ENVIRONMENTAL SENSITIVITY INDEX: Northern California

INTRODUCTION

Environmental Sensitivity Index (ESI) maps have been developed for the coastal areas of Northern California from Point Reyes National Seashore to the Oregon border. The ESI maps are a compilation of information from three main categories: shoreline types, sensitive biological resources, and human-use resources.

The individual map pages in this atlas are divided according to the U.S. Geological Survey (USGS) 7.5-minute, 1-24,000-scale topographic quadrangle index. Black and white scanned images of these maps are used as a backdrop for each map page in the atlas.

SHORELINE MAPPING

The shoreline habitats on the original ESI maps, published in 1994, were re-examined and updated by a coastal geologist via interpretation of a continuous, overlapping set of georeferenced oblique aerial photographs acquired in October 2005 (www.californiacoastline.org) and September 2007. The photographs were acquired during overflights conducted at elevations of 400-600 feet and slow air speed. Where appropriate, revisions to the existing shoreline were made. Where necessary, multiple types were described for each shoreline segment.

To determine the sensitivity of a particular intertidal shoreline type, the following factors are integrated:

1) Shoreline type (substrate, grain size, tidal elevation, origin)
2) Exposure to wave and tidal energy
3) Biological productivity and sensitivity
4) Ease of cleanup

Prediction of the behavior and persistence of oil in intertidal habitats is based on an understanding of the dynamics of the coastal environments, not just the substrate type and grain size. The intensity of energy expended upon a shoreline by wave action, tidal currents, and river currents directly affect the persistence of stranded oil. The need for shoreline cleanup activities is determined, in part, by the slowness of natural processes in removal of oil stranded on the shoreline. The potential for biological injury and ease of cleanup of spilled oil are also important factors in the ESI ranking. Generally speaking, areas exposed to high levels of physical energy, such as wave action and tidal currents, and low biological activity rank low on the scale, whereas sheltered areas with associated high biological activity have the highest ranking. The list below includes the shoreline types delineated for the Northern California region, presented in order of increasing sensitivity to spilled oil.

1A) Exposed Rocky Shores
1B) Exposed, Solid Man-made Structures
2A) Exposed Wave-cut Platforms in Bedrock
3A) Fine- to Medium-grained Sand Beaches
3B) Scarps and Steep Slopes in Sand
4) Coarse-grained Sand Beaches
5) Mixed Sand and Gravel Beaches
6A) Gravel Beaches
6B) Riprap
6D Boulder Rubble
7) Exposed Tidal Flats
8A) Sheltered Rocky Shores
8B) Sheltered, Solid Man-made Structures
8C) Sheltered Riprap
9A) Sheltered Tidal Flats
9B) Vegetated Low Banks
10A) Salt- and Brackish-water Marshes
10B) Freshwater Marshes
10C) Swamps
10D) Scrub-Shrub Wetlands

Each shoreline type is described on pages 11-18 in terms of their physical description, predicted oil behavior, and response considerations.

In addition to the field mapped ESI shoreline types, wetland habitat types derived from 2006 National Wetlands Inventory data (in selected locations), and wetlands previously mapped in the 1994 Northern California ESI Atlas were included in the atlas and in the digital data. These polygonal wetland types were not checked or edited extensively as a part of this project.

SENSITIVE BIOLOGICAL RESOURCES

Biological and human-use information presented in this atlas was collected, compiled, and reviewed with the assistance of biologists and resource managers from the following agencies:

- California Department of Fish and Game (CDF&G), Office of Spill Prevention and Response (OSPR), Marine Region (MR), Biogeographic Data Branch, Fisheries Branch, and Wildlife Programs Branch
- NOAA National Marine Fisheries Service (NMFS)
- Point Reyes Bird Observatory (PRBO)
- U.S. Fish and Wildlife Service (USFWS)
- Mad River Biologists
- California State Parks (CSP)
- National Park Service (NPS)
- Bureau of Land Management (BLM)

The above agencies and organizations provided the majority of information included in the atlas. Other participating individuals and agencies will be cited throughout the atlas and in the metadata accompanying the digital product.

KEY FEATURES ON ESI MAPS

1) Animal and plant species that are at risk during oil spills and/or spill response are represented on the maps by polygons, points, or arcs.

2) Species have been divided into groups and subgroups based on their behavior, morphology, taxonomic classification, and spill vulnerability and sensitivity. The icons below reflect this grouping scheme.

3) Polygons, points, and arcs are color-coded based on the species composition of each feature, as shown below:

ELEMENT	COLOR AND HATCH PATTERN
Marine mammals	Brown horizontal hatch
Birds	Green diagonal hatch
Terrestrial mammals	Brown vertical hatch
Fish	Blue diagonal hatch and blue arcs
Invertebrates	Orange diagonal hatch
Reptiles	Red diagonal hatch
Kelp	Purple 'simplified wetland pattern'
Eelgrass	Purple 'simplified wetland pattern'
Plant	Purple hatch
Multi-element group	Black diagonal hatch

4) There is a Resources at Risk number (RAR#) located under each icon or group of icons. The RAR# references a table on the reverse side of the map with a complete list of species associated with the feature.

5) Also associated with each species in the table is the state and federal protected status as threatened (T) or endangered (E) as well as concentration, seasonality, and life-history information.

6) For species that are found throughout general geographical areas or habitat types on certain maps, displaying the polygons for these species would cover large areas or would obscure the shoreline and biological features, making the maps

very difficult to read. In these cases, a small box is shown on the map which states that the species are "Present in ..." (e.g., "Present in Humboldt Bay" or "Present in Pacific Ocean"). The geographical extent of the polygons is depicted in the digital data available on the CD-ROM.

MARINE MAMMALS

Marine mammals depicted in the Northern California Atlas include selected species of dolphins, porpoises, pinnipeds, sea otters, and whales. Marine mammal concentration distribution was mapped based on interviews with local resource experts from NPS, NMFS, CDF&G, USFWS, and the digital and hardcopy data sources they provided.

Cetacean migration routes and concentration areas – Nearshore and offshore zones used for migration by whales, dolphins, and porpoises commonly found in Northern California waters are mapped. In addition, known areas of higher concentrations were shown for harbor porpoise (*Phocoena phocoena)*, gray whale (*Eschrichtius robustus*), and minke whale (*Balaenoptera acutorostrata)*.

Pinniped haul-outs and rookeries – California sea lion (*Zalophus californianus*), harbor seal (*Phoca vitulina*), northern elephant seal (*Mirounga angustirostris*), and Steller sea lion (*Eumetopias jubatus,* federally threatened*)* haul-outs and rookeries are shown. Location and concentration information for California sea lion, harbor seal, and Steller sea lion is based primarily on surveys conducted by NMFS from 1998-2005. For sites only surveyed during one calendar year, one numeric value is shown, and that is the maximum single day count recorded during the year surveyed (in some cases a site was surveyed two or three times a year, in other cases it was surveyed once a year). For sites surveyed over multiple years, a range of values is shown (e.g. 250-350 INDIV.). The first number represents the maximum single day count from the year with the lowest concentration, and the second number represents the maximum single day count from the year with the highest concentration. In areas where individual haul-out sites nearly overlap due to the scale at which the maps are produced, the individual locations and corresponding concentration information are combined into a single polygon to ensure readability. Local resource experts provided information on northern elephant seal haul-outs, which are rare in this area.

Sea otters – Southern sea otter (*Enhydra lutris nereis*, federally threatened) distribution is depicted on Map 1 in the atlas. UCSC Long Marine Lab provided data on sea otter distribution.

Data providers and expert contacts* for Northern California marine mammals are:

Name	Agency	City	Phone	Species
Mark Lowry	NMFS	La Jolla	858/546 -7174	Seals, sea lions
Karin Forney	NMFS	Moss Landing	831/420 -3908	Cetaceans
John Mello/Ed Roberts	CDF&G	Eureka	707/441 -5755 or 5757	Northern California species
Ron LeValley	Mad River Biologists	Arcata	707/496 -3326	Northern California species
Jay Harris	CSP	Eureka	707/445 -6547	North Coast Redwoods District species
Dave Anderson	NPS	Orick	707/465 -7771	Redwood National Park species
Jim Harvey	Moss Landing Marine Labs	Moss Landing	831/771 -4434	Marine mammals
Tim Tinker	UCSC Long Marine Lab	Santa Cruz	831/459 -2357	Sea otters
Sarah Allen	NPS	Point Reyes	415/464 -5187	Point Reyes NS species
Jan Roletto	NOAA GFNMS	San Francisco	415/561 -6622	GFNMS species

***Note:** this is not a comprehensive list of Northern California marine mammal experts. Contact state and federal agencies, universities, and other appropriate entities in the event of an incident.

Major Data Sources Consulted: Marine Mammals

CDF&G OSPR and U.S. Coast Guard. 2005. 2005 Sector San Francisco – Area Contingency Plan (ACP) Volume II: Section 9800-Area Committee Detail for: ACP 1 – North Coast and ACP 2 – San Francisco Bay and Delta. CDF&G, OSPR, and USCG.

Caretta, J.V., K.A. Forney, M.M. Muto, J. Barlow, J. Baker, B. Hanson, and M. Lowry. 2006. U.S. Pacific marine mammal stock assessments: 2005. NOAA-TM-NMFS-SWFSC-388, U.S. DOC, NOAA, NMFS, SWFSC, 317 pp.

Caretta, J.V., K.A. Forney, M.M. Muto, J. Barlow, J. Baker, and M. Lowry. 2004. U.S. Pacific marine mammal stock assessments 2003. NOAA-TM-NMFS-SWFSC-358, U.S. DOC, NOAA, NMFS, SWFSC, 291 pp.

Lowry, M. 2007. California and Steller sea lion and harbor seal haul-out locations. NOAA NMFS, La Jolla, CA, tabular digital data.

Tinker, T. 2005. Sea otter spring censuses (2003, 2004, and 2005). UCSC Long Marine Lab, Santa Cruz, CA, vector digital data.

TERRESTRIAL MAMMALS

Northern river otter (*Lontra canadensis*), Point Reyes jumping mouse (*Zapustrinotatus trinoatus orarius*), beaver (*Casto canadensis*), muskrat (*Ondatra zibethicus),* Point Arena mountain beaver (*Aplodontia rufa nigra,* federally endangered*),* and Roosevelt elk (*Cervus elaphus roosevelti)* are mapped in limited locations in this atlas. Location information was provided by NPS, NOAA, CDF&G, and CSP. The California Natural Diversity Database (CNDDB), provided by CDF&G, was used to supplement data provided by resource experts.

Data providers and expert contacts* for Northern California terrestrial mammals are:

Name	Agency	City	Phone	Species
Sarah Allen	NPS	Point Reyes	415/464 -5187	Point Reyes NS species
Bruce Deuel	CDF&G	Redding	Retired	Coastal species
Jay Harris	CSP	Eureka	707/445 -6547	North Coast Redwoods District species
Jeff Dayton	CDF&G	Eureka	707/445 -6493	Elk

***Note:** this is not a comprehensive list of Northern California terrestrial mammal experts. Contact state and federal agencies, universities, and other appropriate entities in the event of an incident.

Major Data Sources Consulted: Terrestrial Mammals

CDF&G, Biogeographic Data Branch. 2007. California Natural Diversity Database (CNDDB), vector digital data.

CDF&G OSPR and U.S. Coast Guard. 2005. 2005 Sector San Francisco – Area Contingency Plan (ACP) Volume II: Section 9800-Area Committee Detail for: ACP 1 – North Coast and ACP 2 – San Francisco Bay and Delta. CDF&G OSPR and USCG.

U.S. Fish and Wildlife Service. 1998. Point Arena Mountain Beaver (*Aplondontia rufa nigra* (Rafinesque)) Recovery Plan. Region 1, Portland, OR. 71 pp.

BIRDS

Birds mapped in this atlas include alcids, diving birds, gulls, terns, passerine birds, pelagic birds, raptors, shorebirds, wading birds, and waterfowl. Species that are federally and state listed and coastal nesting, roosting, staging, and rafting locations are specifically emphasized.

Bird concentration areas are based primarily on information gathered at interviews with local resource experts from Mad River Biologists, USFWS, NPS, PRBO, CDF&G, CSP, USGS, and NOAA. Additional sources are listed below and are included in the metadata accompanying the CD-ROM.

