ENVIRONMENTAL SENSITIVITY INDEX: Southern California

INTRODUCTION

Environmental Sensitivity Index (ESI) maps have been developed for the coastal areas of Southern California from Point Conception to the Mexico border, including the Channel Islands. The ESI maps are a compilation of information from three main categories: shoreline types, sensitive biological resources, and human-use resources.

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

SHORELINE MAPPING

The shoreline habitats on the original ESI maps, published in 1994, were re-examined and updated by a coastal geologist via interpretation of a continuous, overlapping set of georeferenced oblique aerial photographs acquired in September and October 2008 (www.californiacoastline.org). The photographs were acquired during overflights conducted at elevations of 400-600 feet (1,000 feet for San Nicholas Island) and slow air speed. Where appropriate, revisions to the existing shoreline were made. Where necessary, multiple types were described for each shoreline segment.

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

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

Prediction of the behavior and persistence of oil in intertidal habitats is based on an understanding of the dynamics of the coastal environments, not just the substrate type and grain size. The intensity of energy expended upon a shoreline by wave action, tidal currents, and river currents directly affects 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 Southern California region, presented in order of increasing sensitivity to spilled oil.

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

Each shoreline type is described on pages 12-19 in terms of their physical description, predicted oil behavior, and response considerations.

In addition to the field mapped ESI shoreline types, wetland habitat types derived from 2006 National Wetlands Inventory data and wetlands previously mapped in the 1994 Southern California ESI Atlas were included in the atlas and 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 entities:

- California Department of Fish and Game (CDF&G), Office of Spill Prevention and Response (OSPR), Biogeographic Data Branch, and Marine Region
- NOAA National Marine Fisheries Service (NMFS) Southwest Fisheries Science Center (SWFSC) and NOAA National Centers for Coastal Ocean Science (NCCOS)
- U.S. Fish and Wildlife Service (USFWS)
- National Park Service (NPS)
- U.S. Geological Survey (USGS)
- U.S. Navy
- University of California Santa Barbara (UCSB)
- University of California Santa Cruz (UCSC) California Marine Life Protection Act Initiative (MLPA) (www.marinemap.org)
- Pepperdine University
- Ryan Ecological Consulting
- Avian Research Associates
- San Diego Audubon
- The Nature Conservancy (TNC)
- California State Parks (CSP)
- Numerous private ecological consultants

The above agencies and organizations provided the majority of information included in the atlas. Other participating individuals and agencies are 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.

BIRD
- Diving Bird
- Gull / Tern
- Passerine Bird
- Raptor
- Seabird
- Shorebird
- Wading Bird
- Waterfowl

MARINE MAMMAL
- Dolphin / Porpoise
- Pinniped
- Sea Otter
- Whale

TERRESTRIAL MAMMAL
- Canine / Small Mammal

REPTILE
- Amphibian / Other Reptile
- Turtle

FISH
- Fish

INVERTEBRATE
- Bivalve
- Gastropod
- Insect
- Other Invertebrates
- Shrimp

HABITAT
- Eelgrass
- Kelp
- Surfgrass
- Plant

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 and points
Terrestrial mammals	Brown vertical hatch
Fish	Blue diagonal hatch and blue arcs
Invertebrates	Orange diagonal hatch
Reptiles	Red diagonal hatch
Kelp	Light purple 'simplified wetland pattern'

Eelgrass, surfgrass	Dark or light purple 'simplified wetland patterns'
Plant	Light purple hatch
Multi-element group	Black diagonal hatch

4) There is a Resources at Risk number (RAR#) located under each icon or group of icons on a map. The RAR# identifies individual polygons, points, or arcs and references a table on the reverse side of the map with a complete list of species associated with the feature. RAR#s are generated during atlas creation and are based on a calculation. The factors that contribute to each RAR number include: the species ID # (there are over 4,000 species mapped in ESIs nationwide), the seasonality ID# (an ID number is attached to each life-history stage for each species, e.g., nesting ID#, wintering ID#, etc.), and the geographic and seasonality source ID#s (all sources used in the atlas are tracked and assigned a number in the database). Therefore, each RAR# is a unique combination, and identical polygons or points have consistent numbers throughout an atlas. A species may be repeated numerous times on a single map under different RAR#s. This is a product of the combination of species represented by that RAR#/polygon, point, or line, differences in seasonality between polygons (e.g., one may represent wintering, while another is a nest site), or differences in source data (e.g., a resource expert may have provided wintering locations while a database may have been used to depict nest locations).

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

6) For species that are found throughout general geographical areas or habitat types on certain maps, displaying the polygons for these species would cover large areas or would obscure the shoreline and biological features, making the maps very difficult to read. In these cases, a small box is shown on the map which states that the species are "Present in ..." (e.g., "Present in San Diego Bay" or "Present in Pacific Ocean"). The geographical extent of the polygons is depicted in the digital data available on the CD-ROM.

MARINE MAMMALS

Marine mammals depicted in the Southern California Atlas include selected species of dolphins, porpoises, pinnipeds (seals and sea lions), sea otters, and whales. Marine mammal distribution was mapped based on interviews with local resource experts from NOAA, NMFS, USGS, U.S. Navy, CDF&G, UCSC, NPS, private consultants, and the digital and hardcopy data sources they provided.

Cetacean distribution in the Southern California Bight – Primary, secondary, and rare occurrence zones were mapped for baleen whales, beaked and sperm whales, coastal bottlenose dolphins, gray whales, dolphins, porpoises, and small whales from Point Conception to the Mexico Border and throughout the waters of the Southern California Bight surrounding the Channel Islands. See the species list for a complete list of mapped cetacean species. The occurrence zones were defined by NMFS experts as follows:

Primary: Areas of suitable habitat where moderate to high densities of a species are expected during a given time period (e.g. core feeding areas for migratory whales, high-density regions of the range of a species that is present year-round).

