ENVIRONMENTAL SENSITIVITY INDEX: Central California

INTRODUCTION

Environmental Sensitivity Index (ESI) maps have been developed for the coastal areas of Central California from Point Conception to Point Reyes National Seashore. 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 using two methods: interpretation of contiguous oblique digital aerial photography acquired in 2004 (www.californiacoastline.org) and verification via overflights and ground surveys conducted in April 2005. The overflights were conducted at elevations of 400-600 feet and slow air speed. During these overflights, the ESI shoreline classification was verified and changes were denoted on hardcopy 1:24,000-scale USGS topographic maps. 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 Central 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
3A) Fine- to Medium-grained Sand Beaches
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
10A) Salt- and Brackish-water Marshes
10B) Freshwater Marshes
10C) Swamps
10D) Scrub-Shrub Wetlands

Each shoreline type is described on pages 12-18 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 the U.S. Fish and Wildlife Service (USFWS), National Wetlands Inventory, and wetlands previously mapped in the 1994 Central 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:

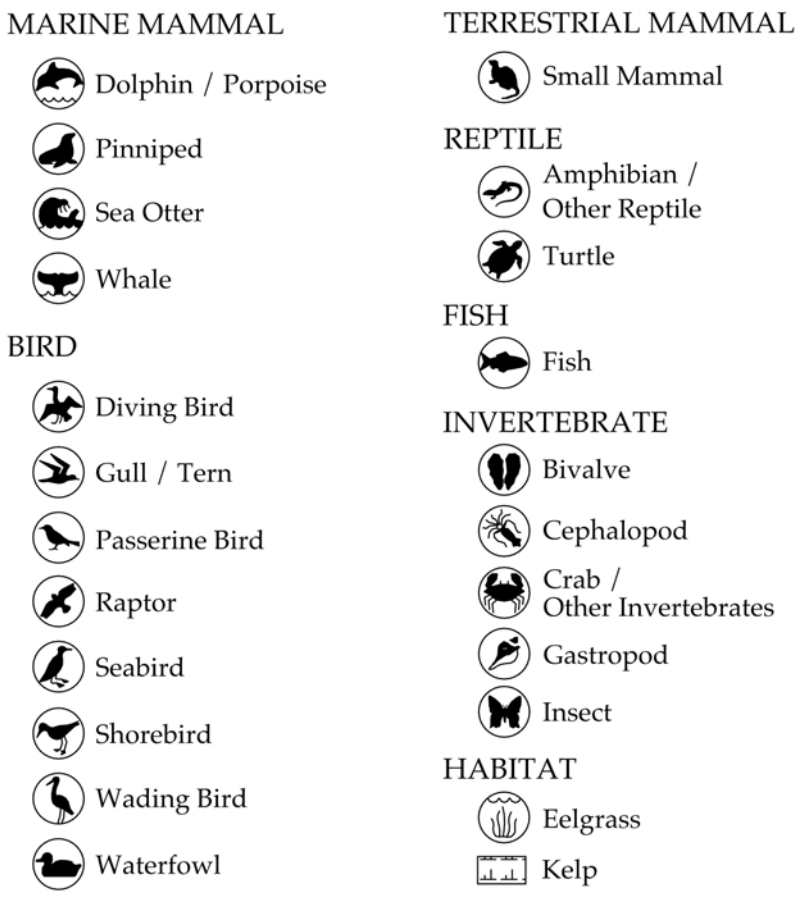
- California Department of Fish and Game (CDF&G), Office of Spill Prevention and Response (OSPR), Marine Region (MR), and Habitat Conservation Planning Division (HCPD)
- National Oceanic and Atmospheric Administration (NOAA), Monterey Bay National Marine Sanctuary (MBNMS)
- NOAA National Marine Fisheries Service (NMFS)
- Moss Landing Marine Laboratories (MLML)
- U.S. Geological Survey (USGS)
- NOAA Gulf of the Farallones National Marine Sanctuary (GFNMS)
- National Park Service (NPS), Point Reyes National Seashore (PRNS), and Golden Gate National Recreation Area (GGNRA)
- University of California Santa Cruz (UCSC), Long Marine Laboratory
- Point Reyes Bird Observatory (PRBO)
- U.S. Fish and Wildlife Service (USFWS)
- UCSC, Santa Cruz Predatory Bird Research Group (SCPBRG)
- Vandenberg Air Force Base
- H.T. Harvey and Associates
- Pacific Eco Logic
- Ventana Wildlife Society
- Pepperdine University
- Partnership for Interdisciplinary Studies of Coastal Oceans (PISCO)
- University of California Santa Barbara (UCSB)
- NOAA National Centers for Coastal Ocean Science Biogeography Team (NCCOS)
- Elkhorn Slough National Estuarine Research Reserve (ESNERR)

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
Invertebrates	Orange diagonal hatch
Reptiles	Red diagonal hatch
Kelp	Purple 'simplified wetland pattern'
Eelgrass	Purple horizontal 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. No icons are associated with kelp plotted on the maps.

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 "Common in ..." (e.g., "Common in Monterey Bay" or "Common Nearshore"). The geographical extent of the polygons is depicted in the digital data available on the CD-ROM.

OFFSHORE SENSITIVITY MAP

In addition to the 41 detailed maps in the atlas, an Offshore Sensitivity Map was created. This map is intended to provide a regional overview of the environmentally sensitive nearshore and offshore marine resources of the Central California Coast, Monterey Bay National Marine Sanctuary, and Gulf of the Farallones National Marine Sanctuary. All of the biological data displayed on the offshore map are included in the digital data available on the CD-ROM. Nearshore biological data shown on the offshore map that overlaps with the detailed maps are also displayed on the individual map sheets. Please refer to the detailed species group (e.g., marine mammals, birds) and human-use resource summaries below for more information on the mapped offshore resources.

MARINE MAMMALS

Marine mammals depicted in the Central California Atlas include selected species of dolphins, porpoises, pinnipeds, sea otters, and whales. Marine mammal concentration areas are mapped based on interviews with local resource experts from UCSC Long Marine Lab, NPS PRNS, NOAA GFNMS, NOAA MBNMS, NMFS, CDF&G, MLML, USFWS, USGS, and the digital and hardcopy data sources they provided. Marine mammal data are included on the 41 detailed maps and/or on the regional offshore map. All data are included digitally on the CD-ROM.

Cetacean migration routes and "hot spots" – Nearshore and offshore zones used for migration by whales, dolphins, and porpoises commonly found in Central California waters are mapped. In addition, known "hot spots" where animals are reported to concentrate are shown, as well as areas known to contain discrete, resident stocks. For instance, harbor porpoise (*Phocoena phocoena),* from three stocks occur in the study area: San Francisco-Russian River stock (~8,500 animals), Monterey Bay stock (~1,600 animals), and Morro Bay stock (~1,600 animals). Nearshore zones and concentration areas are depicted on the 41 detailed maps, or in "Common in Coastal Waters" boxes. Offshore zones and concentration areas are shown on the regional offshore map.

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 1998-2004. 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 and rookeries, as well as supplementary information for the species surveyed by NMFS. USFWS and NMFS personnel provided information on northern fur seal (*Callorhinus ursinus*) and Guadalupe fur seal (*Arctocephalus townsendi,* state and federally threatened).