Raptor concentration areas – American peregrine falcon (*Falco peregrines anatum*, state endangered), bald eagle (*Haliaeetus leucocephalus*, state endangered), osprey (*Pandion haliaetus*) and other raptors commonly found in estuaries, along rivers, and foraging or nesting in coastal areas were mapped. Locations were provided by CDF&G (CNDDB and Area Contingency Plans (ACPs)) and other local resource experts.

Nearshore/estuarine species general distribution and concentration areas Several species of sea ducks (e.g., scoters), diving birds (e.g., loons,

grebes, cormorants, pelicans), seabirds (e.g., murres), and other waterfowl concentrate in the nearshore zone within 1-2 miles of shore, particularly from fall to spring. Mouths of estuaries and sand spits provide important habitat for several species of gulls, terns, and diving birds. Waterfowl and wading birds nest in wetlands, particularly those surrounding Humboldt Bay, Eel River, and Lake Earl. Local resource experts from Mad River Biologists, CDF&G, USFWS, and other agencies provided details on the general distribution and seasonality of these species, as well as any specific concentration areas.

Nesting colonies – Locations of seabird, gull, tern, and shorebird colonies are mapped. NOAA NCCOS provided colony size and location data on the Biogeographic Assessment CD-ROM (see references on the NCCOS CD-ROM for full details on the existing datasets that were compiled to create the coverage used). Most of the colony data provided by the Biogeographic Assessment was similar to that published in the 1994 ESI Atlas, so both data sets were used. These data were supplemented with three publications provided by USFWS which contained updated colony counts for selected species (e.g., Brandt's (*Phalacrocorax penicillatus*) and double-crested cormorants (*Phalacrocorax auritus*), common murres (*Uria aalge*), and California brown pelican (*Pelecanus occidentalis californicus*, state and federally endangered, not nesting)). Resource experts from USFWS and other agencies provided additional colony updates.

Western snowy plover nesting and wintering areas and shorebird concentration areas – Western snowy plover (*Charadrius alexandrinus nivosus,* federally threatened) nesting and wintering areas along beaches are shown. Snowy plovers are vulnerable to disturbance during response activities, as well as oiling. Migratory shorebirds stage in the intertidal zone, along beaches, in marshes, and on tidal flats in certain areas during fall and spring. Humboldt Bay, Eel River, Elk River, and Mad River make up the Humboldt Bay Western Hemisphere Shorebird Reserve Network Complex (WHSRN), a site of international importance. While fall and spring are the key migratory periods, some species overwinter and/or are present during the summer. Location and seasonality information was provided via survey data collected from 2003-2007 (provided by PRBO), expert knowledge, and available publications.

Marbled murrelet nearshore distribution – Marbled murrelet (*Brachyramphus marmoratus*, state endangered, federally threatened) forage in the nearshore zone (up to about 6 km from shore), most commonly from March-October. Murrelets are observed in low numbers from approximately Cape Mendocino north, with highest concentrations in Northern California occurring from Clam Beach/Trinidad to the Oregon border.

Threatened and endangered species – The California Natural Diversity Database (CNDDB) was used to supplement the data described above with additional location information for threatened and endangered coastal bird species.

In some cases, individual species are lumped into species 'assemblages' for summary purposes. Table 1 is a list of species 'assemblages' used in the atlas and representative species in each group.

Table 1. Bird assemblages in the Northern California ESI Atlas.

Assemblage	Species Examples
Seabirds	Auklets, murres, murrelets, guillemots, puffins, etc.
Diving birds	Pelicans, cormorants, grebes, loons, etc.
Raptors	Eagles, osprey, falcons, hawks, etc.
Shorebirds	Plovers, oystercatchers, phalaropes, yellowlegs, sandpipers, willet, tattlers, killdeer, stilt, avocet, curlews, whimbrel, godwits, turnstones, surfbird, sanderling, dunlin, dowitcher, etc.
Wading birds	Rails, bitterns, herons, egrets, etc.
Waterfowl	Brant, dabbling ducks, diving ducks, geese, etc.
Dabbling ducks	Mallard, gadwall, wigeon, teals, shoveler, pintail, etc.
Diving ducks	Canvasback, ring-necked duck, scaup, scoters, bufflehead, goldeneye, mergansers, ruddy duck, etc.
Gulls	California gull, western gull, Heermann's gull, glaucous-winged gull, etc.
Terns	Caspian tern, elegant tern, common tern, Forster's tern, etc.

Concentration and density information for bird points and polygons – When available, concentration information for birds in this atlas was based on survey data and is shown either as a single numeric value from the most recent survey date (e.g., 4,000 INDIV.) or a range of numeric values (e.g., 200-400 INDIV.). Please see the references and accompanying metadata for dates of individual data sets. If no survey data were available or appropriate, concentration information was provided by the resource experts, and was typically subjective (e.g., low, moderate, high). The density terminology is considered to be relative to each individual species. It was not always possible to use numeric values because of variability between seasons and years. Please contact the local resource experts for further clarification in the event of an incident.

Data providers and expert contacts* for Northern California birds are:

Name	Agency	City	Phone	Species
Ron LeValley	Mad River Biologists	Arcata/ Mendocino	707/496-3326	Coastal birds
Gary Page	PRBO	Stinson Beach	415/868-0371	Snowy plovers, shorebirds, waterbirds
Bruce Deuel	CDF&G	Redding	Retired	Waterfowl, other birds
Eric Nelson	USFWS	Loleta	707/733-5406	Humboldt Bay NWR species
Gerry McChesney	USFWS	Newark	510/792-0717	Colonies
Jay Harris	CSP	Eureka	707/445-6547	North Coast Redwoods District
Jeff Dayton/ Dave Lancaster	CDF&G	Eureka	707/445-6493	Coastal birds
Karen Kovacs	CDF&G	Eureka	707/441-5789	Coastal birds
Keith Bensen	NPS	Orick	707/465-7777	Redwood Nat'l Park
Deborah Jaques	Pacific Eco Logic	Crescent City	707/464-5878	Brown pelican
Josh Adams	USGS	Moss Landing	831/633-7259	Seabirds
Jim Harvey	Moss Landing Marine Labs	Moss Landing	831/771-4434	Seabirds
Sarah Allen	NPS	Point Reyes	415/464-5187	Point Reyes NS species
Mark Colwell	HSU	Arcata	707/826-3723	Shorebirds
Richard Golightly	HSU	Arcata	707/826-3952	Seabirds

***Note:** this is not a comprehensive list of Northern California bird experts. Please contact state and federal agencies, universities, and other appropriate entities in the case of an incident.

Major Data Sources Consulted: Birds

Capitolo, P.J., H.R. Carter, R.J. Young, G.J. McChesney, W.R. McIver, R.T. Golightly, and F. Gress. 2004. Changes in breeding population size of Brandt's and double-crested cormorants in California, 1975-2003. Unpublished report, Department of Wildlife, Humboldt State University, Arcata, California.

Capitolo, P.J., G.J. McChesney, H.R. Carter, M.W. Parker, J.N. Hall, R.J. Young, and R.T. Golightly. 2006. Whole-colony counts of common murres, Brandt's cormorants, and double-crested cormorants at sample colonies in northern and central California, 1996-2004. Unpublished report, Department of Wildlife, Humboldt State University, Arcata, California; and U.S. Fish and Wildlife Service, San Francisco Bay National Wildlife Refuge Complex, Newark, California. 40 pp.

Carter, H.R., P.J. Capitolo, G.J. McChesney, W.R. McIver, and J.E. Takekawa. 2000. Population monitoring of seabirds in California: colony and subcolony databases for 1985-1995 surveys of breeding colonies of common murres, Brandt's cormorants, and double-crested cormorants between Point Arena and Point Conception. Unpublished final report, U.S. Geological Survey, Western Ecological Research Center, Dixon, California; Humboldt State University, Department of Wildlife, Arcata, California; and U.S. Fish and Wildlife Service,

San Francisco Bay National Wildlife Refuge Complex, Newark, California. 71 pp.

CDF&G. Biogeographic Data Branch. 2007. California Natural Diversity Database (CNDDB), vector digital data.

CDF&G OSPR and U.S. Coast Guard. 2005. 2005 Sector San Francisco – Area Contingency Plan (ACP) Volume II: Section 9800-Area Committee Detail for: ACP 1 – North Coast and ACP 2 – San Francisco Bay and Delta. CDF&G OSPR and USCG.

Colwell, M.A., T. Danufsky, N.W. Fox-Fernandez, J.E. Roth, and J.R. Conklin. 2003. Variation in shorebird use of diurnal, high-tide roosts: how consistently are roosts used? Waterbirds 26(4): 484-493.

Harris. S.W. 2006. Northwestern California Birds: A Guide to the Status, Distribution, and Habitats of the Birds of Del Norte, Humboldt, Trinity, northern Mendocino, and western Siskiyou counties, California. Living Gold Press, Klamath River, CA, 400 pp.

Kelly, J.P. and S.L. Tappen. 1998. Distribution, abundance, and implications for conservation of winter waterbirds on Tomales Bay, California. Western Birds 29:103-120.

Miller, S.L., C.B. Meyer, and C.J. Ralph. 2002. Land and seascape patterns associated with marbled murrelet abundance offshore. Waterbirds 25(1): 100-108.

NOAA National Centers for Coastal Ocean Science (NCCOS). 2003. A Biogeographic Assessment off North/Central California: To Support the Joint Management Plan Review for Cordell Bank, Gulf of the Farallones, and Monterey Bay National Marine Sanctuaries: Phase I – Marine Fishes, Birds and Mammals. Prepared by NCCOS's Biogeography Team in Cooperation with the National Marine Sanctuary Program, Silver Spring, MD, 145 pp.

PRBO. 2007. 2003-2007 Summer and winter snowy plover surveys of the Pacific coast, unpublished survey data.

Ralph, C.J. and S.L. Miller. 1995. Offshore population estimates of marbled murrelets in California. Ch. 33 in USDA Forest Service Gen. Tech. Rep. PSW-152. Pp. 353-360.

U.S. Fish and Wildlife Service. 2005. Regional Seabird Conservation Plan, Pacific Region. U.S. Fish and Wildlife Service, Migratory Birds and Habitat Programs, Pacific Region, Portland, Oregon.

REPTILES and AMPHIBIANS

Nearshore distribution of leatherback sea turtles (*Dermochelys coriacea*, federally endangered) is included in this atlas. In addition, a few sensitive terrestrial and freshwater/brackishwater species are mapped, including California red-legged frog (*Rana draytoni*), northern red-legged frog (*Rana aurora aurora*), and northwestern pond turtle (*Clemmys marmorata marmorata*).

Reptile and amphibian concentration areas are mapped based on interviews with resource experts from CDF&G, NMFS, and NPS. The CNDDB was used to supplement data from resource experts.

Data providers and expert contacts* for Northern California reptiles and amphibians are:

Name	Agency	City	Phone	Species
Scott Benson	NMFS	Moss Landing	831/771 -4354	Leatherback sea turtle
Darlene McGriff	CDF&G	Sacramento	916/322 -2494	CNDDB

***Note:** this is not a comprehensive list of Northern California reptile and amphibian experts. Contact state and federal agencies, universities, and other appropriate entities in the event of an incident.

Major Data Sources Consulted: Reptiles and Amphibians

Benson, S.R., K.A. Forney, J.T. Harvey, J.V. Caretta, P.H. Dutton. 2007. Abundance, distribution, and habitat of leatherback turtles (*Dermochelys coriacea*) off California, 1990-2003. Fish. Bull. 105:337-347.

CDF&G, Biogeographic Data Branch. 2007. California Natural Diversity Database (CNDDB), vector digital data

FISH

Finfish depicted in this atlas include selected marine, estuarine, anadromous, and freshwater species. Species of commercial, recreational, ecological, and/or conservation interest are emphasized.

Tidewater goby - Tidewater goby (*Eucyclogobius newberryi*, federally endangered) inhabit coastal lagoons and the uppermost brackish zone of larger estuaries. Streams documented by USFWS as occupied by gobies are mapped.

Anadromous populations – The Chinook salmon (*Oncorhynchus tshawytscha)* California Coastal Evolutionary Significant Unit (ESU), (federally threatened) includes naturally spawned coastal spring and fall Chinook salmon between Redwood Creek in Humboldt County and the Russian River in Sonoma County. The Chinook salmon Southern Oregon and Northern California Coastal ESU (federal listing not warranted) includes naturally spawned populations of Chinook salmon from rivers and streams between Cape Blanco, Oregon and the Lower Klamath River, California. The Upper Klamath and Trinity Rivers Chinook ESU (federal listing not warranted) includes naturally spawned populations of Chinook salmon in the Klamath and Trinity River Basins upstream of the confluence of the Klamath and Trinity Rivers.