Secondary: Areas of suitable habitat where low to moderate densities of a species are expected during a given time period (e.g. secondary feeding areas for migratory whales, lower-density regions of the range of a species that is present year-round).

Rare: Areas where species are not generally expected to be observed during a given time period, either because densities are very low (e.g. migratory whales, small populations, species at the edge of their range) or because the habitat is less suitable.

NMFS SWFSC provided digital data, maps, and expert knowledge on the distribution, concentrations, and seasonal presence of these species.

Pinniped haul-outs and rookeries – California sea lion (*Zalophus californianus*), harbor seal (*Phoca vitulina*), and northern elephant seal (*Mirounga angustirostris*) haul-outs and rookeries are shown. Location and concentration information for California sea lion, harbor seal, and northern elephant seal is based primarily on surveys conducted by NMFS from 2001-2008 (survey dates vary by species and location). Because of the large number of individually recorded haul outs (lat./long. locations) for numerous years of data and the scale of the ESI maps, haul outs are displayed by survey divisions, as provided by NMFS, and are shown as a buffers along sections of shoreline for the Channel Islands. These buffer polygons ensure readability of the maps and the ability to display data for pinnipeds and other species of concern on the same maps.

Depending on the recommendations for display of each data set by NMFS, numeric values used were either based on one year of data or multiple years of data. For sites surveyed over multiple years or multiple dates per season, either an average value or a range of values may be shown (e.g. 250-350 INDIV.). Within a division, the concentrations for each haul out were added to produce the sum total of animals for that division. Other, less common, pinniped species were mapped in certain areas and the location information was provided by other sources.

Sea otters – Southern sea otter (*Enhydra lutris nereis*, federally threatened) distribution is depicted on several maps in Santa Barbara County and on a few of the Channel Islands. The information was provided by USGS/UCSB and the U.S. Navy and is based on 2008 spring census data.

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

Name	Agency	City	Phone	Species
Mark Lowry	NMFS SWFSC	La Jolla	858/546-7174	Seals, sea lions
Karin Forney	NMFS SWFSC	Moss Landing	831/420-3908	Cetaceans
Jay Barlow	NMFS SWFSC	La Jolla	858/546-7178	Cetaceans
Susan Chivers	NMFS SWFSC	La Jolla	858/546-7093	Cetaceans
Elizabeth Becker	NMFS SWFSC	Santa Barbara	805/680-3374	Cetaceans/ GIS
Tim Tinker	UCSC Long Marine Lab	Santa Cruz	831/459-2357	Sea otters
Bob Schallman	U.S. Navy	Seal Beach	562/626-7290	U.S. Navy property resources
Natalie Senyk	CINMS	Santa Barbara	805/966-7107	CINMS resources

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

Major Data Sources Consulted: Marine Mammals

CDF&G, OSPR and Department of Homeland Security, U.S. Coast Guard. 2008. 2008 USCG Sector San Diego Area Contingency Plan (ACP). Volume 1: Sections 1000-9700 for the San Diego Area Committee – ACP 6. CDF&G OSPR and USCG.

Koski, W.R., J.W. Lawson, D.H. Thomson, and W.J. Richardson. 1998. Point Mugu Sea Range Marine Mammal Technical Report. Naval Air Warfare Center Weapons Division, Point Mugu, CA, 281 pp. + appendices.

Lowry, M. 2009. California sea lion, northern elephant seal, and harbor seal haul-out locations: 2001-2008. NOAA NMFS, La Jolla, CA, tabular digital data.

NOAA NMFS SWFSC. 2009. Primary, secondary, and rare occurrence zones for dolphins, baleen whales, beaked and sperm whales, gray whales, and coastal bottlenose dolphins in the Southern California Bight, 5 unpublished maps.

USGS. 2008. Sea otter spring census 2008. USGS Western Ecological Research Center, San Simeon, CA, vector digital data.

TERRESTRIAL MAMMALS

A few sensitive species of terrestrial mammals are mapped in limited locations in this atlas, including foxes and a skunk endemic to the Channel Islands, two species of mice, and a jackrabbit. Location information was provided by consultants, USFWS, TNC, the California Natural Diversity Database (CNDDB), and the Area Contingency Plans.

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

Name	Agency	City	Phone	Species
Brian Foster	Avian Research Associates	San Diego	619/887-7372	San Diego County species
Don Brubaker	USFWS	Carlsbad	619/468-9245	NWR species
Lotus Vermeer	TNC	Ventura	805/642-0345 x 504	Santa Cruz Isl. species

***Note:** this is not a comprehensive list of Southern California terrestrial mammal experts. Contact state and federal agencies,

universities, and other appropriate entities in the event of an incident.

Major Data Sources Consulted: Terrestrial Mammals

CDF&G, Biogeographic Data Branch. 2009. California Natural Diversity Database (CNDDB), vector digital data.

CDF&G, OSPR and Department of Homeland Security, U.S. Coast Guard. 2008. 2008 USCG Sector San Diego Area Contingency Plan (ACP). Volume 1: Sections 1000-9700 for the San Diego Area Committee – ACP 6. CDF&G OSPR and USCG.

U.S. Fish and Wildlife Service. 1998. Pacific Pocket Mouse (*Perognathus longimembris, pacificus*) Recovery Plan. Portland, OR. 112 pp.

Zeiner, D.C., W.F. Laudenslayer Jr., K.E. Mayer, and M. White. 1990. Life history accounts for species in the California Wildlife Habitat Relationships (CWHR) System. California's Wildlife. Vol. I-III. California Department of Fish and Game, Sacramento, CA.