Sea otters – Southern sea otter (*Enhydra lutris nereis*, federally threatened) distribution is depicted in the atlas. UCSC, along with partners from other universities and agencies, conduct semi-annual shipboard surveys of sea otters and provided spring/fall range-wide census data for use in this atlas. The data show "sea otter habitat" (defined as bottom from the coastline to the 40-meter isobath) divided into 17 coastline sections. The sections delineate areas of similar bottom habitat. The census data represent a 3-year average (2003-2005) from the spring census data. The 3-year average is the "official gauge of sea otter population dynamics" (T. Tinker, UCSC, pers. comm.). The concentration field contains a numeric 'independents' field, which corresponds to males, females, and pups over 6 months old (the age at which pups are considered to be 'independent' from their mothers) per segment. Population level effects from oil spills are due to female and pup mortality, so a 'pups' concentration field is also included to indicate those segments with higher vulnerability for female and pup oiling. Highest total concentrations of sea otters during the 2003-2005 surveys were in Monterey Bay segments.

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

Name	Agency	City	Phone	Species
Tim Tinker	UCSC Long Marine Lab	Santa Cruz	831/459 -2357	Sea otters
Mark Lowry	NMFS	La Jolla	858/546 -7174	Seals, sea lions
Karin Forney	NMFS	Moss Landing	831/420 -3908	Cetaceans
Scott Benson	NMFS	Moss Landing	831/771 -4354	Marine mammals
Jim Harvey	Moss Landing Marine Labs	Moss Landing	831/771 -4434	Marine mammals
Sarah Allen	NPS Point Reyes NS	Point Reyes	415/464 -5187	Point Reyes NS species
Jan Roletto	NOAA GFNMS	San Francisco	415/561 -6622	GFNMS species
Joelle Buffa	USFWS	Newark	510/792 -0222	Gulf of Farallones NWR species
Michele Roest	NOAA MBNMS	San Simeon	805/927 -2145	Elephant seals
Melissa Boggs-Blalack	CDF&G	Morro Bay	805/772 -7569	SLO County species
Christine Pattison	CDF&G	Morro Bay	805/772 -0114	SLO County species

***Note:** this is not a comprehensive list of Central 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

Brown, J. 2005. Blue whale (Eastern North Pacific stock) *Balaenoptera musculus*. NOAA MBNMS, unpublished draft report, 15 pp.

Brown, J. 2005. Gray whale (Eastern North Pacific stock) *Eschrichtius robustus*. NOAA MBNMS, unpublished draft report, 15 pp.

Brown, J. 2005. Guadalupe fur seal *Arctocephalus townsendi*. NOAA MBNMS, unpublished draft report, 15 pp.

Brown, J. 2005. Harbor porpoise (San Francisco-Russian River, Monterey Bay, and Morro Bay stocks) *Phocoena phocoena*. NOAA MBNMS, unpublished draft report, 11 pp.

Brown, J. 2005. Humpback whale (Eastern North Pacific stock) *Megaptera movaeangliae*. NOAA MBNMS, unpublished draft report, 14 pp.

Brown, J. 2005. Northern elephant seal *Mirounga angustirostris*. NOAA MBNMS, unpublished draft report, 14 pp.

Brown, J. 2005. Sei whale (Eastern North Pacific stock) *Balaenoptera borealis*. NOAA MBNMS, unpublished draft report, 10 pp.

Brown, J. 2005. Sperm whale (California/Oregon/Washington stock) *Physeter macrocephalus*. NOAA MBNMS, unpublished draft report, 17 pp.

Brown, J. 2005. Steller sea lion (Eastern U.S. stock) *Eumetopias jubatus*. NOAA MBNMS, unpublished draft report, 16 pp.

California Department of Fish and Game Office of Spill Prevention and Response (CDF&G OSPR) and U.S. Coast Guard. 2005. 2005 Sector LA/LB – Area Contingency Plan (ACP) Volume II: Section 9810-Area Contingency Plan 4, LA/LB North Area Committee, USCG Sector LA/LB, San Luis Obispo, Santa Barbara, and Ventura Counties and Channel Islands. CDF&G OSPR and USCG, pp 9811-1 – 9812. 3-24.

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 3 – Central Coast. CDF&G OSPR and USCG, 206 pp.

Caretta, J.V., K.A. Forney, M.M. Muto, J. Barlow, J. Baker, B. Hanson, and M.S. Lowry. 2005. U.S. Pacific marine mammal stock assessments 2004. NOAA-TM-NMFS-SWFSC-375, U.S. DOC, NOAA, NMFS, SWFSC, 323 pp.

Lowry, M. 2005. California and Steller sea lion and harbor seal haul-out locations. NOAA NMFS, La Jolla, CA, tabular digital data.

NOAA. 2001. Central California ESI Atlas. CD-ROM, Seattle, WA; adapted from RPI, 1994, Sensitivity of Coastal Environments and Wildlife to Spilled Oil: Central California, Columbia, SC, 41 maps +introductory text.

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 orarius*), and salt-marsh harvest mouse (*Reithrodontomys raviventris*, state and federally endangered) are mapped in this atlas. Location information was provided by NPS PRNS, NPS GGNRA, and NOAA GFNMS. The California Natural Diversity Database (CNDDB), provided by CDF&G, was used to supplement data from resource experts. Only species that are state and/or federally listed and records that were recent since the first draft of the Central California ESI Atlas (published in 1994) were added.

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

Name	Agency	City	Phone	Species
Sarah Allen	NPS Point Reyes NS	Point Reyes	415/464 -5187	Point Reyes NS species
Jan Roletto	NOAA GFNMS	San Francisco	415/561 -6622	GFNMS species
Darren Fong	NPS GGNRA	San Francisco	415/331 -8716	GGNRA species

***Note:** this is not a comprehensive list of Central 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, Habitat Conservation Division, Wildlife and Habitat Data Analysis Branch. 2005. California Natural Diversity Database (CNDDB), vector digital data.

BIRDS

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

Bird concentration areas are based primarily on information gathered at interviews with local resource experts from USGS, PRBO, MLML, NPS PRNS, NOAA GFNMS, NPS GGNRA, Pacific Eco Logic, Ventana Wildlife Society, SCPBRG, CDF&G, and H.T. Harvey and Associates. Additional sources are listed below and are included in the metadata accompanying the CD-ROM.

American peregrine falcons - Due to the sensitive nature of displaying peregrine falcon (*Falco peregrinus anatum*, state endangered) nest locations, "Present in Area" boxes are shown on maps where falcons are likely to occur. Please contact the SCPBRG for more detailed information in the event of an incident. Potential nesting areas along Point Reyes National Seashore were identified by NPS trustees.

Raptor concentration areas – Nearshore and inland "hot spots" for California condor (*Gymnogyps californianus*, federally and state endangered) are depicted on the maps. The spatial extent shown was generated from tagging data provided by Ventana Wildlife Society.

Pelagic species general distribution and concentration areas – Eight 'zones' were created by USGS, NOAA, and MLML marine bird experts in order to depict the overall distribution of pelagic species throughout the study area from the nearshore environment to offshore MBNMS waters. The zones differ in depth, distance from shore, and other habitat features. A variety of species occur in the zones, including: waterfowl, diving birds, gulls, terns, seabirds, and pelagic shorebirds. In addition, nearshore and offshore on-water seasonal "hot spots" for pelagic species were mapped.

Nesting colonies – Locations of seabird, gull, tern, and shorebird colonies are mapped. NOAA NCCOS provided the majority of 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). Vandenberg Air Force Base and local experts (USFWS, NOAA, etc.) provided additional data and 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 and along beaches in certain areas during fall and spring. Some species overwinter and/or are present during the summer. Location and seasonality information was provided via reports and expert knowledge.