The Coho salmon (*Oncorhynchus kisutch*) Central California Coast ESU (state and federally endangered) includes naturally spawned populations in streams from Punta Gorda, Humboldt County to streams south of the Northern California ESI study area. The Coho salmon Southern Oregon/Northern California ESU (state and federally threatened) includes Coho populations from Punta Gorda to the Oregon border.

The Steelhead (*Oncorhynchus mykiss*) Northern California ESU (federally threatened) includes naturally spawned populations residing below impassable barriers in coastal basins from Redwood Creek in Humboldt County to, and including, the Gualala River in Mendocino County. The Steelhead Central California ESU (federally threatened) includes coastal basins from the Russian River to streams south of the ESI study area.

Distribution, seasonality, and critical habitat information for Chinook and Coho salmon and Steelhead were provided by NMFS via digital data layers identifying stream segments where various life-history stages occur within the study area, hardcopy maps and reports, and local knowledge. CDF&G also provided geographic and seasonality information.

Coastal cutthroat trout, a species with some similarity to steelhead, were also mapped. Sea-run cutthroat trout (anadromous) and freshwater migratory populations (potamodromous) may occur from Eel River, California to north of the study area. Data from the CNDDB was used to map this species.

Marine and estuarine species – General distributions of coastal species (e.g., pelagic and bottomfish), kelp-bed and rocky habitat associated species (e.g., rockfish), beach spawners (e.g., surfperch, smelt), and other fishes are mapped in the nearshore zone. Species associated with important estuarine systems (e.g., Humboldt Bay, Eel River, Russian River, Smith River, etc.) are also highlighted. The lists of fish species mapped should be considered representative only. Many of these species have distributions beyond those mapped in the nearshore environment. Local fisheries experts should be contacted for more complete information in the event of an incident.

Concentration and density information - Concentration information was provided by the resource experts or was cited in reports and was typically subjective (e.g., low, high).

Data providers and expert contacts* for Northern California fish are:

Name	Agency	City	Phone	Species
John Mello	CDF&G	Eureka	707/441-5755	Marine/ estuarine fish
Vicki Frey	CDF&G	Eureka	707/445-7830	Marine/ estuarine fish
Ed Roberts	CDF&G	Eureka	707/441-5757	Marine/ estuarine fish
Dave Anderson	NPS	Orick	707/465-7771	Redwood Nat'l Park
Greg Goldsmith	USFWS	Arcata	707/825-5120	Tidewater goby
Bill Cox	CDF&G	Sebastopol	707/823-1001	Sonoma/ Marin fish
Diane Ashton	NMFS	Arcata	707/825-5185	Salmonids
Joe Dillon	NMFS	Santa Rosa	707/575-6093	Salmon, marine spp.
Ryan Watanabe	CDF&G	Bodega Bay	707/875-4262	Marine/ estuarine spp.
Steve Cannata	CDF&G	Eureka	707/725-1015	River/ estuarine spp.
Jay Harris	CSP	Eureka	707/445-6547	North Coast Redwoods

***Note:** this is not a comprehensive list of Northern California fish experts. Contact state and federal agencies, universities, and other appropriate entities in the event of an incident.

Major Data Sources Consulted: Fish

Barnhart, R.A., M.J. Boyd, and J.E. Pequegnat. 1992. The ecology of Humboldt Bay, California: an estuarine profile. U.S. Department of the Interior, Fish and Wildlife Service, Biological Report 1, Washington, D.C.

Busby, P.J., T.C. Wainwright, G.J. Bryant, L. Lierheimer, R.S. Waples, F.W. Waknitz, and I.V. Lagomarsino. 1996. Status review of west coast steelhead from Washington, Idaho, Oregon, and California. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-NWFSC-27, 261 p.

Cannata, S. 1998. Observations of steelhead trout (*Oncorhynchus mykiss*), coho salmon (*O. kisutch*) and water quality of the Navarro River estuary/lagoon May 1996 to December 1997. CDF&G, unpublished report.

CDF&G. 2007. Key spawning areas for Pacific Herring, vector digital data.

CDF&G. 2004. Recovery strategy for California coho salmon. Report to the California Fish and Game Commission. 594 pp.

CDF&G, Biogeographic Data Branch. 2007. California Natural Diversity Database (CNDDB), vector digital data.

CDF&G OSPR and U.S. Coast Guard. 2005. 2005 Sector San Francisco – Area Contingency Plan (ACP) Volume II: Section 9800-Area Committee Detail for: ACP 1 – North Coast and ACP 2 – San Francisco Bay and Delta. CDF&G OSPR and USCG.

Gold Ridge Resource Conservation District. 2007. The Estero Americano watershed management plan, Version 1. SWRCD Contract No. 03-138-250-1, Occidental, CA, 158 pp.

Leet, W.S., C.M. Dewees, R. Klingbeil, E.J. Larson. 2001. California's Living Marine Resources: A Status Report. California Department of Fish and Game, SG01-11, 593 pp.

Love, M. 1996. Probably More Than You Want To Know About the Fishes of the Pacific Coast. Really Big Press, Santa Barbara, CA, 381 pp.

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Miller, D.J. and R.N. Lea. 1972. Guide to the Coastal Marine Fishes of California, Fish Bulletin No. 157. California Department of Fish and Game, Sacramento, CA, 249 pp.

Monaco, M.E., R.L. Emmett, D.M. Nelson, and S.A. Hinton. 1990. Distribution and abundance of fishes and invertebrates in west coast estuaries, Volume I: Data Summaries. ELMR Rep. No. 4. NOAA/NOS Strategic Environmental Assessments Division, Silver Spring, MD, 232 pp.

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

U.S. Fish and Wildlife Service. 2005. Recovery Plan for the Tidewater Goby (*Eucyclogobius newberryi*). U.S. Fish and Wildlife Service, Portland, Oregon. vi+199 pp.

Weitkamp, L.A., T.C. Wainwright, G.J. Bryant, G.B. Milner, D.J. Teel, R.G. Kope, and R.S. Waples. 1995. Status review of Coho salmon from Washington, Oregon, and California. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-NWFSC-24, 258 p.

INVERTEBRATES

Invertebrates depicted in this atlas include selected intertidal, subtidal, marine, and terrestrial species. Species of commercial and recreational (e.g., bivalves, crabs), ecological, and/or conservation interest were emphasized. Invertebrate distributions are based on information gathered at interviews with NPS, CDF&G, NMFS, CSP, and others, and the digital and hardcopy data they provided.

Only a limited number of marine invertebrates (e.g., Dungeness crab, *Cancer magister*) are mapped due to broad extents of distribution and/or a lack of specific location information appropriate for this atlas and database. Some bivalves were mapped in bays and estuaries and along the shoreline where information was available.

Rare and/or listed species of insects and crustaceans in coastal areas were mapped. The California Natural Diversity Database (CNDDB), provided by CDF&G, was used to supplement data from resource experts.

Data providers and expert contacts* for Northern California invertebrates are:

Name	Agency	City	Phone	Species
John Mello	CDF&G	Eureka	707/441 -5755	Marine/ estuarine spp.
Ed Roberts	CDF&G	Eureka	707/441 -5757	Marine/ estuarine spp.
Vicki Frey	CDF&G	Eureka	707/445 -7830	Marine/ estuarine spp.
Jay Harris	CSP	Eureka	707/445 -6547	North Coast Redwoods District
Sarah Allen	NPS	Point Reyes	415/464 -5187	Point Reyes NS species
Bill Cox	CDF&G	Sebastopol	707/823 -1001	Sonoma/ Marin inverts
Steve Cannata	CDF&G	Eureka	707/725 -1015	River/ estuarine spp.
Tom Moore	CDF&G	Bodega Bay	707/875 - 4261	Aquaculture /inverts

***Note:** this is not a comprehensive list of Northern California invertebrate experts. Please contact state and federal agencies, universities, and other appropriate entities in the case of an incident.

Major Data Sources Consulted: Invertebrates

Barnhart, R.A., M.J. Boyd, and J.E. Pequegnat. 1992. The ecology of Humboldt Bay, California: an estuarine profile. U.S. Department of the Interior, Fish and Wildlife Service, Biological Report 1, Washington, D.C.

Cannata S. 1998. Observations of steelhead trout (*Oncorhynchus mykiss*), coho salmon (*O. kisutch*) and water quality of the Navarro River estuary/lagoon May 1996 to December 1997. CDF&G, unpublished report.

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Humboldt Bay Harbor Recreation and Conservation District. 2002. Active production oyster beds, vector digital data.

Leet, W.S., Dewees, C.M., R. Klingbeil, E.J. Larson. 2001. California's Living Marine Resources: A Status Report. California Department of Fish and Game, SG01-11, 593 pp.

Maahs M. and S. Cannata. 1998. The Albion River Estuary. Its history, water quality, and use by salmonids and other fish and wildlife species. CDF&G unpublished report.

Monaco, M.E., R.L. Emmett, D.M. Nelson, and S.A. Hinton. 1990. Distribution and abundance of fishes and invertebrates in west coast estuaries, Volume I: Data Summaries. ELMR Rep. No. 4. NOAA/NOS Strategic Environmental Assessments Division, Silver Spring, MD, 232 pp.

U.S. Fish and Wildlife Service. 1998. California Freshwater Shrimp (*Syncaris pacifica* Holmes) Recovery Plan. U.S. Fish and Wildlife Service, Portland, Oregon. 94 pp.

HABITATS

Kelp and eelgrass are mapped in this atlas.

Kelp - Kelp distribution included in this atlas is based on 2002, 2003, 2004 and 2005 digital coverages provided by CDF&G Marine Region. We joined and processed the four separate coverages, buffered the aggregate, and produced the distribution shown on

the maps. Multiple years of data were combined in order to display a nearshore zone within which kelp may be present, rather than a single year of data. A purple pattern was used to display kelp. A few additional areas where kelp is present were added by local resource experts and from NMFS data. Icons and RAR numbers are not used for the CDF&G kelp data. The kelp canopy is most often present from March to November. Storms often knock down the plants during winter months.

Eelgrass – Eelgrass is mapped in several locations (e.g, Tomales Bay, Humboldt Bay, several rivers etc.). Digital coverages were provided by CDF&G, NPS, and NMFS. Local experts provided additional information on eelgrass distribution.

Terrestrial plants are not specifically mapped throughout the atlas. California State Parks North Coast Redwood District provided location information for some sensitive species that occur within park boundaries.

Data providers* for Northern California habitats are:

Name	Agency	City	Phone	Species
Sarah Allen	NPS	Point Reyes Station	415/464 -5187	Point Reyes NS species
Jay Harris	CSP	Eureka	707/445 -6547	North Coast Redwoods District
John Mello	CDF&G	Eureka	707/441 -5755	Eelgrass
Vicki Frey	CDF&G	Eureka	707/445 -7830	Eelgrass
Bill Cox	CDF&G	Sebastopol	707/823 -1001	Eelgrass
Jeff Dayton	CDF&G	Eureka	707/445 -6493	Kelp
Don Brown	NPS	Point Reyes Station	415/464 -5195	Tomales Bay Eelgrass

***Note:** this is not a list of Northern California habitat experts. Contact state and federal agencies, universities, and other appropriate entities in the event of an incident.

Major Data Sources Consulted: Habitats

Brown, D. 2007. Eelgrass_Tomales_2005. Point Reyes National Seashore, Point Reyes Station, vector digital data.

CDF&G. 2006. California coastal kelp survey from spring to fall 2005, vector digital data.

CDF&G. 2005. California coastal kelp survey from fall 2004, vector digital data.

CDF&G. 2003. California coastal kelp survey from summer/fall 2003, vector digital data.

CDF&G. 2003. California coastal kelp survey for summer/fall of 2002, vector digital data.

CDF&G, 2007. Mid channel beds, vector digital data.

CDF&G. 2004. North Bay beds, vector digital data.

CDF&G. 2007. South Bay eelgrass polygons, vector digital data.

CDF&G OSPR and U.S. Coast Guard. 2005. 2005 Sector San Francisco – Area Contingency Plan (ACP) Volume II: Section 9800-Area Committee Detail for: ACP 1 – North Coast and ACP 2 – San Francisco Bay and Delta. CDF&G OSPR and USCG.