BIRDS

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

Bird concentration areas are based on information gathered at workshops with local resource experts from USFWS, U.S. Navy, CDF&G, CSP, Ryan Ecological Consulting, Avian Research Associates, NOAA, San Diego Audubon, NPS, and various other private consultants and volunteers. Additional hardcopy and digital sources are listed below and are included in the metadata accompanying the CD-ROM.

Seabirds, diving birds, gulls, terns and sea ducks - Several species of alcids (e.g., auklets, guillemots, puffin, murrelets), diving birds (e.g., cormorants, grebes, pelicans, loons), gulls, terns, pelagic birds (e.g., storm-petrels, shearwaters), and sea ducks (e.g., scaup, scoters) have been observed coastally and at-sea off southern California. During three aerial surveys conducted in 2007, 54 species and over 135,000 individuals were recorded, and it is estimated that over one million seabirds may be utilizing these habitats annually, which may actually indicate a decline in total numbers over the last two decades (Mason et. al., 2007). To capture this important information, species are mapped in zones at varying distances from mainland and island shorelines, based on observed habitat usage by species, such as within 0.5-mile, 1-mile, 2-miles, and 10-miles of shore and offshore. In addition, waterfowl, gulls, terns, and diving birds were mapped in estuaries, harbors, on breakwaters, in wetlands, and in other critical areas where they congregate seasonally or reside year-round.

Brown pelican – California brown pelican (*Pelicanus occidentalis californicus*) has been state delisted, as of June 2009. Brown pelican (*Pelicanus occidentalis)* has been federally delisted, as of November 2009. Pelicans are common residents of the southern California coastline and Channel Islands (USFWS, 2009). Communal roost sites are shown along the mainland coast, and the tables include a numeric range of birds observed at each roost based on surveys conducted from 1991-2007. U.S. breeding colonies are restricted to West Anacapa Island and Santa Barbara Island.

Western snowy plovers, California least terns, and shorebirds – 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. Data for snowy plover wintering and nesting concentrations were based on survey data collected between 2003 and 2009 by numerous consultants and volunteers. California least tern (*Sterna antillarum browni,* state and federally endangered) breeding and roosting habitat locations were provided by various resource experts. In particular, the USFWS provided breeding information from 2008. Migratory shorebirds stage in the intertidal zone, along beaches, in marshes, and on tidal flats in certain areas during fall and spring. While fall and spring are the key migratory periods, some species overwinter and/or are present during the summer. South San Diego Bay is a Western Hemispheric Shorebird Reserve Network (WHSRN) site of regional importance.

Nesting colonies – Locations of seabird colonies are mapped. Colony locations were available via the UCSB MLPA database (www.marinemap.org) for the majority of well-known sites that have been surveyed by USFWS and other entities beginning prior to 1980. Additional site location (lat./long. coordinates) and colony size data were provided by Glenn Ford via the 1992 Carter et. al 2-volume unpublished report entitled 'Breeding populations of seabirds in California, 1989-1991.' These data were supplemented with publications provided by UCSC which contained updated colony counts for selected species (e.g., Brandt's (*Phalacrocorax penicillatus*), double-crested (*Phalacrocorax auritus*), and pelagic cormorants (*Phalacrocorax pelagicus*). Other colony numbers were updated for various species based on surveys conducted within the last few years at select locations (e.g., the Channel Islands). In most cases, breeding sites are shown as a buffer along the coast. In cases where there are individual nest points mapped, users should be advised that the points are a representative location, and nests may be found in the vicinity of the point.

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.

Raptors – Information on the distribution of select raptors was included, specifically for peregrine falcon (state delisted in November 2009), bald eagle (federally delisted in August 2007, state endangered at the date of publication of this atlas, but under review for delisting), and osprey. Little specific information was available regarding nesting and roosting locations for these species, so their general distribution is mapped throughout the study area.

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 Southern California ESI Atlas.

Assemblage	Species Examples
Seabirds	Auklets, murrelets, guillemots, puffins, storm-petrels, shearwaters, fulmars, etc.
Diving birds	Pelicans, cormorants, grebes, loons, etc.
Raptors	Kestrel, eagle, owls, hawks, merlin, harrier, osprey, falcon, kite, etc.
Shorebirds	Avocet, oystercatcher, turnstones, plovers, stilt, dowitchers, dunlin, yellowlegs, killdeer, sandpipers, curlew, godwit, phalaropes, knot, sanderling, surfbird, tattler, whimbrel, willet, etc.
Wading birds	Herons, egrets, rails, sora, etc.
Waterfowl	Brant, geese, coot, diving ducks, dabbling ducks, sea ducks, etc.
Dabbling ducks	Mallard, gadwall, wigeon, teals, shoveler, pintail, etc.
Diving ducks	Canvasback, scaup, scoters, bufflehead, merganser, redhead, ruddy duck, etc.
Sea ducks	Scaup, scoters, etc.
Gulls	Bonaparte's, California, glaucous-winged, Heermann's, mew, ring-billed, western, etc.
Terns	California least, Caspian, common, elegant, Forster's, gull-billed, least, royal, 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) or a range of numeric values (e.g., 200-400 BIRDS or PAIRS or NESTS). 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., rare, common, very high). The density terminology is considered to be relative to each individual species. It was not always possible to use numeric values because of variability between seasons and years. Please contact the local resource experts for further clarification in the event of an incident.