Estuarine, wetland, and upland concentration areas – Waterfowl, diving birds, wading birds, shorebirds, raptors, and passerine species that concentrate in estuaries and wetlands (e.g., Elkhorn Slough, Drakes Estero) or sensitive upland areas are mapped. The information was provided via reports and local expert knowledge.

Brown pelican roost locations – Brown pelican (*Pelecanus occidentalis,* state and federally endangered) roost sites are depicted on the maps. Location and concentration information was compiled from a report documenting aerial surveys conducted from 1998-2000 in MBNMS and GFNMS. The surveys were supported by CDF&G and the American Trader Oilspill Restoration Trustee Council. Ranges shown in the concentration field were the minimum and maximum counts across the 3-year survey period. Roost sites outside of the study area covered by the report were provided by Vandenberg Air Force Base and other resource experts. American white pelican (*Pelecanus erythrorhynchos*) concentration areas are also mapped.

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. Only species that are state and/or federally listed and records that were recent since the first draft of the Central California ESI Atlas (published in 1994) were added.

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 Central California ESI Atlas.

Assemblage	Species Examples
Seabirds	Auklets, murres, murrelets, storm-petrels, albatrosses, shearwaters, guillemots, etc.
Diving birds	Pelicans, cormorants, grebes, and loons
Raptors	Condor, osprey, falcons, hawks, etc.
Shorebirds	Plovers, oystercatchers, phalaropes, yellowlegs, sandpipers, willet, tattlers, killdeer, stilt, avocet, curlews, whimbrel, godwits, turnstones, surfbird, knot, sanderling, dunlin, dowitcher, snipe, etc.
Wading birds	Rails, bitterns, herons, egrets, etc.
Waterfowl	Brant, dabbling ducks, diving ducks, geese, etc.
Dabbling ducks	Mallard, gadwall, wigeons, teals, shoveler, pintail, etc.
Diving ducks	Canvasback, ring-necked duck, scaup, scoters, bufflehead, goldeneye, mergansers, ruddy duck, etc.
Gulls	California gull, western gull, herring gull, glaucous-winged gull, Sabine's gull, etc.
Terns	Caspian tern, elegant tern, common tern, Forster's tern, California least 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; a 'high' density of loons (e.g., thousands) may be a smaller number of birds than a 'high' density of sooty shearwaters, which, for instance, may occur in the 100,000s on the water. 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 Central California birds are:

Name	Agency	City	Phone/web site	Species
Josh Adams	USGS	Moss Landing	831/633-7259	Seabirds
Gary Page	PRBO	Stinson Beach	415/868-0371	Snowy plovers, shorebirds, waterbirds
Jim Harvey	Moss Landing Marine Labs	Moss Landing	831/771-4434	Seabirds
Sarah Allen	NPS Point Reyes NS	Point Reyes	415/464-5187	Point Reyes NS species
Jan Roletto	NOAA GFNMS	San Francisco	415/561-6622	GFNMS species
Bill Merkle	NPS GGNRA	San Francisco	415/331-2894	GGNRA species
Laird Henkel	H.T. Harvey & Assoc.	Watsonville	831/786-1700 x104	Seabirds
Deborah Jaques	Pacific Eco Logic	Crescent City	707/464-5878	Brown pelican
Kelly Sorenson	Ventana Wildlife Society	Salinas	831/455-9514	California condor
SCPBRG	Long Marine Lab	Santa Cruz	http://www2.ucsc.edu/scpbrg/	Peregrine falcon/ raptors
Melissa Boggs-Blalack	CDF&G	Morro Bay	805/772-7569	SLO County species
Christine Pattison	CDF&G	Morro Bay	805/772-0114	SLO County species

***Note:** this is not a comprehensive list of Central 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

CDF&G, Habitat Conservation Division, Wildlife and Habitat Data Analysis Branch. 2005. California Natural Diversity Database (CNDDB), vector digital data.

California Department of Fish and Game Office of Spill Prevention and Response (CDF&G OSPR) and U.S. Coast Guard. 2005. 2005 Sector LA/LB – Area Contingency Plan (ACP) Volume II: Section 9810-Area Contingency Plan 4, LA/LB North Area Committee, USCG Sector LA/LB, San Luis Obispo, Santa Barbara, and Ventura Counties and Channel Islands. CDF&G OSPR and USCG, pp 9811-1 – 9812.3-24.

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 3 – Central Coast. CDF&G OSPR and USCG, 206 pp.

Golden Gate National Recreation Area. 1998. Snowy plover management plan: Ocean Beach, San Francisco. Draft report. GGNRA, 58 pp. + appendices.

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.

Robeson, D. 2002. Monterey Birds. Monterey Peninsula Audubon Society, Carmel, CA, 536 pp.

Strong, C.S. and D.J. Jaques. 2000. Aerial surveys of brown pelicans at roost sites within the Monterey Bay and Gulf of the Farallones National Marine Sanctuaries, 1998-2000. A report to the Monterey Bay NMS and Gulf of the Farallones NMS, the American Trader Oilspill Restoration Trustee Council, and California Dept. of Fish and Game, unpublished report, 5 pp.

U.S. Air Force, Vandenberg Air Force Base. 2005. Seabird, brown pelican, and least tern locations, vector digital data.

Ventana Wildlife Society. 2005. Locations of GPS marked California condors: Big Sur release area, digital map.

REPTILES and AMPHIBIANS

Documented nearshore and offshore concentration areas for leatherback sea turtles (*Dermochelys coriacea*, federally endangered) are included in this atlas. In addition, a few sensitive terrestrial and freshwater/brackishwater species are mapped, including California red-legged frog (*Rana aurora draytonii*, federally threatened), San Francisco garter snake (*Thamnophis sirtalis tetrataenia*, state and federally endangered), western pond turtle (*Clemmys marmorata*), Santa Cruz long-toed salamander (*Ambystoma macrodactylum croceum*, state and federally endangered), and California legless lizard (*Anniella pulchra*).

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. Only species that are state and/or federally listed and records that were recent since the first draft of the Central California ESI Atlas (published in 1994) were added.

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

Name	Agency	City	Phone	Species
Scott Benson	NMFS	Moss Landing	831/771-4354	Leatherback sea turtle
Sarah Allen	NPS Point Reyes NS	Point Reyes	415/464-5187	Point Reyes NS species
Darren Fong	NPS GGNRA	San Francisco	415/331-8716	Aquatic species
Jennifer Nelson	CDF&G	Aptos	831/688-6768	Terrestrial/ estuarine species
Melissa Boggs-Blalack	CDF&G	Morro Bay	805/772-7569	SLO County species

***Note:** this is not a comprehensive list of Central 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

CDF&G, Habitat Conservation Division, Wildlife and Habitat Data Analysis Branch. 2005. California Natural Diversity Database (CNDDB), vector digital data.

CDF&G OSPR and U.S. Coast Guard. 2005. 2005 Sector LA/LB – Area Contingency Plan (ACP) Volume II: Section 9810-Area Contingency Plan 4, LA/LB North Area Committee, USCG Sector LA/LB, San Luis Obispo, Santa Barbara, and Ventura Counties and Channel Islands. CDF&G OSPR and USCG, pp. 9811-1 – 9812.3-24.

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 3 – Central Coast. CDF&G OSPR and USCG, 206 pp.

FISH

Finfish depicted in this atlas include selected marine, estuarine, and anadromous species. Species of commercial, recreational, ecological, and/or conservation interest are emphasized. Species using habitats that are more likely to be impacted by oil spills were prioritized for inclusion over widely distributed, mobile, and offshore species.

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 in or prior to 2005 are mapped.