California State Parks (CSP) North Coast Redwoods District (NCRD), 2007. Maps of Special Status Species, Recreational Activities, and Management Issues at CSP NCRD State Parks, 18 maps.

Gold Ridge Resource Conservation District. 2007. The Estero Americano watershed management plan, Version 1. SWRCD Contract No. 03-138-250-1, Occidental, CA, 158 pp.

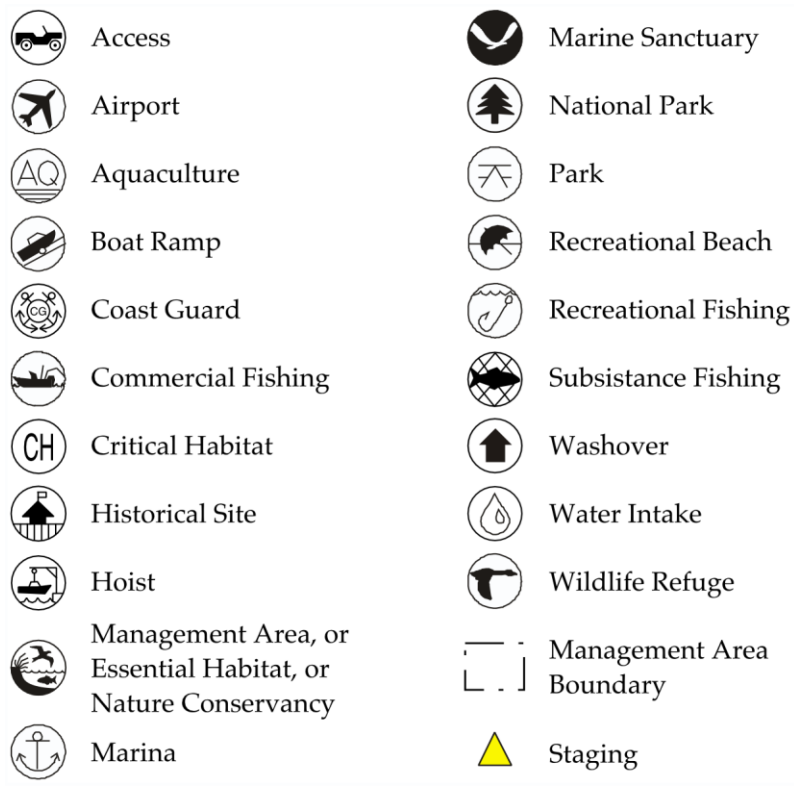
Terralogic GIS, Inc., 2005. Alternative B.2 of The Pacific Coast Groundfish Essential Fish Habitat Draft EIS: Canopy Kelp Habitat Areas of Particular Concern (HAPC), vector digital data.

Terralogic GIS, Inc., 2005. Alternative B.4 of The Pacific Coast Groundfish Essential Fish Habitat Draft EIS: Seagrass Habitat Areas of Particular Concern (HAPC), vector digital data.

HUMAN-USE RESOURCES

Management areas such as national marine sanctuaries, wildlife refuges, and national parks are mapped as polygons, with the boundaries indicated as a black dot-dash line with the corresponding icon placed near the center of the polygon. Where the feature is a known point location (e.g., aquaculture site, marina), the location is shown as a small black dot and a leader line is drawn from it to the icon. In cases of sensitive resources or features in more general locations (e.g., recreational fishing, beaches), an icon without a leader line may be placed in the vicinity of the feature.

A human-use number (HU#) can be found below the icon for some human-use resources, such as management areas, recreational beaches, and aquaculture sites. The HU# references a table on the reverse side of the map and may provide more information (i.e., name, contact) for that particular resource. The types of human use resources mapped in this atlas are depicted below.



Access: Sites where beach access by vehicle is possible.

Airport: Location of airports, airfields, landing strips, helipads, etc., whether they are manned or unmanned.

Aquaculture: Location of aquaculture/mariculture facilities.

Boat Ramp: Location of boat ramps.

Coast Guard: Location of U.S. Coast Guard stations.

Commercial Fishing: Areas used for commercial fishing.

Critical Habitat: Designated Critical Habitat for western snowy plover (USFWS), steelhead (NMFS), Chinook salmon (NMFS), coho salmon (NMFS), and monarch butterfly (CDF&G).

Essential Habitat: Locations of NMFS designated Essential Fish Habitat (EFH) Habitat Areas of Particular Concern (HAPC) for canopy kelp, eelgrass, estuaries, and rocky reefs.

Historical Site: A very limited number of historical sites are shown on NPS lands. Most cultural resource information is confidential and is, therefore, not displayed on the maps. Please consult with the Office of Historic Preservation of the California Department of Parks and Recreation and the Native American Heritage Commission for more information in the event of an incident.

Hoist: Location of facilities that have the capability to hoist boats in and out of the water.

Management Area: Locations of coastal CDF&G managed properties. For more information and updates regarding state marine protected areas, including, marine reserves, state marine parks, and state marine conservation areas, please refer to the CDF&G Marine Life Protection Act Initiative website, http://www.dfg.ca.gov/mrd/mlpa/.

Marina: Location of marinas.

Marine Sanctuary: Boundaries of NOAA National Marine Sanctuaries.

National Park: Boundaries of National Park lands.

Nature Conservancy: Boundaries of Nature Conservancy lands.

Park: Boundaries of state parks managed by California Department of Parks and Recreation.

Recreational Beach: Location of recreational beaches.

Recreational Fishing: Areas utilized for recreational fishing and/or for harvesting invertebrates.

Staging: Location of area used for staging cleanup equipment.

Subsistence Fishing: Areas utilized for subsistence fishing and/or harvesting invertebrates.

Washover Site: Locations of sites along the coast where tidal waters may overwash the land surface, particularly during storms, forming non-permanent or ephemeral connections to estuaries, small streams, coastal ponds, etc.

Water Intake: Location of seawater intakes.

Wildlife Refuge: Locations of wildlife refuges managed by USFWS.

Major Data Sources Used: Human-Use Resources

CDF&G Marine Region. 2006. Marine Protected Areas, vector digital data.

CDF&G, OSPR, GIS Unit. 2005. Economically significant sites, vector digital data.

California Resources Agency Legacy Project. 2003. Public Conservation and Trust Lands, vector digital data.

NMFS. 2005. Central California Chinook Critical Habitat, 6/2005, vector digital data.

NMFS. 2005. Central California Coast Steelhead Critical Habitat 6/2005, vector digital data.

NMFS. 2005. Northern California Steelhead Critical Habitat 6/2005, vector digital data.

NPS. 2007. Redwood National and State Park Boundaries, vector digital data.

NOAA National Marine Sanctuary Program (NMSP). 2004. National Marine Sanctuary Program Digital Boundary Files, vector digital data.

Point Reyes National Seashore GIS, 2006. Golden Gate National Recreation Area boundaries, Point Reyes National Seashore boundary, and Philip Burton Wilderness boundary, vector digital data.

Teale GIS Solutions Group. 1997. Airports, vector digital data.

Terralogic GIS, Inc. 2005. Alternative B.2 of The Pacific Coast Groundfish Essential Fish Habitat Draft EIS: Canopy Kelp Habitat Areas of Particular Concern (HAPC), vector digital data.

Terralogic GIS, Inc. 2005. Alternative B.3 of The Pacific Coast Groundfish Essential Fish Habitat Draft EIS: Estuaries Habitat Areas of Particular Concern (HAPC), vector digital data.

Terralogic GIS, Inc. 2005. Alternative B.4 of The Pacific Coast Groundfish Essential Fish Habitat Draft EIS: Seagrass Habitat Areas of Particular Concern (HAPC), vector digital data.

Terralogic GIS, Inc. 2005. Alternative B.6 of The Pacific Coast Groundfish Essential Fish Habitat Draft EIS: Rocky Reefs Habitat Areas of Particular Concern (HAPC), vector digital data.

USFWS. 2005. Final Critical Habitat for the Western Snowy Plover (*Charadrius alexandrius nivosus*), vector digital data.

GEOGRAPHIC INFORMATION SYSTEM

The entire atlas product is stored in digital form in a Geographic Information System (GIS) as spatial data layers and associated databases. The format for the data varies depending on the type of information or features for which the data are being stored.

Under separate cover is a metadata document that details the data dictionary, processing techniques, data lineage, and other descriptive information for the digital data sets and maps that were used to create this atlas. Below is a brief synopsis of the information contained in the digital version. Refer to the metadata file for a full explanation of the data and its structure.

SHORELINE CLASSIFICATIONS

The ESI shoreline habitat classification is stored as lines and polygons with associated attributes. In many cases, a shoreline may have two or three different classifications or colored lines. These multiple classifications are represented on the maps by double and triple line patterns and in the database by ESI#1/ESI#2, where ESI#1 is the landward-most classification and ESI#2 is the seaward-most classification. In addition to the line features, tidal flats (ESI = 7, ESI = 9A) and salt-and brackish-water marshes (ESI = 10A) are also stored as polygons. Therefore, the legend on each map may contain two patterns depicted on a map, a linear feature as well as a polygonal feature. Freshwater marshes (ESI = 10B), swamps (ESI = 10C), and scrub-shrub wetlands (ESI = 10D) were only mapped as polygonal features.

SENSITIVE BIOLOGICAL RESOURCES

Biological resources are stored as polygons, points, or arcs. Associated with each feature is a unique identification number that is linked to a series of data tables that further identify the resources. The main biological resource table consists of a list of species identification numbers for each site, the concentration of each species at each site, and identification codes for seasonality and source information. This data table is linked to other tables that describe the seasonality and life-history time-periods for each species (at month resolution) for the specified map feature. Other data tables linked to the first table include: the species identification table, which includes common and scientific names; the species status table, which gives information for state and/or federal threatened or endangered listings; and the source database, which provides source metadata at the feature-species level (specific sources are listed for each species occurring at each mapped feature in the biology coverages).

HUMAN-USE FEATURES

Human-use features are represented as points or polygons. The resource name, a contact, and phone number are included in the database for management areas, water intakes, recreational beaches, aquaculture sites, etc. when available. All metadata sources are documented at the feature level.

ACKNOWLEDGMENTS

This project was funded by California Department of Fish and Game (CDF&G) Office of Spill Prevention and Response (OSPR) and NOAA Office of Response and Restoration (OR&R), Hazardous Materials Response Division.

The biological and human-use data included on the maps were provided by numerous individuals and agencies. Staff with NMFS, CDF&G, NPS, USFWS, PRBO, CSP, Mad River Biologists, and BLM contributed a vast amount of information to this effort, including first-hand expertise, unpublished data, reports, published documents, maps, and digital data.

At Research Planning, Inc. (RPI) of Columbia, South Carolina, numerous scientific, GIS, and graphic staff were involved with different phases of the project. Shoreline habitat mapping was conducted by Zach Nixon. The biological and human-use data were collected and compiled onto base maps by Christine L. Boring. Mark White, Lee Diveley, Chris Locke, and Katy Beckham entered, processed, and produced the GIS data and hardcopy atlas. Graphic art production was conducted by Joe Holmes. Christine Boring, Chris Locke, Katy Beckham, Wendy Early, and Joe Holmes prepared the final text documents and metadata.

APPROPRIATE USE OF ATLAS AND DATA

This atlas and the associated database were developed to provide summary information on sensitive natural and human-use resources for the purposes of oil and chemical spill planning and response. Although the atlas and database should be very useful for other environmental and natural resource planning purposes, it should not be used in place of data held by participating agencies. Likewise, information contained in the atlas and database cannot be used in place of consultations with natural and cultural resource agencies or in place of field surveys. Also, this atlas should not be used for navigation.