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

Name	Agency	City	Contact	Species
Harry Carter	Carter Biological Consulting	Victoria, BC	250/370-7031	Seabird colonies
R. Glenn Ford	R.G. Ford Consulting	Portland, OR	503/287-5173	Seabird colonies
Jennifer Boyce	NOAA	Long Beach	562/980-4086	Brown pelican
Chris Delith	USFWS	Ventura	805/644-1766	T/E species
Gerry McChesney	USFWS	Newark	510/792-0717	Seabird colonies
Elizabeth Copper	Avian Research Assoc.	San Diego	619/248-9154	San Diego County birds
Phil Capitolo	UCSC	Santa Cruz	pcapito@ucsc.edu	Cormorants
David Pryor	CSP	San Clemente	949/497-1421	State Park resources

Tom Ryan	Ryan Ecological Consulting	Pasadena	949/923-8224	Snowy plover
Bob Schallman	U.S. Navy	Seal Beach	562/626-7290	U.S. Navy resources
Brian Foster	Avian Research Assoc.	San Diego	619/887-7372	San Diego County birds
Shauna Wolf	Avian Research Assoc.	San Diego	858/695-6604	San Diego County birds
Reed Smith	Audubon Society	Ventura	805/407-7070	Snowy plover and least tern
Jim Peugh	San Diego Audubon	San Diego	619/224-4591	San Diego County birds
Dave Povey	San Diego Audubon	San Diego	dpovey@nethere.com	Offshore birds
Dan Richards	NPS	Ventura	805/658-5760	Channel Islands
John Mason	USGS and UC Davis	Sacramen-to	530/752-0485	Offshore birds

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

Major Data Sources Consulted: Birds

Capitolo, P.J., J.N. Davis, L.A. Henkel, W.B. Tyler, and H.R. Carter. 2008. Aerial photographic surveys of breeding colonies of Brandt's, Double-crested, and Pelagic Cormorants in southern California, 2005-07. Unpub. report, University of California, Institute of Marine Sciences, Santa Cruz, California, 49 pp.

Carter, H.R., G.J. McChesney, D.L. Jaques, C.S. Strong, M.W. Parker, J.E. Takekawa, D.L. Jory, and D.L. Whitworth. 1992. Breeding Populations of Seabirds in California, 1989-1991. Volume I – Population Estimates. Volume II – Colony Maps and Appendices. Draft Final Report. U.S. Fish and Wildlife Service, Point Reyes Bird Observatory, and Channel Islands National Park. Vol. I – 492 pp., Vol. II – 327 pp.

CDF&G, Biogeographic Data Branch. 2009. California Natural Diversity Database (CNDDB), vector digital data.

CDF&G, OSPR and Department of Homeland Security, U.S. Coast Guard. 2008. 2008 USCG Sector San Diego Area Contingency Plan (ACP). Volume 1: Sections 1000-9700 for the San Diego Area Committee – ACP 6. CDF&G OSPR and USCG.

CDF&G, OSPR and Department of Homeland Security, U.S. Coast Guard. 2008. Volume I: Area Contingency Plan (ACP) Sector Los Angeles/Long Beach (Northern-ACP4 & Southern Sector – ACP5). CDF&G OSPR and USCG.

Cooper, D.S. 2006. Annotated checklist of extirpated, reestablished, and newly colonized avian taxa of the Ballona Valley, Los Angeles County, California. Bull. Southern California Acad. Sci. 105(3), pp. 91-112.

Lentz, J.E. 2006. Introduction to Birds of the Southern California Coast. University of California Press, Berkeley, 316 pp.

Mason, J.W., G.J. McChesney, W.R. McIver, H.R. Carter, J.Y. Takekawa, R.L. Golightly, J.T. Ackerman, D.L. Orthmeyer, W.M. Perry, J.L. Yee, M.O. Pierson, and M.D. McCrary. 2007. At-Sea Distribution and Abundance of Seabirds Off Southern California: A 20-Year Comparison. Studies in Avian Biology No. 33. A Publication of the Cooper Ornithological Society. 101 pp.

NOAA National Centers for Coastal Ocean Science (NCCOS) 2005. A Biogeographic Assessment of the Channel Islands National Marine Sanctuary: A Review of Boundary Expansion Concepts for NOAA's National Marine Sanctuary Program. Silver Spring, MD. NOAA Technical Memorandum NOS NCCOS 21. 215 pp.

Ryan Ecological Consulting, Los Angeles Audubon, and Santa Monica Bay Audubon. 2008. Working Draft: The Western Snowy Plover in Los Angeles County, California: 2008 Annual Report (January-September). Prepared for the California Department of Fish and Game Office of Spill Prevention and Response. 33 pp. + appendices.

Shuford, W.D. and T. Gardali, eds. 2008. California Bird Species of Special Concern: A ranked assessment of species, subspecies, and distinct populations of birds of immediate conservation concern in California. Studies of Western Birds 1. Western Field Ornithologists, Camarillo, California, and California Department of Fish and Game, Sacramento.

U.S. Fish and Wildlife Service. 2009. Atlas of California brown pelican roost sites on the southern California mainland. Technical Report CFWO-EC 2009-1. U.S. Fish and Wildlife Service, Carlsbad, CA. 61 pages + appendices.

U.S. Fish and Wildlife Service. 2007. Recovery Plan for the Pacific Coast Population of the Western Snowy Plover (*Charadrinus alexandrines nivosus*). In 2 volumes. Sacramento, California. xiv + 751 pp.

Whitworth, D.L., H.R. Carter, J.S. Koepke, and F. Gress. 2008. Nest monitoring of Xantus's murrelets at Anacapa Island, California: 2007 annual report. Unpublished report, California Institute of Environmental Studies, Davis, California (prepared for the American Trader Trustee Council and Channel Islands National Park). 33 pp.

Zeiner, D.C., W.F. Laudenslayer, Jr., K.E. Mayer, and M. White, eds. 1988-1990. California's Wildlife. Vol. I-III. California Dept. of Fish and Game, Sacramento, California.