Anadromous populations – The Central California Coast coho salmon (*Oncorhynchus kisutch*) ESU (federally and state endangered) occurs

in streams and rivers from north of the study area to Monterey Bay. The Central California Coast (federally threatened), South-Central California Coast (federally threatened), and Southern California (federally endangered) steelhead (*Oncorhynchus mykiss*) ESUs occur in the study area. Pacific lamprey (*Lampetra tridentata*) occurs in the study area, but is not federally or state listed. Adult steelhead and coho would be most at risk from late October to mid-June as they congregate at river mouths waiting for sand bars to breach. Migration from creeks to the ocean occurs around June 15. During the summer and fall, juveniles are rearing in lagoons and adults and juveniles may be nearshore. Anadromous species distribution information was provided by CDF&G.

Marine and estuarine species – Concentration areas and some general distributions of coastal (e.g., California halibut, *Paralichthys californicus*), kelp-bed associated (e.g., rockfish), sandy habitat associated (e.g., California grunion, *Leuresthes tenuis*), and rocky habitat associated species (e.g., seaperch), particularly those that spawn nearshore during part of the year (e.g., surfperch), are mapped. Species associated with important estuarine systems (e.g., Elkhorn Slough, Morro Bay) are also highlighted. The lists of fish species associated with sensitive, mapped habitats 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).

Mapping all fish species that are potentially vulnerable to oil spills in Central California was not possible, due to the wide distribution of some species and a lack of specific spatial and temporal data. Table 2 lists some representative species that occur in potentially sensitive habitats. This is not a comprehensive list of species that occur in the area, but rather highlights some key habitats and species associated with them.

Table 2. Representative fish species and sensitive habitats in Central California

Common Name	Scientific Name	General Habitat and Distribution	Species 'Group'
Pacific sardine	*Sardinops sagax*	Schooling, pelagic	Forage fish – concentrate in bird/marine mammal 'feeding areas'
Northern anchovy	*Engraulis mordax*	Within 160 km of shore; surface to 300 m	Forage fish – concentrate in bird/marine mammal 'feeding areas'
Basking shark	*Cetorhinus maximus*	On or near the surface, near plankton concentrations	Species vulnerable to surface slicks
Ocean sunfish	*Mola mola*	At or near the surface, singly or in small groups	Species vulnerable to surface slicks
Swordfish	*Xiphias gladius*	Surface to 125 m; move between inshore and offshore	Pelagic
California grunion	*Leuresthes tenuis*	Pelagic, schooling, surf line to 18 m; spawn out of water on beach	Beach spawners
Surf smelt	*Hypomesus pretiosus*	Spawn in upper intertidal, coarse-sand/ gravel beaches	Beach spawners
Nursery species	Numerous	Larval and juvenile fish use eelgrass beds as refuge	Eelgrass beds, estuaries
Rockfish (certain species)	*Sebastes spp.*	Juveniles, in particular, use shallow water kelp beds	Kelp beds
Rubberlip seaperch	*Rhacochilus toxotes*	Mid-water to bottom in lower kelp canopy, hard structures	Kelp beds, rocky reefs, manmade structures
Monkeyface prickleback	*Cebisichthys violaceus*	Crevices and caves in upper intertidal zone, shallow subtidal rocky areas	Rocky intertidal
Rockfish (certain species)	*Sebastes spp.*	Tide pools, around rocks, structure	Rocky intertidal
Larval fishes (rockfishes, etc.)	Numerous	Coastal waters out to 80-100 km offshore (typically late winter to early spring)	Open water

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

Name	Agency	City	Phone	Species
Ken Oda	CDF&G	Monterey	831/649 -2884	Marine fish
Darren Fong	NPS GGNRA	San Francisco	415/331 -8716	Aquatic species
Jennifer Nelson	CDF&G	Aptos	831/688 -6768	Anadromous species
Paul Reilly	CDF&G	Monterey	831/649 -2879	Marine fish
Milton Love	UCSB	Santa Barbara	805/893 -2935	Marine fish
Linda Snook	UCSB	Santa Cruz	831/457 -9291	Marine fish
Christine Pattison	CDF&G	Morro Bay	805/772 -0114	SLO County species
Melissa Boggs-Blalack	CDF&G	Morro Bay	805/772 -7569	SLO County species
Karen Martin	Pepperdine	Malibu	310/506 -4808	Grunion
Sarah Allen	NPS Point Reyes NS	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 Central California fish experts. Contact state and federal agencies, universities, and other appropriate entities in the event of an incident.

Major Data Sources Consulted: Fish

Brown, J.A. 2002. A plan for monitoring the fish assemblage in Elkhorn Slough. Elkhorn Slough Technical Report Series 2002:1.

CDF&G, Habitat Conservation Division, Wildlife and Habitat Data Analysis Branch. 2005. California Natural Diversity Database (CNDDB), vector digital data.

CDF&G OSPR, and U.S. Coast Guard. 2005. 2005 Sector LA/LB – Area Contingency Plan (ACP) Volume II: Section 9810-Area Contingency Plan 4, LA/LB North Area Committee, USCG Sector LA/LB, San Luis Obispo, Santa Barbara, and Ventura Counties and Channel Islands. CDF&G OSPR and USCG, pp 9811-1 – 9812.3-24.

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 3 – Central Coast. CDF&G OSPR and USCG, 206 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.

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.

NOAA. 2001. Central California ESI Atlas. CD-ROM, Seattle, WA; adapted from RPI, 1994, Sensitivity of Coastal Environments and Wildlife to Spilled Oil: Central California, Columbia, SC, 41 maps +introductory text.

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.

INVERTEBRATES

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

A limited number of marine invertebrate are mapped due to broad extents of distribution and/or a lack of specific location information appropriate for this atlas and database. A few nearshore hot spots are identified for squid, an important commercial resource, and Dungeness crab females that may be in the surf zone along sandy beaches during the summer months. Beaches where pismo clams, a recreationally harvested species, occur were also highlighted. A few other bivalves are mapped in discrete areas like estuaries.

Because the California coast has very diverse tidepool and other nearshore invertebrate communities, it is not practical or possible to map the extent of all invertebrate species that may be impacted by oil spills. We attempted to show the distributions of a few species (e.g., black abalone) that are considered to be "target species" by PISCO (Partnership for Interdisciplinary Studies of Coastal Oceans, www.pisco.org) and MARINe (Multi-Agency Rocky Intertidal Network, www.marine.gov). In addition, we included a socio-economic feature called "Sampling Sites" that provides information on the locations of long-term rocky intertidal survey sites. In the event of a spill, the principal investigators may be contacted for additional information on individual sites or areas of interest. Some intertidal species have long recovery periods following oil spills.

Rare and/or listed species of gastropods and insects in coastal areas were mapped. The California Natural Diversity Database (CNDDB), provided by CDF&G, was used to supplement data from resource experts. Only species that were state and/or federally listed and records that were recent since the first draft of the Central California ESI Atlas (published in 1994) were added.

Table 3 includes some basic information on representative invertebrate species in sensitive intertidal and subtidal habitats. This is not a comprehensive list of species that occur in the area, but rather highlights key habitats and species associated with them.