SPECIES LIST

Common Name*	Scientific Name*
BIRDS	
DIVING BIRD	
American white pelican	*Pelecanus erythrorhynchos*
Brandt's cormorant	*Phalacrocorax penicillatus*
Brown pelican	*Pelecanus occidentalis*
Clark's grebe	*Aechmophorus clarkii*
Common loon	*Gavia immer*
Cormorants	*Phalacrocorax spp.*
Diving birds	-
Double-crested cormorant	*Phalacrocorax auritus*
Eared grebe	*Podiceps nigricollis*
Grebes	-
Horned grebe	*Podiceps auritus*
Pacific loon	*Gavia pacifica*
Pelagic cormorant	*Phalacrocorax pelagicus*
Pelicans	*Pelecanus spp.*
Pied-billed grebe	*Podilymbus podiceps*
Red-necked grebe	*Podiceps grisegena*
Red-throated loon	*Gavia stellata*
Western grebe	*Aechmophorus occidentalis*
GULL / TERN	
Bonaparte's gull	*Larus philadelphia*
California gull	*Larus californicus*
Caspian tern	*Sterna caspia*
Elegant tern	*Sterna elegans*
Forster's tern	*Sterna forsteri*
Glaucous-winged gull	*Larus glaucescens*
Gulls	-
Heermann's gull	*Larus heermanni*
Herring gull	*Larus argentatus*
Mew gull	*Larus canus*
Ring-billed gull	*Larus delawarensis*
Terns	-
Western gull	*Larus occidentalis*
PASSERINE BIRD	
Band-tailed pigeon	*Patagioenas fasciata*
Bank swallow	*Riparia riparia*
Belted kingfisher	*Ceryle alcyon*
Common yellowthroat	*Geothlypis trichas*
Saltmarsh common yellowthroat	*Geothlypis trichas sinuosa*
Tricolored blackbird	*Agelaius tricolor*
Yellow-billed cuckoo	*Coccyzus americanus*
RAPTOR	
American kestrel	*Falco sparverius*
American peregrine falcon	*Falco peregrinus anatum*
Bald eagle	*Haliaeetus leucocephalus*
Burrowing owl	*Athene cunicularia hypugea*
Golden eagle	*Aquila chrysaetos*
Merlin	*Falco columbarius*
Northern harrier	*Circus cyaneus*
Osprey	*Pandion haliaetus*
Raptors	-
Red-shouldered hawk	*Buteo lineatus*
Red-tailed hawk	*Buteo jamaicensis*
White-tailed kite	*Elanus leucurus*
SEABIRDS	
-ALCID	
Cassin's auklet	*Ptychoramphus aleuticus*
Common murre	*Uria aalge*
Marbled murrelet	*Brachyramphus marmoratus*
Pigeon guillemot	*Cepphus columba*
Rhinoceros auklet	*Cerorhinca monocerata*
Tufted puffin	*Fratercula cirrhata*
-PELAGIC	
Ashy storm-petrel	*Oceanodroma homochroa*
Fork-tailed storm-petrel	*Oceanodroma furcata*
Laysan albatross	*Phoebastria immutabilis*
Leach's storm-petrel	*Oceanodroma leucorhoa*
Seabirds	-
Shearwaters	-
Sooty shearwater	*Puffinus griseus*
SHOREBIRD	
American avocet	*Recurvirostra americana*
Black oystercatcher	*Haematopus bachmani*
Black turnstone	*Arenaria melanocephala*
Black-bellied plover	*Pluvialis squatarola*
Dunlin	*Calidris alpina*
Greater yellowlegs	*Tringa melanoleuca*
Killdeer	*Charadrius vociferus*
Least sandpiper	*Calidris minutilla*
Long-billed curlew	*Numenius americanus*
Long-billed dowitcher	*Limnodromus scolopaceus*

***** Threatened and endangered species are designated by underlining

Common Name*	Scientific Name*
BIRDS, cont.	
SHOREBIRD, cont.	
Marbled godwit	*Limosa fedoa*
Phalaropes	*Phalaropus spp.*
Red phalarope	*Phalaropus fulicaria*
Rock sandpiper	*Calidris ptilocnemis*
Sanderling	*Calidris alba*
Semipalmated plover	*Charadrius semipalmatus*
Shorebirds	-
Short-billed dowitcher	*Limnodromus griseus*
Surfbird	*Aphriza virgata*
Wandering tattler	*Heteroscelus incanus*
Western sandpiper	*Calidris mauri*
Western snowy plover	*Charadrius alexandrinus nivosus*
Whimbrel	*Numenius phaeopus*
Willet	*Catoptrophorus semipalmatus*
WADING BIRD	
American bittern	*Botaurus lentiginosus*
Black-crowned night-heron	*Nycticorax nycticorax*
California black rail	*Laterallus jamaicensis coturniculus*
California clapper rail	*Rallus longirostris obsoletus*
Cattle egret	*Bubulcus ibis*
Great blue heron	*Ardea herodias*
Great egret	*Ardea alba*
Green heron	*Butorides virescens*
Snowy egret	*Egretta thula*
Virginia rail	*Rallus limicola*
Wading birds	-
WATERFOWL	
Aleutian cackling goose	*Branta hutchinsii leucopareia*
American coot	*Fulica americana*
American wigeon	*Anas americana*
Black scoter	*Melanitta nigra*
Brant	*Branta bernicla*
Bufflehead	*Bucephala albeola*
Canada goose	*Branta canadensis*
Canvasback	*Aythya valisineria*
Cinnamon teal	*Anas cyanoptera*
Common goldeneye	*Bucephala clangula*
Common merganser	*Mergus merganser*
Dabbling ducks	-
Diving ducks	-
Ducks	-
Gadwall	*Anas strepera*
Geese	-
Greater scaup	*Aythya marila*
Green-winged teal	*Anas crecca*
Harlequin duck	*Histrionicus histrionicus*
Hooded merganser	*Lophodytes cucullatus*
Lesser scaup	*Aythya affinis*
Mallard	*Anas platyrhynchos*
Northern pintail	*Anas acuta*
Northern shoveler	*Anas clypeata*
Red-breasted merganser	*Mergus serrator*
Redhead	*Aythya americana*
Ring-necked duck	*Aythya collaris*
Ruddy duck	*Oxyura jamaicensis*
Scoters	*Melanitta spp.*
Sea ducks	-
Surf scoter	*Melanitta perspicillata*
Tundra swan	*Cygnus columbianus*
Waterfowl	-
White-winged scoter	*Melanitta fusca*
Wood duck	*Aix sponsa*
FISH	
FISH	
American shad	*Alosa sapidissima*
Arrow goby	*Clevelandia ios*
Barred surfperch	*Amphistichus argenteus*
Bat ray	*Myliobatis californica*
Bay goby	*Lepidogobius lepidus*
Bay pipefish	*Syngnathus leptorhynchus*
Big skate	*Raja binoculata*
Black rockfish	*Sebastes melanops*
Black-and-yellow rockfish	*Sebastes chrysomelas*
Blue rockfish	*Sebastes mystinus*
Bocaccio	*Sebastes paucispinis*
Brown rockfish	*Sebastes auriculatus*
Brown smoothhound	*Mustelus henlei*
Buffalo sculpin	*Enophrys bison*
Cabezon	*Scorpaenichthys marmoratus*

***** Threatened and endangered species are designated by underlining

Common Name*	Scientific Name*
FISH, cont.	
FISH, cont.	
Calico surfperch	*Amphistichus koelzi*
California grunion	*Leuresthes tenuis*
California halibut	*Paralichthys californicus*
California roach	*Hesperoleucus symmetricus*
California skate	*Raja inornata*
Canary rockfish (orange)	*Sebastes pinniger*
Chilipepper	*Sebastes goodei*
China rockfish	*Sebastes nebulosus*
Chinook salmon	*Oncorhynchus tshawytscha*
Chum salmon	*Oncorhynchus keta*
Coastal cutthroat trout	*Oncorhynchus clarkii clarkii*
Coastrange sculpin	*Cottus aleuticus*
Coho salmon	*Oncorhynchus kisutch*
Copper rockfish	*Sebastes caurinus*
English sole	*Parophrys vetulus*
Eulachon	*Thaleichthys pacificus*
Gobies	-
Gopher rockfish	*Sebastes carnatus*
Grass rockfish	*Sebastes rastrelliger*
Gray smoothhound	*Mustelus californicus*
Green sturgeon	*Acipenser medirostris*
Jack mackerel	*Trachurus symmetricus*
Jacksmelt	*Atherinopsis californiensis*
Kelp greenling	*Hexagrammos decagrammus*
Largemouth bass	*Micropterus salmoides*
Leopard shark	*Triakis semifasciata*
Lingcod	*Ophiodon elongatus*
Longfin smelt	*Spirinchus thaleichthys*
Longnose skate	*Raja rhina*
Monkeyface prickleback	*Cebidichthys violaceus*
Night smelt	*Spirinchus starksi*
Northern anchovy	*Engraulis mordax*
Pacific halibut	*Hippoglossus stenolepis*
Pacific herring	*Clupea pallasii pallasii*
Pacific lamprey	*Lampetra tridentata*
Pacific sand lance	*Ammodytes hexapterus*
Pacific sanddab	*Citharichthys sordidus*
Pacific sardine	*Sardinops sagax*
Pacific staghorn sculpin	*Leptocottus armatus*
Pacific tomcod	*Microgadus proximus*
Penpoint gunnel	*Apodichthys flavidus*
Pile surfperch	*Rhacochilus vacca*
Pink salmon	*Oncorhynchus gorbuscha*
Plainfin midshipman	*Porichthys notatus*
Prickly sculpin	*Cottus asper*
Quillback rockfish	*Sebastes maliger*
Rainbow seaperch	*Hypsurus caryi*
Redtail surfperch	*Amphistichus rhodoterus*
Ringtail snailfish	*Liparis rutteri*
Rock greenling	*Hexagrammos lagocephalus*
Rockfish	*Sebastes spp.*
Rubberlip surfperch	*Rhacochilus toxotes*
Saddleback gunnel	*Pholis ornata*
Salmon	
Sand sole	*Psettichthys melanostictus*
Sandpaper skate	*Bathyraja interrupta*
Sculpin	*Cottidae*
Sevengill shark	*Notorynchus cepedianus*
Shiner surfperch	*Cymatogaster aggregata*
Silver surfperch	*Hyperprosopon ellipticum*
Silverspotted sculpin	*Blepsias cirrhosus*
Sixgill shark	*Hexanchus griseus*
Speckled sanddab	*Citharichthys stigmaeus*
Spiny dogfish	*Squalus acanthias*
Starry flounder	*Platichthys stellatus*
Steelhead	*Oncorhynchus mykiss*
Striped bass	*Morone saxatilis*
Striped surfperch	*Embiotoca lateralis*
Surf smelt	*Hypomesus pretiosus*
Surfperch	-
Threespine stickleback	*Gasterosteus aculeatus*
Tidepool sculpin	*Oligocottus maculosus*
Tidewater goby	*Eucyclogobius newberryi*
Topsmelt	*Atherinops affinis*
Vermilion rockfish	*Sebastes miniatus*
Walleye surfperch	*Hyperprosopon argenteum*
White croaker	*Genyonemus lineatus*
White seabass	*Atractoscion nobilis*
White seaperch	*Phanerodon furcatus*
White shark	*Carcharodon carcharias*
White sturgeon	*Acipenser transmontanus*
Yellowtail rockfish	*Sebastes flavidus*

* Threatened and endangered species are designated by underlining

Common Name*	Scientific Name*
HABITATS	
KELP	
Giant kelp	*Macrocystis pyrifera*
Kelp	-
PLANT	
Beach pea	*Lathyrus japonicus*
Dark-eyed gilia	*Gilia millefoliata*
Langsdorf's violet	*Viola langsdorffii*
Marsh pea	*Lathyrus palustris*
Marsh violet	*Viola palustris*
Mendocino Coast Indian paintbrush	*Castilleja mendocinensis*
Oregon Coast Indian paintbrush	*Castilleja affinis ssp. litoralis*
Pacific gilia	*Gilia capitata ssp. pacifica*
Pink sand verbena	*Abronia umbellata ssp. breviflora*
Sanddune phacelia	*Phacelia argentea*
SAV	
Eelgrass	*Zostera marina*
INVERTEBRATES	
BIVALVE	
Bay mussel	*Mytilus edulis*
California butterclam	*Saxidomus nuttallii*
California jacknife clam	*Tagelus californianus*
California mussel	*Mytilus californianus*
California native oyster	*Ostrea conchaphila*
Cockles	
Geoduck	*Panopea abrupta*
Horseneck gaper	*Tresus capax*
Manila clam	*Venerupis philippinarum*
Mediterranean mussel	*Mytilus galloprovincialis*
Mussels	
Pacific gaper	*Tresus nuttallii*
Pacific littleneck	*Protothaca staminea*
Pacific oyster	*Crassostrea gigas*
Pacific razor clam	*Siliqua patula*
Softshell clam	*Mya arenaria*
Washington butterclam	*Saxidomus gigantea*
CEPHALOPOD	
California market squid	*Loligo opalescens*
CRAB	
Brown rock crab	*Cancer antennarius*
Dungeness crab	*Cancer magister*
Green crab	*Carcinus maenas*
Lined shore crab	*Pachygrapsus crassipes*
Pacific sand crab	*Emerita analoga*
Purple shore crab	*Hemigrapsus nudus*
Red rock crab	*Cancer productus*
Yellow shore crab	*Hemigrapsus oregonensis*
ECHINODERM	
Sea urchins	-
GASTROPOD	
Black abalone	*Haliotis cracherodii*
Black tegula	*Tegula funebralis*
Brown tegula	*Tegula brunnea*
Lewis's moonsnail	*Euspira lewisii*
Red abalone	*Haliotis rufescens*
Zebra leafslug	*Phyllaplysia taylori*
INSECT	
Behren's silverspot butterfly	*Speyeria zerene behrensii*
Globose dune beetle	*Coelus globosus*
Lotis blue butterfly	*Lycaeides argyrognomon lotis*
Monarch butterfly	*Danaus plexippus*
Myrtle's silverspot	*Speyeria zerene myrtleae*
Oregon silverspot butterfly	*Speyeria zerene hippolyta*
San Bruno elfin butterfly	*Incisalia mossii bayensis*
SHRIMP	
California bay shrimp	*Crangon franciscorum*
California freshwater shrimp	*Syncaris pacifica*
Ghost shrimp	*Calianassa sp.*
Ocean pink shrimp	*Pandalus jordani*
Spot prawn	*Pandalus platyceros*
MARINE MAMMALS	
DOLPHIN / PORPOISE	
Bottlenose dolphin	*Tursiops truncatus*
Dall's porpoise	*Phocoenoides dalli dalli*
Harbor porpoise	*Phocoena phocoena*

* Threatened and endangered species are designated by underlining

Common Name*	Scientific Name*

MARINE MAMMALS, cont.