REPTILES and AMPHIBIANS

Oceanic distributions of leatherback (*Dermochelys coriacea*, federally endangered) and loggerhead (*Caretta caretta*, federally threatened) sea turtles are mapped in this atlas. Leatherbacks gain access to central California foraging areas (north of Point Conception) by passing through the Southern California Bight during the late spring - early summer (March-July) (S. Benson, NOAA, pers. comm.). A few turtles move north through the northern Channel Islands. These turtles are primarily returning individuals that occupied coastal central California foraging grounds during the previous summer/fall and moved into the inter-tropical convergence zone during winter (~5-10 degrees north latitude) before turning back towards the California coast (apparently not ready to nest in New Guinea). Most have not been observed near the immediate coast, but instead track west of the Channel Islands. The probability of turtles stopping is greater north of Point Vicente. If jellyfish densities occur in the Southern California Bight (most likely in nearshore waters; seasonal aggregations are more likely to occur north of Point Vincente near the northern Channel Islands), turtles may use these areas for foraging, although not necessarily for prolonged periods.

Loggerheads are rare in Southern California waters, and are observed more frequently during El Nino years (typically January and August) (T. Fahy, NOAA, pers. comm.). It is also possible that that there is an influx of loggerheads from Mexican waters during warm water events (J. Seminoff, NOAA NMFS, pers. comm.). There are resident green sea turtles (*Chelonia mydas*, federally threatened) in San Diego Bay, Mission Bay, and Alamitos Bay, particularly in areas adjacent to power plants where there is warm water effluent (NOAA NMFS, pers. comm.).

In addition, a few sensitive terrestrial and freshwater/brackishwater species are mapped (see species list). Reptile and amphibian concentration areas are mapped based on interviews with resource experts from the U.S. Navy, USFWS, NOAA NMFS, and CDF&G. The CNDDB was used to supplement data from resource experts.

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

Name	Agency	City	Phone	Species
Scott Benson	NMFS	Moss Landing	831/771-4354	Sea turtles
Tina Fahy	NMFS	Long Beach	562/980-4023	Sea turtles
Peter Dutton	NMFS	La Jolla	858/546-5636	Sea turtles
Jeff Seminoff	NMFS	La Jolla	858/546-7152	Sea turtles
Chris Delith	USFWS	Ventura	805/644-1766	T/E species
Bob Schallman	U.S. Navy	Seal Beach	562/626-7290	U.S. Navy resources
Jennifer Gold	CDF&G OSPR	Santa Barbara	805/450-8695	SB County and OC resources
Jon Avery	USFWS	Carlsbad	760/431-9440 x 309	USFWS species

*__Note:__ this is not a comprehensive list of Southern 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, OSPR and Department of Homeland Security, U.S. Coast Guard. 2008. Volume I: Area Contingency Plan (ACP) Sector Los Angeles/Long Beach (Northern-ACP4 & Southern Sector – ACP5). CDF&G OSPR and USCG.

CDF&G, Biogeographic Data Branch. 2009. California Natural Diversity Database (CNDDB), vector digital data

NOAA, NMFS. 2001. Figure 10. Southern closure drift gillnet closed area for months of January and August during El Nino years. *In* Environmental assessment on the implementation of the reasonable and prudent alternative on the issuance of the marine mammal permit under section 101(a)(5)(E) of the Marine Mammal Protection Act for the California/Oregon drift gillnet fishery. NOAA NMFS.

FISH AND COMMERCIAL/RECREATIONAL FISHERIES

A small number of ecologically sensitive and unique fish species were mapped in this atlas. Life histories of key species are described below. In addition, a grid system was used to map commercial and recreational fisheries throughout the Southern California Bight. Data providers included USFWS, UCSB, CSP, Avian Research Associates, Pepperdine University, and CDF&G.

Tidewater goby - Tidewater goby (*Eucyclogobius newberryi*, federally endangered) inhabit waters of brackish, shallow, coastal lagoons, estuaries, marshes, river mouths, and lower stream reaches. Water bodies documented by USFWS as occupied by gobies are mapped. Gobies have been documented in approximately 60 locations in the study area, accounting for nearly half of all reported locations in California.

Anadromous populations – The Southern California Steelhead (*Oncorhynchus mykiss*) Distinct Population Segment (federally endangered) includes all naturally spawned populations residing below natural and manmade impassable barriers in streams from San Luis Obispo County south to the U.S.-Mexico Border. Populations within this region have declined dramatically compared to historical occurrences. Populations from over half of the watersheds once supporting steelhead are thought to be extirpated, and the largest rivers have experienced 90% declines in run sizes. Expert knowledge on potential occurrences was used to map steelhead in this atlas.

California grunion – California grunion (*Leuresthes tenuis*) are endemic to the California and Baha California coasts with 90% of the population residing in San Diego, Orange, and Los Angeles Counties (Martin, 2006). Grunion have unique spawning behavior; they come completely out of the water to lay their eggs on sandy beaches. Shortly after high tide, after the new or full moon, sections of spawning beaches may be covered with thousands of fish. Some of the largest, most consistent grunion runs occur in Orange County. Heaviest runs in Southern California are usually in April through June. Data on spawning beaches and run size and consistency were provided by Karen Martin (Pepperdine) and the UCSB MLPA data set (K. Martin was the originator of this spatial data set).

Commercial and recreational fisheries – Commercial and recreational fisheries were mapped in a unique way in the Southern California ESI Atlas. OSPR fisheries biologists selected a list of species of commercial and recreational importance and described the months each fishery is typically open annually in Southern California waters. The distribution of species was mapped via a grid/block system covering the Southern California Bight. In the original data, each species was mapped on either a 1 km x 1 km or a 10 km x 10 km block (the data were made available through the MLPA program). For simplicity, in this atlas a fishery was mapped based on presence/absence criteria within a 10 km block. Specific data on landings per block were not included. Within each block there is an icon (black and white with three fish) with a number underneath. The number corresponds to the table on the back of the map where all fisheries that are present within that block are listed with the dates of the open fishery.