Table 3. Representative invertebrate species and sensitive habitats in Central California

Common Name	Scientific Name	Habitat	Species 'Group'
Black abalone	*Haliotis cracherodii*	High intertidal zone to 6 m depth	Rocky intertidal
Red abalone	*Haliotis rufescens*	Subtidal waters to 20 m depth	Subtidal
Anenomes	*Anthopleura spp.*	Intertidal zone, tidepools	Rocky intertidal
Barnacles	Multiple species	Intertidal zone	Rocky intertidal
Owl limpet	*Lottia gigantea*	Intertidal zone	Rocky intertidal
California mussel	*Mytilus californianus*	Intertidal and subtidal zones, form beds that create habitat for other spp.	Rocky intertidal
Sea stars	Multiple species	Intertidal and subtidal zones	Rocky intertidal

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

Name	Agency	City	Phone	Species
Ken Oda	CDF&G	Monterey	831/649-2884	Marine invertebrates
Steve Lonhart	NOAA MBNMS	Monterey	831/647-4222	Marine invertebrates, PISCO
Paul Reilly	CDF&G	Monterey	831/649-2879	Marine invertebrates
Pete Raimondi	UCSC	Santa Cruz	831/459-5674	Marine invertebrates, PISCO
Sarah Allen	NPS Point Reyes NS	Point Reyes	415/464-5187	Point Reyes NS species
Christine Pattison	CDF&G	Morro Bay	805/772-0114	SLO County species
Jan Roletto	NOAA GFNMS	San Francisco	415/561-6622	GFNMS species
Melissa Boggs-Blalack	CDF&G	Morro Bay	805/772-7569	SLO County species

***Note:** this is not a comprehensive list of Central 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

CDF&G, Habitat Conservation Division, Wildlife and Habitat Data Analysis Branch. 2005. California Natural Diversity Database (CNDDB), vector digital data.

http://www.fitzgeraldreserve.org/

NOAA. 2001. Central California ESI Atlas. CD-ROM, Seattle, WA; adapted from RPI, 1994, Sensitivity of Coastal Environments and Wildlife to Spilled Oil: Central California, Columbia, SC, 41 maps +introductory text.

HABITATS

Kelp and eelgrass are mapped in this atlas.

Kelp - Kelp distribution included in this atlas is based on 1999, 2002, and 2003 digital coverages provided by CDF&G Marine Resources GIS. We joined and processed the three 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. No icons or RAR numbers are used. 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 Morro Bay and Drakes Estero.

Terrestrial plants are not specifically mapped in this atlas. "Alerts" (see human-use resources) were placed in some known locations of endangered, threatened, or rare plants or communities that may be vulnerable to oil or response activities. Please contact CDF&G and/or refer to the CNDDB for more information.

Data providers and expert contacts* for Central California habitats are:

Name	Agency	City	Phone	Species
Judd Muskat	CDF&G	Sacramento	916/324-3411	GIS – CNDDB
Sarah Allen	NPS Point Reyes NS	Point Reyes	415/464-5187	Point Reyes NS species
Jan Roletto	NOAA GFNMS	San Francisco	415/561-6622	GFNMS species
Paul Reilly	CDF&G	Monterey	831/649-2879	Kelp and associated fish species
Deborah Hillyard	CDF&G	Morro Bay	805/772-4318	Terrestrial plants

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

Major Data Sources Consulted: Habitats

CDF&G, Habitat Conservation Division, Wildlife and Habitat Data Analysis Branch. 2005. California Natural Diversity Database (CNDDB), vector digital data.

CDF&G Marine Region GIS Unit. 2003. California coastal kelp surveys: 1999, 2002, 2003, vector digital data.

Morro Bay Volunteer Monitoring Program. 2005. Eelgrass monitoring update, 1 map.

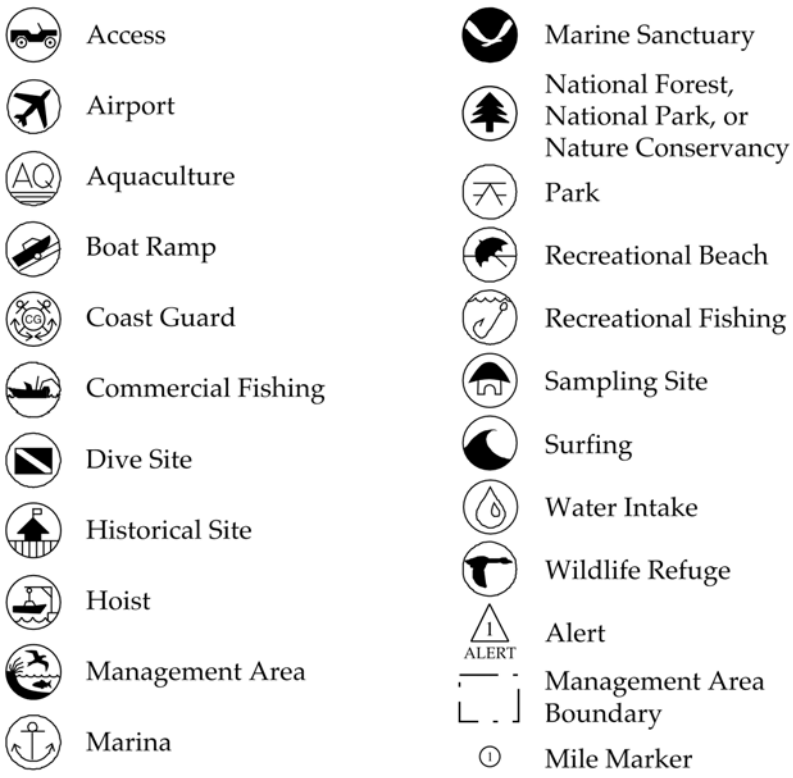
NOAA. 2001. Central California ESI Atlas. CD-ROM, Seattle, WA; adapted from RPI, 1994, Sensitivity of Coastal Environments and Wildlife to Spilled Oil: Central California, Columbia, SC, 41 maps +introductory text.

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., water intake, 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., dive sites, 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 facilities including hatcheries and oyster farms.

Boat Ramp: Location of boat ramps.

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

Commercial Fishing: Areas used for commercial fishing.

Dive Site: Location of popular dive sites.

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 National Marine Sanctuaries managed by NOAA.

Mile Marker: Mile markers in 2-mile intervals are shown on Highway 1 along the Big Sur coast as reference points. More detailed 0.1-mile intervals are available within the original data set included on the CD-ROM.

National Forest: Boundaries of National Forest lands.

National Park: Boundaries of National Park lands.

National Park Service Wilderness: Boundaries of wilderness lands managed by NPS.

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 harvesting invertebrates.

Sampling Site: Location of survey sites for scientific monitoring (e.g., PISCO sites used for intertidal community studies).

Surfing: Location of popular surfing spots.

Water Intake: Location of seawater intakes.

Wildlife Refuge: Location of wildlife refuges managed by USFWS and CDF&G.

Alert: CDF&G provided a list of "Alerts" or locations that should be highlighted for protection due to the presence of certain highly vulnerable resources. Additional "Alerts" were added to maps with similar resources that were not highlighted in the previous atlas, published in 1994. A yellow triangle representing the "Alert" is shown on the map and a description of the resource(s) of concern is provided in the table. For all maps with specific "Alerts", the following information should also be considered:

"All natural resources indicated are sensitive to the adverse effects of oil spills and response activities.

The resources highlighted on the map are ultra-sensitive to disturbance by response activities and may be harmed to a greater degree by misguided or uncoordinated response activities than by the spill itself. These impacts are avoidable if understood. Many of the plants and wildlife identified are either state or federally listed as threatened or endangered or represent wildlife populations whose numbers are declining.

Disturbance to colonial nesting seabirds by helicopters is potentially the most damaging result from spill response activities. In seconds, all eggs and young can be destroyed when the adults are flushed from a colony. 4-wheel drive vehicles and ATVs must operate with caution to avoid disturbing or destroying ground nesting birds. During the months shown, vehicles will need to be escorted until nesting areas are delineated with barrier tape and flags. Also be aware of the potential presence of sea otters when operating outboard motors, etc., in a sea otter habitat zone.