DOLPHIN / PORPOISE, cont.

Long-beaked saddleback dolphin	*Delphinus capensis*
Pacific white-sided dolphin	*Lagenorhynchus obliquidens*
Risso's dolphin	*Grampus griseus*
Short-beaked saddleback dolphin	*Delphinus delphis*

PINNIPED

California sea lion	*Zalophus californianus*
Harbor seal	*Phoca vitulina*
Northern elephant seal	*Mirounga angustirostris*
Pinnipeds	-
Sea lions	-
Seals	-
Steller sea lion	*Eumetopias jubatus*

SEA OTTER

Sea otter	*Enhydra lutris*

WHALE

Blue whale	*Balaenoptera musculus*
Fin whale	*Balaenoptera physalus*
Gray whale	*Eschrichtius robustus*
Humpback whale	*Megaptera novaeangliae*
Killer whale	*Orcinus orca*
Minke whale	*Balaenoptera acutorostrata*
North Pacific right whale	*Eubalaena japonica*
Short-finned pilot whale	*Globicephala macrorhynchus*

REPTILES / AMPHIBIANS

AMPHIBIAN

California red-legged frog	*Rana draytonii*
Northern red-legged frog	*Rana aurora*

TURTLE

Leatherback sea turtle	*Dermochelys coriacea*
Northwestern pond turtle	*Clemmys marmorata marmorata*

TERRESTRIAL MAMMALS

SMALL MAMMAL

Beaver	*Castor canadensis*
Muskrat	*Ondatra zibethicus*
Northern river otter	*Lontra canadensis*
Point Arena mountain beaver	*Aplodontia rufa nigra*
Point Reyes jumping mouse	*Zapus trinotatus orarius*

UNGULATE

Roosevelt elk	*Cervus elaphus roosevelti*

* Threatened and endangered species are designated by underlining

SHORELINE DESCRIPTIONS

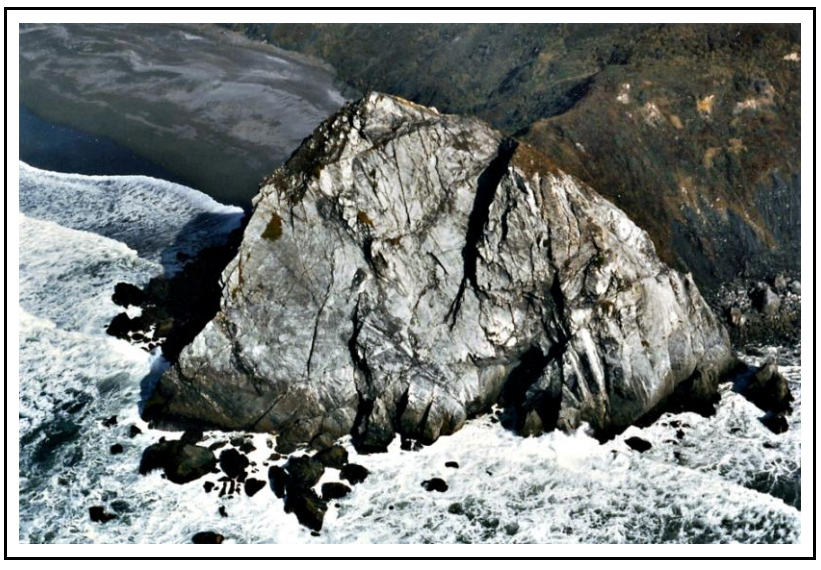
EXPOSED ROCKY SHORES **ESI = 1A**

DESCRIPTION

- The intertidal zone is steep (greater than 30° slope), with very little width
- Sediment accumulations are uncommon and usually ephemeral, because waves remove the debris that has slumped from the eroding cliffs
- There is strong vertical zonation of intertidal biological communities
- Species density and diversity vary greatly, but barnacles, snails, mussels, seastars, limpets, sea anemones, shore crabs, polychaetes, and macroalgae are often very abundant
- Common throughout Northern California

PREDICTED OIL BEHAVIOR

- Oil is held offshore by waves reflecting off the steep cliffs
- Any oil that is deposited is rapidly removed from exposed faces
- The most resistant oil would remain as a patchy band at or above the high-tide line
- Impacts to intertidal communities are expected to be short-term; an exception would be where heavy concentrations of a light refined product came ashore very quickly



RESPONSE CONSIDERATIONS

- Cleanup is usually not required
- Access can be difficult and dangerous

EXPOSED, SOLID MAN-MADE STRUCTURES **ESI = 1B**

DESCRIPTION

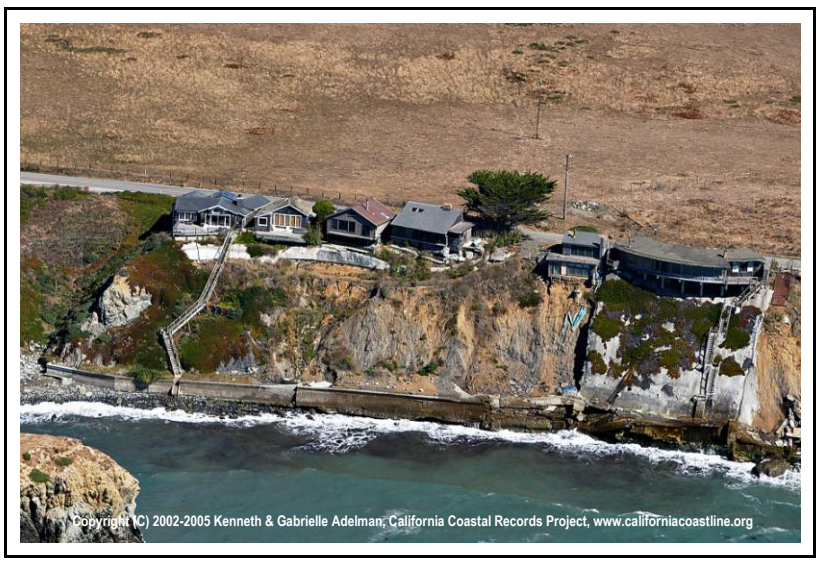
- These structures are solid, man-made structures such as seawalls, groins, revetments, piers, and port facilities
- Many structures are constructed of concrete, wood, or metal
- Often there is no exposed substrate at low tide, but multiple habitats are indicated if present
- They are built to protect the shore from erosion by waves, boat wakes, and currents, and thus are exposed to rapid natural removal processes
- Organisms, such as barnacles, mussels, and algae, may be common on the lower levels, whereas biota along the upper intertidal zones are sparse
- They are present in harbors and developed areas along the open coast

PREDICTED OIL BEHAVIOR

- Oil can penetrate into the joints of the structures
- Oil tends to persist as a band along the high-tide line
- Biota can be impacted under heavy accumulations

RESPONSE CONSIDERATIONS

- High-pressure spraying may be required in order to:
  - remove oil;



  - prepare substrate for recolonization of attached communities;
  - minimize aesthetic damage;
  - prevent the chronic leaching of oil from the structure

EXPOSED WAVE-CUT PLATFORMS IN BEDROCK **ESI = 2A**

DESCRIPTION

- The intertidal zone consists of a flat rock bench of highly variable width
- The shoreline may be backed by a steep scarp or low bluff
- There may be a perched beach of sand- to boulder-sized sediments at the base of the scarp
- The platform surface is irregular and tidal pools are common
- Small accumulations of gravel can be found in the tidal pools and crevices in the platform
- These habitats can support large populations of encrusting animals and plants, with rich tidal pool communities. Dominant species include barnacles, snails, mussels, seastars, limpets, sea anemones, shore crabs, and polychaetes
- Very common in Northern California

PREDICTED OIL BEHAVIOR

- Oil will not adhere to the rock platform, but rather be transported across the platform and accumulate along the high-tide line
- Oil can penetrate in beach sediments, if present
- Persistence of oiled sediments is usually short-term, except in wave shadows or larger sediment accumulations

RESPONSE CONSIDERATIONS

- Cleanup is usually not required
- Where the high-tide area is accessible, it may be feasible to remove heavy oil accumulations and oiled debris

FINE- TO MEDIUM-GRAINED SAND BEACHES ESI = 3A

DESCRIPTION

- These beaches are generally flat, wide, and hard-packed
- They can occur at the upper intertidal zone on wave-cut platforms
- There can be significant seasonal changes in the beach sediments
- Upper beach fauna are scarce; lower beach fauna can be dense, but are highly variable; they are important areas for shorebirds
- Very common in Northern California

PREDICTED OIL BEHAVIOR

- Light oil accumulations will be deposited as oily swashes or bands along the upper intertidal zone
- Heavy oil accumulations will cover the entire beach surface; the oil will be lifted off the lower beach with the rising tide
- Maximum penetration of oil into fine- to medium-grained sand is about 10-15 cm
- Burial of oiled layers by clean sand within the first few weeks will be less than 30 cm along the upper beach face
- Organisms living in the beach may be killed by smothering or lethal oil concentrations in the interstitial water
- Biological impacts include temporary declines in infaunal populations, which can also affect important shorebird foraging areas

RESPONSE CONSIDERATIONS

- These beaches are among the easiest beach types to clean

- Cleanup should concentrate on the removal of oil from the upper swash zone after all oil has come ashore
- Activity through both oiled and dune areas should be severely limited, to prevent contamination of clean areas
- Manual cleanup, rather than road graders and front-end loaders, is advised to minimize the volume of sand removed from the shore and requiring disposal
- All efforts should focus on preventing the mixture of oil deeper into the sediments by vehicular and foot traffic

SCARPS AND STEEP SLOPES IN SAND ESI = 3B

DESCRIPTION

- This shoreline type occurs where sandy bluffs are undercut by waves or currents and slump
- The scarps are generally fronted by narrow beaches, if the erosion rates are moderate and episodic
- Trees growing at the top of these slopes are eventually undercut and the logs can accumulate at the base of the scarp
- Biological utilization by birds and infauna is low
- They are common along shorelines composed of glacial materials

PREDICTED OIL BEHAVIOR

- Any stranded oil will concentrate at the high-water line and may penetrate sandy sediments
- Oil will also adhere to the dry surfaces of any logs that have accumulated at the base of the scarp
- There is little potential for burial except when major slumping of the bluff occurs
- Active erosion of the scarp will remove the oil

RESPONSE CONSIDERATIONS

- In most cases, cleanup is not necessary because of the short residence time of the oil

- Closely supervised manual labor should be used so that the minimal amount of material is removed during cleanup
- The need for removal of oiled sediments and debris should be carefully evaluated because of the potential for increased erosion