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

Name	Agency	City	Phone	Species
Mike Connell	OSPR	Santa Barbara	805/568-1229	Fisheries
Corey Kong	OSPR	Los Alamitos	562/598-6203	Fisheries
Robin Lewis	OSPR	San Diego	858/467 4215	Fisheries
Karen Martin	Pepperdine	Malibu	310/506-4808	Grunion
Chris Delith	USFWS	Ventura	805/644-1766	Goby, steelhead
Jack Engle	UCSB	Santa Barbara	805/893-8547	Rocky intertidal communities
David Pryor	CSP	San Clemente	949/497-1421	State Park resources
Brian Foster	Avian Research Assoc.	San Diego	619/887-7372	San Diego County resources
Eric Kirschner	USFWS	Carlsbad	760/431-9440	USFWS species
Jon Avery	USFWS	Carlsbad	760/431-9440 x 309	USFWS species, tidewater goby
Missy Kroninger	CDF&G OSPR	Los Alamitos	562/598-2849	LA and Orange County Species

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

Major Data Sources Consulted: Fish

CDF&G. 2001. California's Living Marine Resources: A Status Report. California Department of Fish and Game. 550 pp. + appendices.

CDF&G, OSPR and Department of Homeland Security, U.S. Coast Guard. 2008. Volume I: Area Contingency Plan (ACP) Sector Los Angeles/Long Beach (Northern-ACP4 & Southern Sector – ACP5). CDF&G OSPR and USCG.

Drill, S. 2009. Southern California Species Profiles. UC Cooperative Extension Natural Resources Program. Los Angeles and Ventura Counties. Arroyo chub. 2 pp.

Martin, K. 2006. Introduction to Grunion Biology. Grunion.org. 5 pp.

UCSB MLPA. 2009. Grunion spawn, vector digital data.

UCSB MLPA. 2009. MLPA_CPFV (various species), vector digital data.

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

INVERTEBRATES

Invertebrates depicted in this atlas include selected intertidal, subtidal, and terrestrial species. Recreationally harvested species (e.g., pismo clams, mussels, cockles, chiones, littlenecks), and those of ecological and/or conservation interest (e.g., abalone) were emphasized. Invertebrate distributions are based on information gathered at workshops with the U.S. Navy, UCSB, USFWS, CDF&G and the digital and hardcopy data they provided.

Rare and/or listed species of invertebrates (e.g., black abalone, federally endangered as of February 2009; white abalone, federally endangered; and riverside and San Diego fairy shrimps, both federally endangered) in coastal areas were mapped. The California Natural Diversity Database (CNDDB), provided by CDF&G, was used to supplement data from resource experts.

Commercial and recreational invertebrate harvest – Commercial and recreational fisheries (finfish and invertebrates) were mapped in a unique way in the Southern California ESI Atlas. OSPR fisheries biologists selected a list of species of commercial and recreational importance and described the months each fishery is typically open annually in Southern California waters. The distribution of species was mapped via a grid/block system covering the Southern California Bight. In the original data, each species was mapped on either a 1 km x 1 km or a 10 km x 10 km block (the data were made available through the MLPA program). For simplicity in this atlas, a fishery was mapped based on presence/absence criteria within a 10 km block. Specific data on landings per block were not included. Within each block there is an icon (black and white with three fish) with a number underneath. The number corresponds to the table on the back of the map where all fisheries that are present within that block are listed with the dates of the open fishery.

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

Name	Agency	City	Phone	Species
Dave Ono	CDF&G	Santa Barbara	805/568-1221	Clams, mussels, etc.
Jack Engle	UCSB	Santa Barbara	805/893-8547	Rocky intertidal communities
Travis Buck	CDF&G	San Diego	858/467-4214	Clams, mussels, etc.
Derek Lerma	Tierra Data Inc.	San Diego	760/749-3885	U.S. Navy resources
Robin Lewis	OSPR	San Diego	858/467 4215	Fisheries
Missy Kroninger	CDF&G OSPR	Los Alamitos	562/598-2849	LA and Orange County

				Species
Mike Connell	OSPR	Santa Barbara	805/568-1229	Fisheries
Corey Kong	OSPR	Los Alamitos	562/598-6203	Fisheries

*__Note:__ this is not a comprehensive list of Southern 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, Biogeographic Data Branch. 2009. California Natural Diversity Database (CNDDB), vector digital data.

CDF&G. 2001. California's Living Marine Resources: A Status Report. California Department of Fish and Game. 550 pp. + appendices.

CDF&G, OSPR and Department of Homeland Security, U.S. Coast Guard. 2008. Volume I: Area Contingency Plan (ACP) Sector Los Angeles/Long Beach (Northern-ACP4 & Southern Sector – ACP5). CDF&G OSPR and USCG.

National Marine Fisheries Service. 2008. White Abalone Recovery Plan (*Haliotis sorenseni*). National Marine Fisheries Service, Long Beach, CA.

UCSB MLPA. 2004. Crane_2004_abalone, vector digital data.

U.S. Navy. 2009. Black_abalone_model, vector digital data.

U.S. Navy. 2009. White_abalone_model, vector digital data.

HABITATS

Kelp, eelgrass, surfgrass, and selected plants of special concern are mapped in this atlas. Habitat information was provided by experts from the following agencies: CDF&G, USFWS, CSP, Ryan Ecological Consulting, U.S. Navy, UCSB, Santa Barbara ChannelKeeper, and NOAA.