When responding in this area, be aware that uncoordinated response activities can cause great substantial damage to wildlife resources. See areas of greatest concern. Consult CDFG-OSPR, USFWS, NPS, or NOAA for details."

Major Data Sources Used: Human-Use Resources

California DOT. 1997. Airports. California Environmental Resources Evaluation System (CERES), vector digital data.

CDF&G Marine Region GIS Lab. 2005. California Marine Protected Areas, vector digital data.

CDF&G OSPR. 2005. Economic sites for counties in study area, vector digital data.

CDF&G OSPR. 2005. MBNMS boundary, vector digital data.

California Resources Agency Legacy Project. 2005. Public, conservation, and land trust ownership in the state of California, vector digital data.

NOAA. 2001. Central California ESI Atlas. CD-ROM, Seattle, WA; adapted from RPI, 1994, Sensitivity of Coastal Environments and Wildlife to Spilled Oil: Central California, Columbia, SC, 41 maps +introductory text.

NOAA MBNMS. 2005. Marine Zones, 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.

ADDITIONAL DATA SETS

Several additional data sets are included either in the atlas, offshore map, and/or on the CD-ROM as separate data layers, including:

State Operational Divisions: OSPR provided a digital coverage of state operational divisions used for oil spill response and planning by county. Figure 1 contains an image of the Central California shoreline with the ESI map index overlaid. The operational segments (numbered 1-49) correspond to pre-determined response divisions (see table in Figure 1).

Bridge Annotation: State bridges along a 75-mile portion of California State Route 1 along the Big Sur Coast are designated by points and annotated for reference. Bridge names are displayed on the maps.

Beach Names: Coastal beach names are annotated on the maps. The data were created to help standardize beach names during spill response. Beach names are displayed in the atlas.

Marine Zones: MBNMS provided digital coverages of marine zones, including: military areas, restricted overflight zones, and wildlife protection area boundaries. Marine zones are included as separate digital data layers. Restricted overflight zones are depicted on the offshore map. Wildlife protection area boundaries are included in the ESI management layer and are depicted on the maps.

Dispersant Zones: The "RRT Approval Required" zone is included as a separate digital data layer. The zone includes a 3-mile buffer along the entire California coast and the offshore extent of all National Marine Sanctuaries.

Shipping Lanes: Shipping lanes outside of the San Francisco Bay entrance are displayed on the offshore map and are included as a separate digital data layer.

Shipwrecks: Shipwreck location data was deemed to be too sensitive and not of appropriate geographical accuracy to be shown on the maps or included as a digital data layer. For more information please contact NOAA.

Beach Comber and Beach Watch: These data layers represent beach comber (MBNMS) and beach watch (GFNMS) survey segments. They were developed to visualize beach segments and

link survey data to a geographic location. They are included as separate digital data layers.

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 NOAA Monterey Bay National Marine Sanctuary (MBNMS) Sanctuary Integrated Monitoring Network (SIMoN), California Department of Fish and Game (CDF&G) Office of Spill Prevention and Response (OSPR), and the Monterey Bay Sanctuary Foundation. In addition, this project was supported by NOAA Office of Response and Restoration (OR&R), Hazardous Materials Response Division. John Tarpley (formerly of CDF&G OSPR, currently NOAA), Randy Imai (CDF&G OSPR), and Jean de Marignac (NOAA MBNMS) assisted in the coordination of the project.

The biological and human-use data included on the maps were provided by numerous individuals and agencies. Staff with NOAA (NMFS, MBNMS, GFNMS, and NCCOS), CDF&G, National Park Service (PRNS and GGNRA), UCSC (Long Marine Lab), USFWS, Moss Landing Marine Labs, USGS, Vandenberg Air Force Base, Pacific Eco Logic, Ventana Wildlife Society, PRBO, and PISCO 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. Christine Lord Boring, biologist, was Project Manager. Shoreline habitat mapping was conducted by Zach Nixon. The biological and human-use data were collected and compiled onto base maps by Christine Boring. Lee Diveley, Chris Locke, Mark White, and Katy Riggins entered, processed, and produced the GIS data and hardcopy atlas. Graphic art production was conducted by Joe Holmes. Christine Boring, Chris Locke, Mark White, 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.

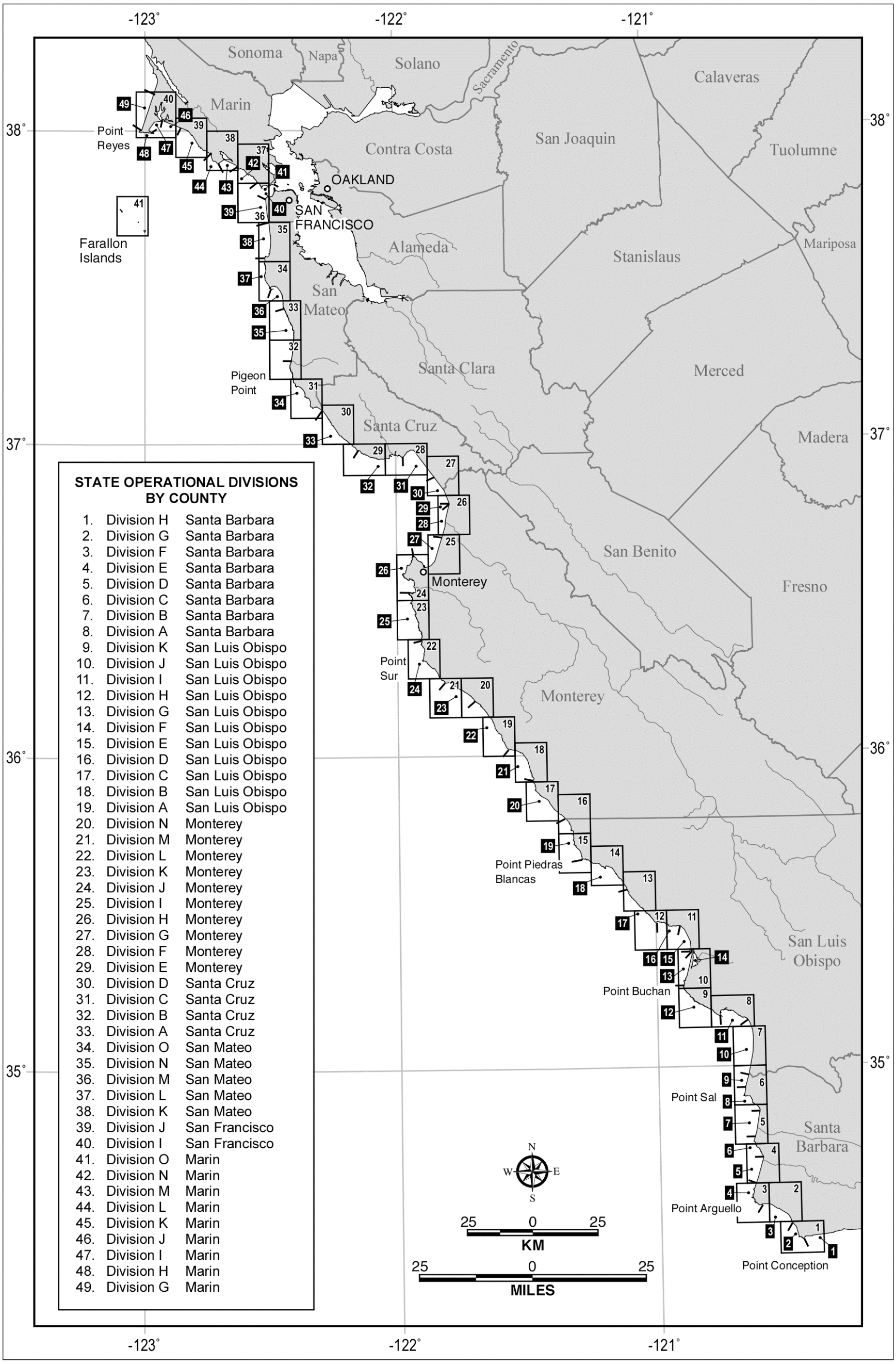


FIGURE 1. State operational divisions used for oil spill response and planning by county. Data provided by OSPR and MBNMS.