COARSE-GRAINED SAND BEACHES ESI = 4

DESCRIPTION

- These beaches are moderate-to-steep, of variable width, and have soft sediments; these characteristics combine to lower their trafficability
- They are commonly backed by dunes or rocky cliffs along exposed, outer coasts
- There can be significant seasonal changes in the beach sediments
- Generally species density and diversity is lower than on fine-grained sand beaches
- Common in Northern California

PREDICTED OIL BEHAVIOR

- During small spills, oil will be deposited primarily as a band along the high-tide line
- Under very heavy accumulations, oil may spread across the entire beach face, though the oil will be lifted off the lower part of the beach with the rising tide
- Penetration of oil into coarse-grained sand can reach 25 cm
- Burial of oiled layers by clean sand can be rapid, and to depths of 60 cm or more
- Burial to depths over one meter is possible if the oil comes ashore at the start of a depositional period

- Biological impacts include temporary declines in infaunal populations, which can also affect important shorebird foraging areas

RESPONSE CONSIDERATIONS

- Remove oil primarily from the upper swash lines
- Removal of sediment should be limited to avoid erosion problems
- Mechanical reworking of the sediment into the surf zone may be used to release the oil without sediment removal
- Activity in the oiled sand should be limited to prevent mixing oil deeper into the beach
- Use of heavy equipment for oil/sand removal may result in the removal of excessive amounts of sand; manual cleanup may be more effective

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MIXED SAND AND GRAVEL BEACHES — ESI = 5

DESCRIPTION

- Moderately sloping beach composed of a mixture of sand and gravel (gravel component should comprise between 20 to 80 percent of total sediments)
- Because of the mixed sediment sizes, there may be zones of pure sand, pebbles, or cobbles
- There can be large-scale changes in the sediment distribution patterns depending upon season, because of the transport of the sand offshore during storms
- Because of sediment mobility and desiccation, on exposed beaches there are low densities of attached animals and plants
- The presence of attached algae, mussels, and barnacles indicates beaches that are relatively sheltered, with the more stable substrate supporting a richer biota
- Relatively common in Northern California

PREDICTED OIL BEHAVIOR

- During small spills, oil will be deposited along and above the high-tide swash
- Large spills will spread across the entire intertidal area
- Oil penetration into the beach sediments may be up to 50 cm; however, the sand fraction can be quite mobile, and oil behavior is much like on a sand beach if the sand fraction exceeds about 40 percent
- Burial of oil may be deep at and above the high-tide line, where oil tends to persist, particularly where beaches are only intermittently exposed to waves
- In sheltered pockets on the beach, pavements of asphalted sediments can form if there is no removal of heavy oil accumulations, because most of the oil remains on the surface
- Once formed, these asphalt pavements can persist for years
- Oil can be stranded in the coarse sediments on the lower part of the beach, particularly if the oil is weathered or emulsified

RESPONSE CONSIDERATIONS

- Remove heavy accumulations of pooled oil from the upper beachface
- All oiled debris should be removed
- Sediment removal should be limited as much as possible
- Low-pressure flushing can be used to lift oil from the sediments for recovery by skimmers or sorbents. High-pressure spraying should be avoided because of potential for transporting contaminated finer sediments (sand) to the lower intertidal or subtidal zones
- Mechanical reworking of oiled sediments from the high-tide zone to the upper intertidal zone can be effective in areas regularly exposed to wave activity (as evidenced by storm berms). However, oiled sediments should not be relocated below the mid-tide zone
- In-place tilling may be used to reach deeply buried oil layers in the middle zone on exposed beaches

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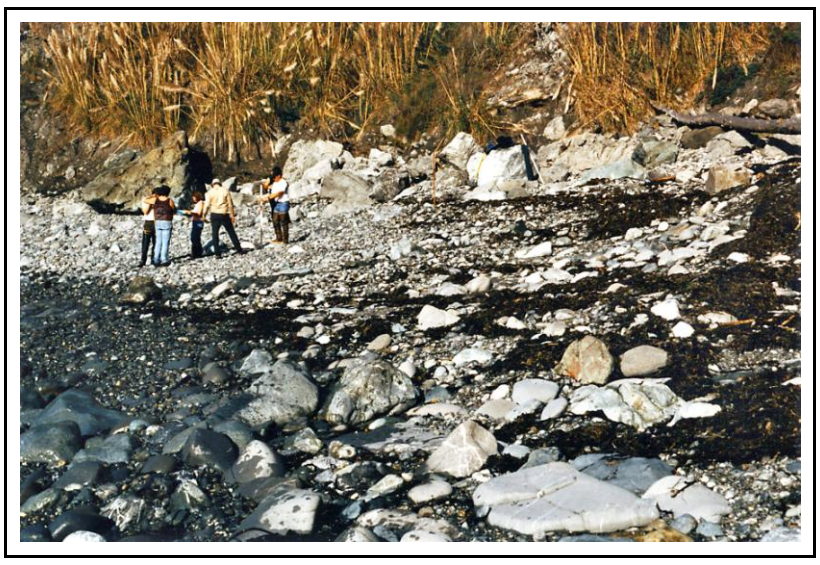
GRAVEL BEACHES — ESI = 6A



DESCRIPTION

- Gravel beaches are composed of sediments ranging in size from pebbles to boulders
- They can be very steep, with multiple wave-built berms forming the upper beach
- Attached biota are usually restricted to the lowest parts of the beach, where the sediments are less mobile
- The presence of attached biota indicates beaches that are relatively sheltered, with the more stable substrate supporting richer biological communities
- Common adjacent to cliffs and platforms

PREDICTED OIL BEHAVIOR

- Deep penetration and rapid burial of stranded oil is likely on gravel beaches
- On exposed beaches, oil can be pushed over the high-tide and storm berms, pooling and persisting above the normal zone of wave wash
- Long-term persistence will be controlled by the depth of penetration versus the depth of routine reworking by storm waves
- On the more sheltered portions of beaches, formation of asphalt pavements is likely where accumulations are heavy

RESPONSE CONSIDERATIONS

- Heavy accumulations of pooled oil should be removed quickly from the upper beach
- All oiled debris should be removed
- Sediment removal should be limited as much as possible
- Low- to high-pressure flushing can be used to lift oil from the sediments for recovery by skimmers or sorbents
- Mechanical reworking of oiled sediments from the high-tide zone to the upper intertidal zone can be effective in areas regularly exposed to wave activity (as evidenced by storm berms). However, oiled sediments should not be relocated below the mid-tide zone
- In-place tilling may be used to reach deeply buried oil layers in the middle intertidal zone on exposed beaches

RIPRAP **ESI = 6B**

DESCRIPTION

- Riprap structures are composed of cobble- to boulder-sized rock fragments
- Riprap structures are placed for shoreline protection and inlet stabilization
- Attached biota may be common at lower intertidal levels, whereas biota along the upper intertidal zones are sparse
- Relatively uncommon in Northern California; associated with harbors and developed areas along the open coast

PREDICTED OIL BEHAVIOR

- Deep penetration of oil between the boulders is likely
- Oil adheres readily to the rough rock surfaces
- If oil is left uncleaned, it may cause chronic leaching until the oil hardens
- Resident fauna and flora may be killed by the oil

RESPONSE CONSIDERATIONS

- When the oil is fresh and liquid, high-pressure spraying and/or water flooding may be effective, making sure to recover all released oil

- Heavy and weathered oils are more difficult to remove, requiring scraping and/or hot-water spraying
- It may be necessary to remove heavily oiled riprap and replace it

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BOULDER RUBBLE **ESI = 6D**

DESCRIPTION

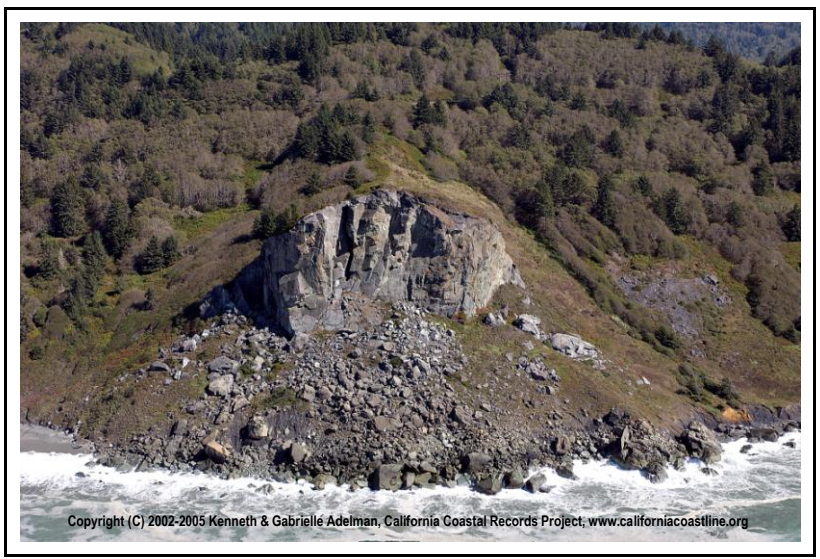
- Relatively steep rocky shores with accumulations of angular boulder rubble displaying limited evidence of re-working by waves or sediment transport
- Attached biota may be common at lower intertidal levels, whereas biota along the upper intertidal zones are sparse
- Can co-occur with gravel beaches or exposed rocky shorelines; associated gravel beaches can be either at the upper or the lower half of the intertidal zone, depending on the nature of the rock outcrop
- Relatively uncommon in Northern California; associated with actively eroding zones and talus fields

PREDICTED OIL BEHAVIOR

- Oil tends to adhere to the upper intertidal zone where the rock surface dries out during low tide, and the algal cover is sparse
- On solid bedrock surfaces, the oil can occur as a surface coating
- Oil can pool and penetrate crevices in the surface rubble
- Where the rubble is loosely packed, oil can penetrate deeply, causing long-term contamination of the subsurface

RESPONSE CONSIDERATIONS

- Thick accumulations of pooled oil should be of high priority for removal, to prevent re-mobilization and/or penetration



- Flushing techniques will be most effective when oil is still fresh and liquid; restrict operations to tidal levels that will prevent oily effluents from impacting lower tidal elevations with rich intertidal communities
- Access can be difficult and dangerous

EXPOSED TIDAL FLATS **ESI = 7**

DESCRIPTION

- Exposed tidal flats are broad, flat intertidal areas composed primarily of sand and mud
- The presence of sand indicates that tidal currents and waves are strong enough to mobilize the sediments
- They are usually associated with another shoreline type on the landward side of the flat, though they can occur as separate shoals; they are commonly associated with tidal inlets
- The sediments are water-saturated, with only the topographically higher ridges drying out during low tide
- Biological utilization can be very high, with large numbers of infauna, heavy use by birds for roosting and foraging, by fish for feeding and migration, and use as haulouts for marine mammals
- Present in and near estuary, slough or river inlet mouths

PREDICTED OIL BEHAVIOR

- Oil does not usually adhere to the surface of exposed tidal flats, but rather moves across the flat and accumulates at the high-tide line
- Deposition of oil on the flat may occur on a falling tide if concentrations are heavy
- Oil does not penetrate water-saturated sediments
- Biological damage may be severe, primarily to infauna, thereby reducing food sources for birds and other predators

RESPONSE CONSIDERATIONS

- Currents and waves can be very effective in natural removal of the oil
- Cleanup is very difficult (and possible only during low tides)
- The use of heavy machinery should be restricted to prevent mixing of oil into the sediments
- Manual removal methods are preferred, taking care to minimize sediment removal and mixing oil deeper into the sediments

SHELTERED ROCKY SHORES — ESI = 8A

DESCRIPTION

- They are bedrock shores of variable slope (from vertical cliffs to wide, rocky ledges) that are sheltered from exposure to most wave and tidal energy
- The wider shores may have some surface sediments, but the bedrock is the dominant substrate type
- Species density and diversity vary greatly, but attached biota may be present at high densities at lower tidal elevations
- Relatively rare in Northern California; associated with high-relief areas along estuaries, sloughs, and rivers

PREDICTED OIL BEHAVIOR

- Oil will adhere readily to the rough rocky surface, particularly along the high-tide line, forming a distinct oil band
- Even on wide ledges, the lower intertidal zone usually stays wet (particularly when algae covered), preventing oil from adhering to the rock surface
- Heavy and weathered oils can cover the upper zone with little impacts to the rich biological communities of the lower zone
- Where the rubble is loosely packed, oil will penetrate deeply, causing long-term contamination of the subsurface sediments
- Where surface sediments are abundant, oil will penetrate into the crevices formed by the surface rubble and pool at the contact of the sediments and the rock surface