Kelp - Kelp distribution included in this atlas is based on 1999, 2002, 2003, 2004, 2005, and 2006 digital coverages provided by CDF&G Marine Region. We joined and processed the six 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. Icons and RAR#s are not used for the kelp data. The kelp canopy is most often present from March to November. Storms often knock down the plants during winter months.

Eelgrass – Eelgrass and surfgrass are mapped in several locations (e.g., San Diego Bay, nearshore waters, estuaries, Channel Islands). Data for most of the eelgrass and surfgrass mapped were extracted from the UCSB MLPA program data (www.marinemap.org). Data for the Channel Islands was provided by the Santa Barbara ChannelKeeper and the Channel Islands NMS and were collected by diver and kayak off of three islands.

Plants - Terrestrial plants are not specifically mapped throughout the atlas. Selected sensitive species that were highlighted by resource experts were included. The CNDDB was used to supplement data from resource experts, but only for specific species highlighted by the experts, and only recent records were included.

Data providers and expert contacts* for Southern California habitats and plants are:

Name	Agency	City	Contact	Species
Chris Delith	USFWS	Ventura	805/644-1766	T/E species
Jack Engle	UCSB	Santa Barbara	805/893-8547	Rocky intertidal communi-ties
David Pryor	CSP	San Clemente	949/497-1421	State Park resources
Tom Ryan	Ryan Ecological Consulting	Pasadena	949/923-8224	Snowy plover
Bob Schallman	U.S. Navy	Seal Beach	562/626-7290	U.S. Navy resources
Eric Kirschner	USFWS	Carlsbad	760/431-9440	USFWS resources
Don Brubaker	USFWS	Carlsbad	619/468-9245	NWR species
Missy Kroninger	CDF&G OSPR	Los Alamitos	562/598-2849	LA and Orange County Species
Gjon Hazard	USFWS	Carlsbad	760/431-9440 x 287	USFWS resources
Natalie Senyk	CINMS	Santa Barbara	805/966-7107	CINMS resources
Jessie Allstat	Santa Barbara Channel-keeper	Santa Barbara	jessie@sbck.org	Eelgrass

*__Note:__ this is not a comprehensive list of Southern California habitat and plant experts. Please contact state and federal agencies, universities, and other appropriate entities in the case of an incident.

Major Data Sources Consulted: Habitats

CDF&G, Biogeographic Data Branch. 2009. California Natural Diversity Database (CNDDB), vector digital data

CDF&G. 2007. 2006 kelp canopy for Southern California, vector digital data.

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

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

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

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

CDF&G, OSPR and Department of Homeland Security, U.S. Coast Guard. 2008. Volume I: Area Contingency Plan (ACP) Sector Los Angeles/Long Beach (Northern-ACP4 & Southern Sector – ACP5). CDF&G OSPR and USCG.

Littler, M.M., D.S. Littler, and Woodward-Clyde Consultants. 1982. Surf Grass Along the California Coast, vector digital data.

NOAA NOS NCCOS CCMA Biogeography Team. 2006. Seagrass distribution off California, vector digital data.

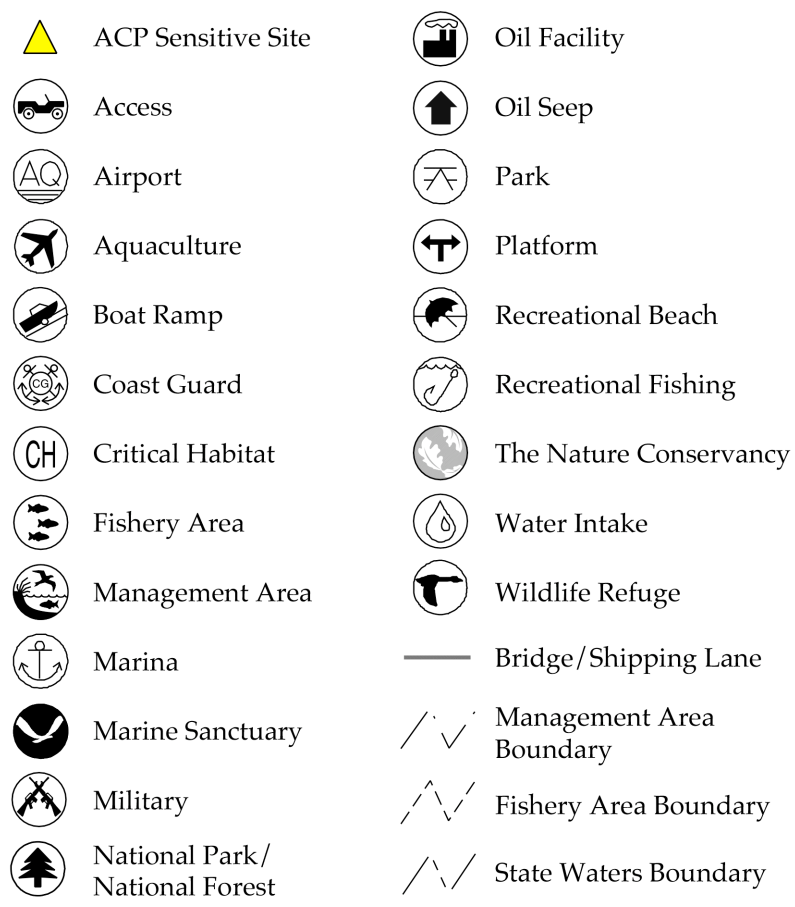
Santa Barbara Channelkeeper. 2009. Northern Channel Islands eelgrass beds, vector digital data.

The Nature Conservancy. 2004. California eelgrass, vector digital data.

HUMAN-USE RESOURCES

Management areas such as national marine sanctuaries, wildlife refuges, and critical habitats 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., access point, 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., fisheries, 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.