SPECIES LIST

Common Name*	Scientific Name*
BIRDS	
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*
Xantus' murrelet	*Synthliboramphus hypoleucus*
DIVING BIRD	
American white pelican	*Pelecanus erythrorhynchos*
Brandt's cormorant	*Phalacrocorax penicillatus*
Brown pelican	*Pelecanus occidentalis*
Clark's grebe	*Aechmophorus clarkii*
Cormorant	*Phalacrocorax sp.*
Diving birds	-
Double-crested cormorant	*Phalacrocorax auritus*
Eared grebe	*Podiceps nigricollis*
Grebes	-
Horned grebe	*Podiceps auritus*
Loons	*Gavia spp.*
Pelagic cormorant	*Phalacrocorax pelagicus*
Pelicans	*Pelecanus spp.*
Western grebe	*Aechmophorus occidentalis*
GULL / TERN	
California gull	*Larus californicus*
California least tern	*Sterna antillarum browni*
Caspian tern	*Sterna caspia*
Gulls	-
Terns	-
Western gull	*Larus occidentalis*
PASSERINE BIRD	
Bank swallow	*Riparia riparia*
Common yellowthroat	*Geothlypis trichas*
PELAGIC	
Ashy storm-petrel	*Oceanodroma homochroa*
Black-footed albatross	*Phoebastria nigripes*
Leach's storm-petrel	*Oceanodroma leucorhoa*
Seabirds	-
Shearwaters	-
Sooty shearwater	*Puffinus griseus*
Storm-petrels	*Oceanodroma spp.*
RAPTOR	
American peregrine falcon	*Falco peregrinus anatum*
California condor	*Gymnogyps californianus*
Osprey	*Pandion haliaetus*
Raptors	-
SHOREBIRD	
American avocet	*Recurvirostra americana*
Black oystercatcher	*Haematopus bachmani*
Black-necked stilt	*Himantopus mexicanus*
Killdeer	*Charadrius alexandrinus nivosus*
Phalaropes	*Phalaropus spp.*
Shorebirds	-
Western snowy plover	*Charadrius alexandrinus nivosus*
WADING BIRD	
American bittern	*Botaurus lentiginosus*
California black rail	*Laterallus jamaicensis coturniculus*
Wading birds	-
WATERFOWL	
Brant	*Branta bernicla*
Dabbling ducks	
Diving ducks	-
Ducks	-
Gadwall	*Anas strepera*
Geese	-
Mallard	*Anas platyrhynchos*
Scoters	*Melanitta spp.*
Surf scoter	*Melanitta perspicillata*
Waterfowl	-
White-winged scoter	*Melanitta fusca*
FISH	
FISH	
Barred surfperch	*Amphistichus argenteus*
Bat ray	*Myliobatis californica*
Black rockfish	*Sebastes melanops*
Black-and-yellow rockfish	*Sebastes chrysomelas*
Blue rockfish	*Sebastes mystinus*
Bocaccio	*Sebastes paucispinis*
Cabezon	*Scorpaenichthys marmoratus*
Calico surfperch	*Amphistichus koelzi*

Common Name*	Scientific Name*
FISH, cont.	
FISH, cont.	
California grunion	*Leuresthes tenuis*
California halibut	*Paralichthys californicus*
Canary rockfish (orange)	*Sebastes pinniger*
China rockfish	*Sebastes nebulosus*
Coho salmon	*Oncorhynchus kisutch*
Copper rockfish	*Sebastes caurinus*
English sole	*Parophrys vetulus*
Gobies	-
Gopher rockfish	*Sebastes carnatus*
Grass rockfish	*Sebastes rastrelliger*
Jacksmelt	*Atherinopsis californiensis*
Kelp rockfish	*Sebastes atrovirens*
Leopard shark	*Triakis semifasciata*
Lingcod	*Ophiodon elongatus*
Monkeyface prickleback	*Cebidichthys violaceus*
Night smelt	*Spirinchus starksi*
Northern anchovy	*Engraulis mordax*
Nursery fish	-
Olive rockfish	*Sebastes serranoides*
Pacific chub mackerel	*Scomber japonicus*
Pacific herring	*Clupea pallasii pallasii*
Pacific lamprey	*Lampetra tridentata*
Pacific sanddab	*Citharichthys sordidus*
Pacific sardine	*Sardinops sagax*
Pacific staghorn sculpin	*Leptocottus armatus*
Redtail surfperch	*Amphistichus rhodoterus*
Rockfish	*Sebastes spp.*
Rubberlip seaperch	*Rhacochilus toxotes*
Salmon	-
Shiner surfperch	*Cymatogaster aggregata*
Speckled sanddab	*Citharichthys stigmaeus*
Starry flounder	*Platichthys stellatus*
Steelhead	*Oncorhynchus mykiss*
Striped bass	*Morone saxatilis*
Striped seaperch	*Embiotoca lateralis*
Surf smelt	*Hypomesus pretiosus*
Surfperch	-
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*
Widow rockfish	*Sebastes entomelas*
Yellowtail rockfish	*Sebastes flavidus*
HABITATS	
KELP	
Kelp	-
SAV	
Eelgrass	*Zostera marina*
INVERTEBRATES	
BIVALVE	
Clams	-
Pacific littleneck	*Protothaca staminea*
Pismo clam	*Tivela stultorum*
CEPHALOPOD	
Squid	*Loligo spp.*
CRAB	
Dungeness crab	*Cancer magister*
GASTROPOD	
Black abalone	*Haliotis cracherodii*
California brackishwater snail	*Tryonia imitator*
Morro shoulderband	*Helminthoglypta walkeriana*
INSECT	
Globose dune beetle	*Coelus globosus*
Myrtle's Silverspot	*Speyeria zerene myrtleae*
INVERT	
Invertebrates	-
Tidepool invertebrates	-

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

Common Name*	Scientific Name*

MARINE MAMMALS

DOLPHIN/PORPOISE

Bottlenose dolphin	*Tursiops truncatus*
Dall's porpoise	*Phocoenoides dalli dalli*
Dolphins	-
Harbor porpoise	*Phocoena phocoena*
Long-beaked common dolphin	*Delphinus capensis*
Northern right-whale dolphin	*Lissodelphis borealis*
Pacific white-sided dolphin	*Lagenorhynchus obliquidens*
Risso's dolphin	*Grampus griseus*
Short-beaked common dolphin	*Delphinus delphis*

PINNIPED

California sea lion	*Zalophus californianus*
Guadalupe fur seal	*Arctocephalus townsendi*
Harbor seal	*Phoca vitulina*
Northern elephant seal	*Mirounga angustirostris*
Northern fur seal	*Callorhinus ursinus*
Pinnipeds	-
Sea lions	-
Seals	-
Steller sea lion	*Eumetopias jubatus*