RESPONSE CONSIDERATIONS

- Low- to high-pressure spraying at ambient water temperatures is most effective when the oil is fresh
- Extreme care must be taken not to spray in the biologically rich lower intertidal zone or when the tidal level reaches that zone
- Cutting of oiled, attached algae is not recommended; tidal action will eventually float this oil off, so sorbents should be deployed

SHELTERED, SOLID MAN-MADE STRUCTURES — ESI = 8B

DESCRIPTION

- These structures are solid man-made structures such as seawalls, groins, revetments, piers, and port facilities; Composition, design, and condition may be highly variable
- Most structures are constructed of concrete, wood, or metal
- Often there is no exposed beach at low tide, but multiple habitats are indicated if present
- High densities of attached biota may be present at lower tidal elevations
- Relatively uncommon in Northern California

PREDICTED OIL BEHAVIOR

- Oil will adhere readily to rough surfaces, particularly along the high-tide line, forming a distinct oil band; chronic leaching may occur
- The lower intertidal zone usually stays wet (particularly if algae covered), preventing oil from adhering to the surface

RESPONSE CONSIDERATIONS

- Cleanup of seawalls is usually conducted for aesthetic reasons or to prevent leaching of oil
- Low- to high-pressure spraying at ambient water temperatures is most effective when the oil is fresh

SHELTERED RIPRAP — ESI = 8C

DESCRIPTION

- Riprap structures are composed of cobble- to boulder-sized blocks of bedrock or concrete
- These structures are found inside harbors and bays in developed areas, sheltered from direct exposure to waves
- High densities of attached biota may be present at lower tidal elevations
- Relatively uncommon in Northern California

PREDICTED OIL BEHAVIOR

- Deep penetration of oil between the boulders is likely
- Oil adheres readily to the rough surfaces
- If oil is left uncleaned, it may cause chronic leaching until the oil hardens

RESPONSE CONSIDERATIONS

- High-pressure spraying may be required to remove oil for aesthetic reasons and to prevent leaching of oil from the structure
- Cleanup crews should make sure to recover all released oil

SHELTERED TIDAL FLATS — ESI = 9A

DESCRIPTION

- Sheltered tidal flats are broad, flat intertidal areas composed primarily of mud, silt and clay
- They are present in calm-water habitats, sheltered from major wave activity, and are frequently fronted by marshes
- Wave energy is very low, although there may be strong tidal currents on parts of the flat and in channels across the flat
- The sediments are very soft and cannot support even light foot traffic in many areas
- Large concentrations of shellfish, worms, and snails can be found on and in the sediments
- Bird life is seasonally abundant, and flats are heavily utilized by birds for feeding
- Present in major bays, such as Tomales and Humboldt Bays

PREDICTED OIL BEHAVIOR

- Oil does not usually adhere to the wet, muddy sediments, but rather moves across the flat and accumulates at the high-tide line
- Deposition of oil on the flat may occur on a falling tide if concentrations are heavy
- Oil will not penetrate the water-saturated sediments, but can penetrate into borrows and root cavities
- In areas of high suspended sediments, sorption of oil can result in deposition of contaminated sediments on the flats.
- Biological damage may be severe

RESPONSE CONSIDERATIONS

- These are high-priority areas necessitating the use of spill protection devices to limit oil-spill impact; deflection or sorbent booms and open water skimmers should be used
- Cleanup of the flat surface is very difficult because of the soft substrate and many methods may be restricted
- Low-pressure flushing and deployment of sorbents from shallow-draft boats may be helpful

SHELTERED, VEGETATED LOW BANKS — ESI = 9B

DESCRIPTION

- These habitats are either low banks with grasses or trees and tree roots exposed to the water
- They are flooded occasionally by high water
- These shorelines are most common along the major river tributaries and upper sections of tidal creeks to the bay and comprise 9% of the shoreline

PREDICTED OIL BEHAVIOR

- During low water stages there is little impact, with the oil coating a narrow band of sediment at the water level
- During high water, the oil will cover and coat the grasses and base of trees
- May cause loss of the grasses, but the trees should survive unless oil penetrates and persists in the substrate

RESPONSE CONSIDERATIONS

- Low-pressure flushing of oiled areas is effective in removing moderate to heavy accumulations of oil from along the banks
- Sorbent and containment boom should be placed on the water side of the cleanup operations to contain and collect oil outflow

- Low- to high-pressure flushing can be used to remove oil from tree roots and trunks, if deemed necessary in high-use areas

SALT- AND BRACKISH-WATER MARSHES — ESI = 10A

DESCRIPTION

- These are grassy wetlands composed of emergent herbaceous vegetation in salt water settings
- Width of the marsh can vary widely, from a narrow fringe to extensive areas
- They are relatively sheltered from waves and strong tidal currents
- Resident flora and fauna are abundant with numerous species with high utilization by birds, fish, and shellfish
- Present in major bays, such as Tomales and Humboldt Bays

PREDICTED OIL BEHAVIOR

- Oil adheres readily to marsh vegetation
- The band of coating will vary widely, depending upon the tidal stage at the time oil slicks are in the vegetation; there may be multiple bands
- Large slicks will persist through multiple tidal cycles and coat the entire stem from the high-tide line to the base
- If the vegetation is thick, heavy oil coating will be restricted to the outer fringe, with penetration and lighter oiling to the limit of tidal influence
- Medium to heavy oils do not readily adhere or penetrate the fine sediments, but can pool on the surface and penetrate into burrows and root cavities
- Light oils can penetrate the top few centimeters of sediment and deeply into burrows and cracks (up to one meter)

RESPONSE CONSIDERATIONS

- Under light oiling, the best practice is natural recovery

- Heavy accumulations of pooled oil can be removed by vacuum, sorbents, or low-pressure flushing. During flushing, care must be taken to prevent transporting oil to sensitive areas down slope or along shore
- Cleanup activities should be carefully supervised to avoid vegetation damage
- Any cleanup activity must not mix the oil deeper into the sediments; trampling of the roots must be minimized
- Cutting of oiled vegetation should only be considered when other resources present are at great risk from leaving the oiled vegetation in place

FRESHWATER MARSHES **ESI = 10B**

DESCRIPTION

- These are grassy wetlands composed of emergent herbaceous vegetation in freshwater settings
- Width of the marsh can vary widely, from a narrow fringe to extensive areas
- They are relatively sheltered from waves and tidal currents
- Resident flora and fauna are abundant
- Relatively uncommon in Northern California; present along upstream portions of estuaries, sloughs, and rivers

PREDICTED OIL BEHAVIOR

- Oil adheres readily to marsh vegetation
- The band of coating will vary widely, depending upon the water level changes at the time oil slicks are in the vegetation
- If the vegetation is thick, heavy oil coating will be restricted to the outer fringe, although lighter oils can penetrate deeper
- Medium to heavy oils do not readily adhere or penetrate the fine sediments, but can pool on the surface or in burrows
- Light oils can penetrate the top few centimeters of sediment and deeply into burrows and cracks (up to one meter)

RESPONSE CONSIDERATIONS

- Under light oiling, the best practice is natural recovery; natural removal processes and rates should be evaluated prior to conducting cleanup

- Heavy accumulations of pooled oil can be removed by vacuum, sorbents, or low-pressure flushing
- Cleanup activities should be carefully supervised to avoid vegetation damage
- Any cleanup activity must not mix the oil deeper into the sediments. Trampling of the roots must be minimized
- Cutting of oiled vegetation should only be considered when other resources present are at great risk from leaving the oiled vegetation in place

SWAMPS **ESI = 10C**

DESCRIPTION

- Swamps consist of shrubs and forested wetlands, essentially flooded forests; vegetation is taller than 6 meters, on average
- The sediment tends to be silty clay with large amounts of organic debris
- They are seasonally flooded, though there are many low, permanently flooded areas. In California, most are located above normal spring high tides, thus they are seldom inundated by salt water
- Resident flora and fauna are abundant with numerous species
- Relatively uncommon in Northern California; present along upstream portions of estuaries, sloughs, and rivers

PREDICTED OIL BEHAVIOR

- Though generally not a risk of oiling from marine spills because of their position above normal high tides, they could become oiled during very high water levels, from land-based spills, or during cleanup of adjacent areas
- Oil behavior depends on whether the swamp is flooded or not
- During floods, most of the oil passes through the forest, coating the vegetation at the waterline, which changes levels throughout the flood event
- Oiled woody vegetation is less sensitive than grasses to oil coating
- Some oil can be trapped and pooled on the swamp floodplain as water levels drop
- Penetration into the floodplain soils is usually limited because of high water levels, saturated soils, muddy composition, surface organic debris, and vegetation cover
- Large amounts of oily debris can remain
- During dry periods, terrestrial spills flow downhill and accumulate in depressions or reach waterbodies

RESPONSE CONSIDERATIONS

- Under light oiling, the best practice is to let the area recover naturally
- Heavy accumulations of pooled oil can be removed by vacuum, sorbents, or low-pressure flushing. During flushing, care must be taken to prevent transporting oil to sensitive areas down slope or along shore
- Under stagnant water conditions, herding of oil with water spray may be needed to push oil to collection areas
- Oily debris can be removed where there is access
- Any cleanup activity must not mix the oil deeper into the sediments
- Woody vegetation should not be cut

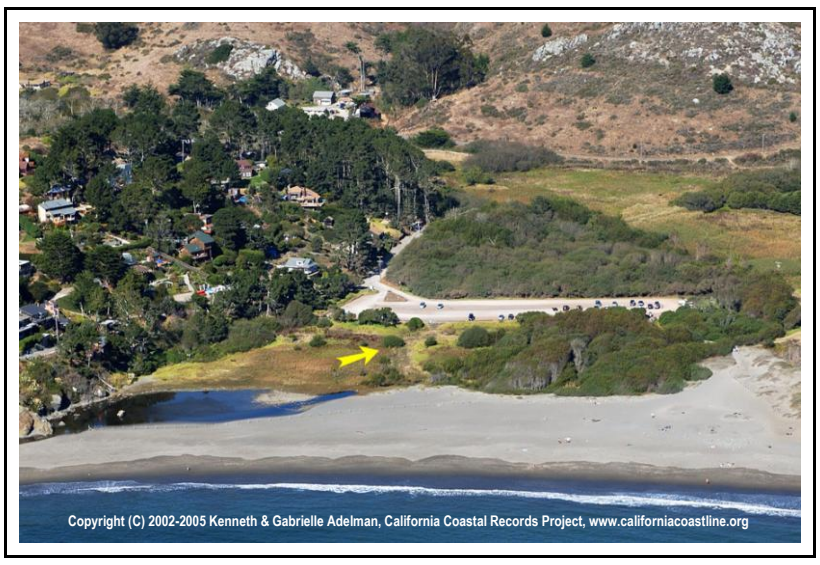
SCRUB-SHRUB WETLANDS **ESI = 10D**

DESCRIPTION

- Scrub-shrub wetlands consist of woody vegetation less than 6 meters tall including true shrubs, small trees, and trees and shrubs that are stunted due to environmental conditions
- The sediments are silty clay mixed with organic debris
- They are seasonally flooded, though there are many low, permanently flooded areas. In California, most are located above normal spring high tides, thus they are seldom inundated by salt water
- Resident flora and fauna are abundant
- Relatively uncommon in Northern California; present along upstream portions of estuaries, sloughs, and rivers

PREDICTED OIL BEHAVIOR

- Though generally not a risk of oiling from marine spills because of their position above normal high tides, they could become oiled during very high water levels, from land-based spills, or during cleanup of adjacent areas



- Oil behavior depends on whether the wetland is flooded or not
- During floods, most of the oil passes through the wetland, coating the vegetation at the waterline, which changes levels throughout the flood event
- Woody vegetation is less sensitive than grasses to oil
- Some oil can be trapped and pooled on the floodplain as water levels drop
- Penetration into the floodplain soils is usually limited because of high water levels, muddy composition, surface organic debris, and vegetation cover
- Large amounts of oily debris can remain in the wetland
- During dry periods, terrestrial spills flow downhill and accumulate in depressions or reach waterbodies

RESPONSE CONSIDERATIONS

- Under light oiling, the best practice is natural recovery
- Heavy accumulations of pooled oil can be removed by vacuum, sorbents, or low-pressure flushing
- Oily debris can be removed where there is access
- Any cleanup activity must not mix the oil deeper into the sediments. Trampling of the roots must be minimized
- Woody vegetation should not be cut