Herring Injury Report (Incardona et al. 2011)

Appendix E: Habitat Equivalency Analysis (HEA) Details for Marsh, Flats, and Sand/Gravel Beaches

Appendix F: Rocky Intertidal Service Loss Report

Appendix G: Baseline Shoreline Use Estimates (IEc 2010a)

Appendix H: Recreational Fishing Damages (IEc 2010b)

Appendix I: Recreational Boating Damages (IEc 2010c)

Appendix J: Shoreline Use Damages (Stratus 2010)

Appendix K: Benthic Invertebrates on Beach and Tidal Flat Habitat (Peterson and Michel 2010)

Appendix L: Summary of Public Comments and Trustee Responses

Appendix M: NEPA Compliance Documents