SEA OTTER

Sea otter	*Enhydra lutris*

WHALE

Baird's beaked whale	*Berardius bairdii*
Blue whale	*Balaenoptera musculus*
Cuvier's beaked whale	*Ziphius cavirostris*
Dwarf sperm whale	*Kogia simus*
Fin whale	*Balaenoptera physalus*
Gray whale	*Eschrichtius robustus*
Humpback whale	*Megaptera novaeangliae*
Killer whale	*Orcinus orca*
Mesoplodont beaked whales	*Mesoplodon spp.*
Minke whale	*Balaenoptera acutorostrata*
Northern right whale	*Eubalaena glacialis*
Pygmy sperm whale	*Kogia breviceps*
Sei whale	*Balaenoptera borealis*
Short-finned pilot whale	*Globicephala macrorhynchus*
Sperm whale	*Physeter macrocephalus*

REPTILES / AMPHIBIANS

AMPHIBIAN

California red-legged frog	*Rana aurora draytonii*
Santa Cruz long-toed salamander	*Ambystoma macrodactylum croceum*

LIZARD

California legless lizard	*Anniella pulchra*

SNAKE

San Francisco garter snake	*Thamnophis sirtalis tetrataenia*

TURTLE

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

TERRESTRIAL MAMMALS

SMALL MAMMAL

Northern river otter	*Lontra canadensis*
Point Reyes jumping mouse	*Zapus trinotatus orarius*
Salt-marsh harvest mouse	*Reithrodontomys raviventris*

***** 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 Central 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 Central 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 Central 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

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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 Central 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 Central 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 remove
- 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

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RIPRAP **ESI = 6B**

DESCRIPTION

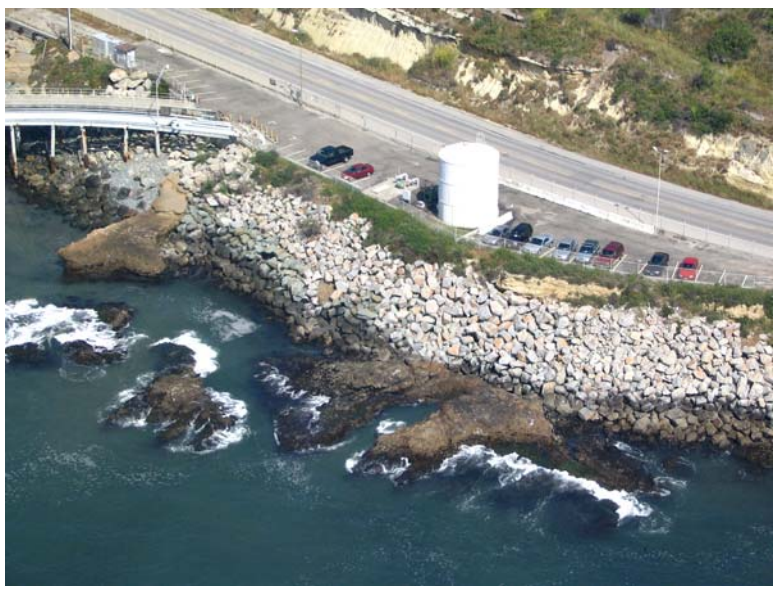
- Riprap structures are composed of cobble- to boulder-sized rock fragments
- Riprap structures are placed for shoreline protection and inlet stabilization
- Attached biota may be common at lower intertidal levels, whereas biota along the upper intertidal zones are sparse
- Relatively uncommon in Central 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



BOULDER RUBBLE **ESI = 6D**

DESCRIPTION

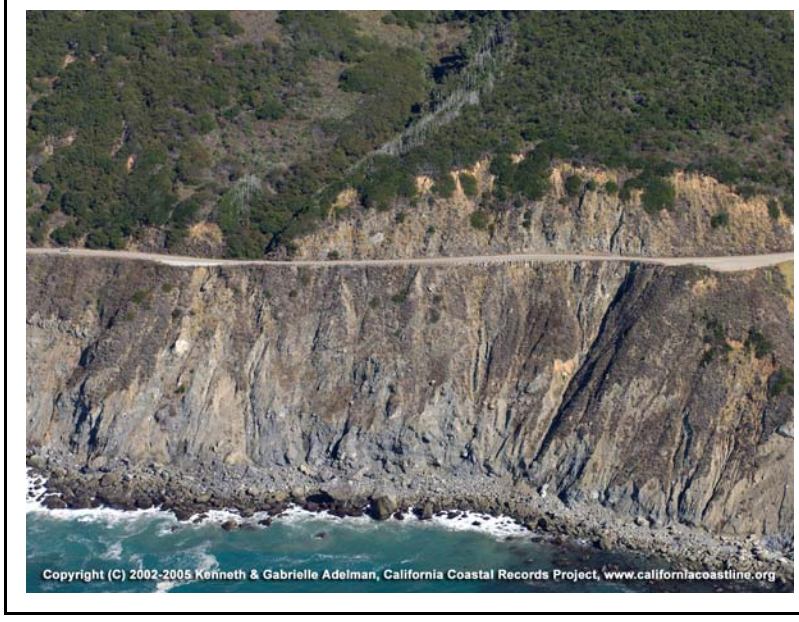
- Relatively steep rocky shores with accumulations of angular boulder rubble displaying limited evidence of re-working by waves or sediment transport
- Attached biota may be common at lower intertidal levels, whereas biota along the upper intertidal zones are sparse
- Can co-occur with gravel beaches 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 Central 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 Central 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

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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 Central 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

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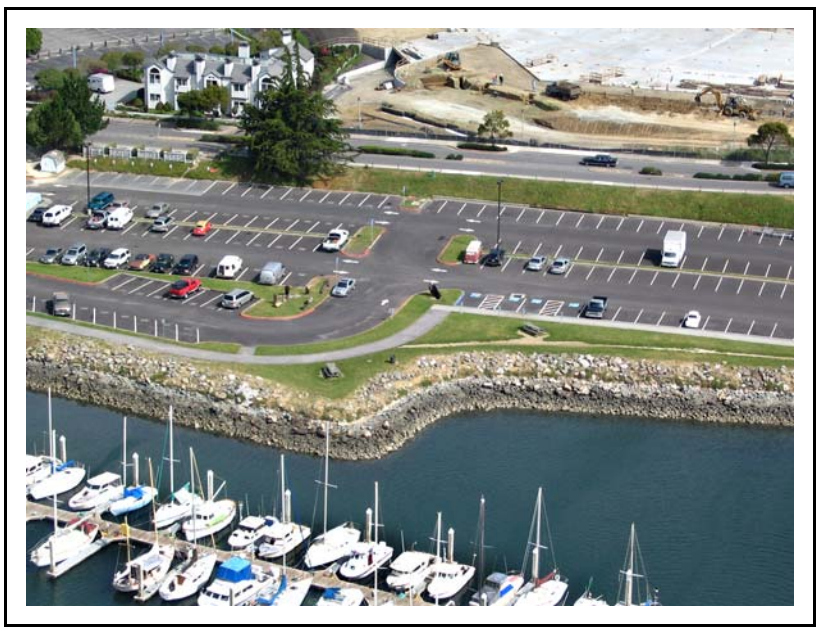
SHELTERED RIPRAP **ESI = 8C**



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 Central 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 Morro Bay, Elkhorn Slough, and Drake's Estero

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

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 Morro Bay, Elkhorn Slough, and Drake's Estero

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

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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 Central 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

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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
- This shoreline type occurs 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

PREDICTED OIL BEHAVIOR, cont.

- 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 Central 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