ACP (Area Contingency Plan) Sensitive Sites: ACP Sensitive Sites represent Environmentally Sensitive Sites described in detail in the ACPs for Santa Barbara, Ventura, Los Angeles, Orange, and San

Diego Counties. An example site number, shown under a yellow triangle on the ESI maps, is 4-800-A. The 4 represents the ACP number, the 800 is the site number, and the A is the site ranking. Category A sites are 'extremely sensitive' and are first priority for protection, category B sites are 'very sensitive' and a second priority for protection, and category C sites are 'sensitive' and a third priority for protection. Location information for the 2008 ACP sensitive sites was provided by OSPR. State Operational Divisions by county are displayed in Figure 1. For more detail on ACP sensitive sites, access sites, and operational divisions, the complete Area Contingency Plans by county are available on the CDF&G website at: http://www.dfg.ca.gov/ospr/response/acp/marine_acp.html.

Access: Sites where beach access is possible. These sites were included as part of the Area Contingency Plan and provided by OSPR.

Airport: Location of airports, airfields, landing strips, helipads, etc., whether they are manned or unmanned. Airport locations were mapped by CALTRANS and provided by OSPR.

Aquaculture: Location of aquaculture facilities. A limited number of facilities were shown, and locations were provided by CDF&G.

Boat Ramp: Location of boat ramps. Location data were extracted from the UCSB MLPA (www.marinemap.org).

Coast Guard: Location of U.S. Coast Guard stations. USCG stations were mapped in the previous atlas and were maintained in the update.

Critical Habitat: Designated Critical Habitat for western snowy plover, steelhead, California red-legged frog, riverside fairy shrimp, San Diego fairy shrimp, arroyo toad, least bell's vireo, spreading navarretia, and Ventura marsh milk-vetch were mapped. Critical habitat boundaries were downloaded from http://criticalhabitat.fws.gov/.

Fishery Area: Fisheries are mapped using a grid system in the Southern California Bight. Please see the fish and invertebrates sections earlier in the document for further details.

Management Area: Locations of coastal CDF&G managed properties such as estuarine reserves (ER). The data were provided by CDF&G Owned Lands.

Marina: Location of marinas. Data for marinas were provided by OSPR.

Marine Sanctuary: Boundaries of the Channel Islands National Marine Sanctuary. The NOAA National Marine Sanctuaries Program provided the digital coverage.

Military: Boundaries for select military properties were mapped and provided by the U.S. Navy.

National Forest: Boundaries of National Forest lands.

National Park: Boundaries of National Park lands. The coverage was provided by the NPS.

Oil Facilities: Locations of coastal oil facilities. Locations were provided by OSPR.

Oil Seep: Oil seeps occur naturally along the coast of California, particularly in the Santa Barbara Channel near Coal Oil Point. Oil seep location data were extracted from the UCSB MLPA database.

Park: Boundaries of parks, beaches, recreation areas, natural preserves, natural reserves, and historic parks managed by California State Parks.

Platform: Locations of oil platforms offshore of California. The data were provided by OSPR.

Recreational Beach: Locations of recreational beaches where activities such as swimming, water sports, beach combing, etc. occur. Some may be State parks. Data sources are varied.

Recreational Fishing: Locations of public fishing piers. The data were provided by CDF&G Marine Region.

The Nature Conservancy: Boundaries of Nature Conservancy Land on Santa Cruz Island.

Water Intake: Location of seawater intakes. Water intakes were mapped in the previous atlas and were maintained for the update.

Wildlife Refuge: Locations of wildlife refuges managed by USFWS. Digital boundaries were provided by USFWS.

Note: Cultural heritage sites were not included in this atlas. Please contact the proper agencies in case of an incident.

Major Data Sources Used: Human-Use Resources

CDF&G. 2009. California Department of Fish and Game Owned Lands (DFG Owned Lands), vector digital data.

CDF&G, OSPR. 2009. Sensitive sites and shoreline access points from the Area Contingency Plans, vector digital data.

California State Parks Acquisition and Development Division. 2008. CSP_OPBDYS072008, vector digital data.

CALTRANS. 2008. California airports, vector digital data.

National Park Service. 2009. Current Administrative Boundaries of National Park System Units 04/01/2009, vector digital data.

NOAA National Marine Sanctuaries Program. 2008. CINMS Boundary 6_08, vector digital data.

OSPR, CSLC. 2004. California coastal boating facilities, vector digital data.

USDA Forest Service, Pacific Southwest Region Regional Office. 2009. AdministrativeForest09_1, vector digital data.

USFWS. 2009. FWS Critical Habitat for western snowy plover, steelhead, California red-legged frog, riverside fairy shrimp, San Diego fairy shrimp, arroyo toad, least bell's vireo, spreading navarretia, and Ventura marsh milk-vetch, vector digital data.

USFWS. Region 1, Division of Refuge Planning. 2004. FWS_RI_NWR_ApBnd, vector digital data.

GEOGRAPHIC INFORMATION SYSTEM

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

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

SHORELINE CLASSIFICATIONS

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

SENSITIVE BIOLOGICAL RESOURCES

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

HUMAN-USE FEATURES

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

ACKNOWLEDGMENTS

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

The biological and human-use data included on the maps were provided by numerous individuals and agencies. Staff with NMFS, CDF&G, USFWS, UCSB, NPS, and Pepperdine University 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. David Betenbaugh conducted the shoreline habitat classification. Christine L. Boring collected and compiled the biological and human-use data onto base maps. Mark White, Lee Diveley, Chris Locke, and Katy Beckham entered, processed, and produced the GIS data and hardcopy atlas. Joe Holmes was responsible for graphic art production. Christine Boring, Chris Locke, Wendy Early, and Joe Holmes prepared the final text documents and metadata.

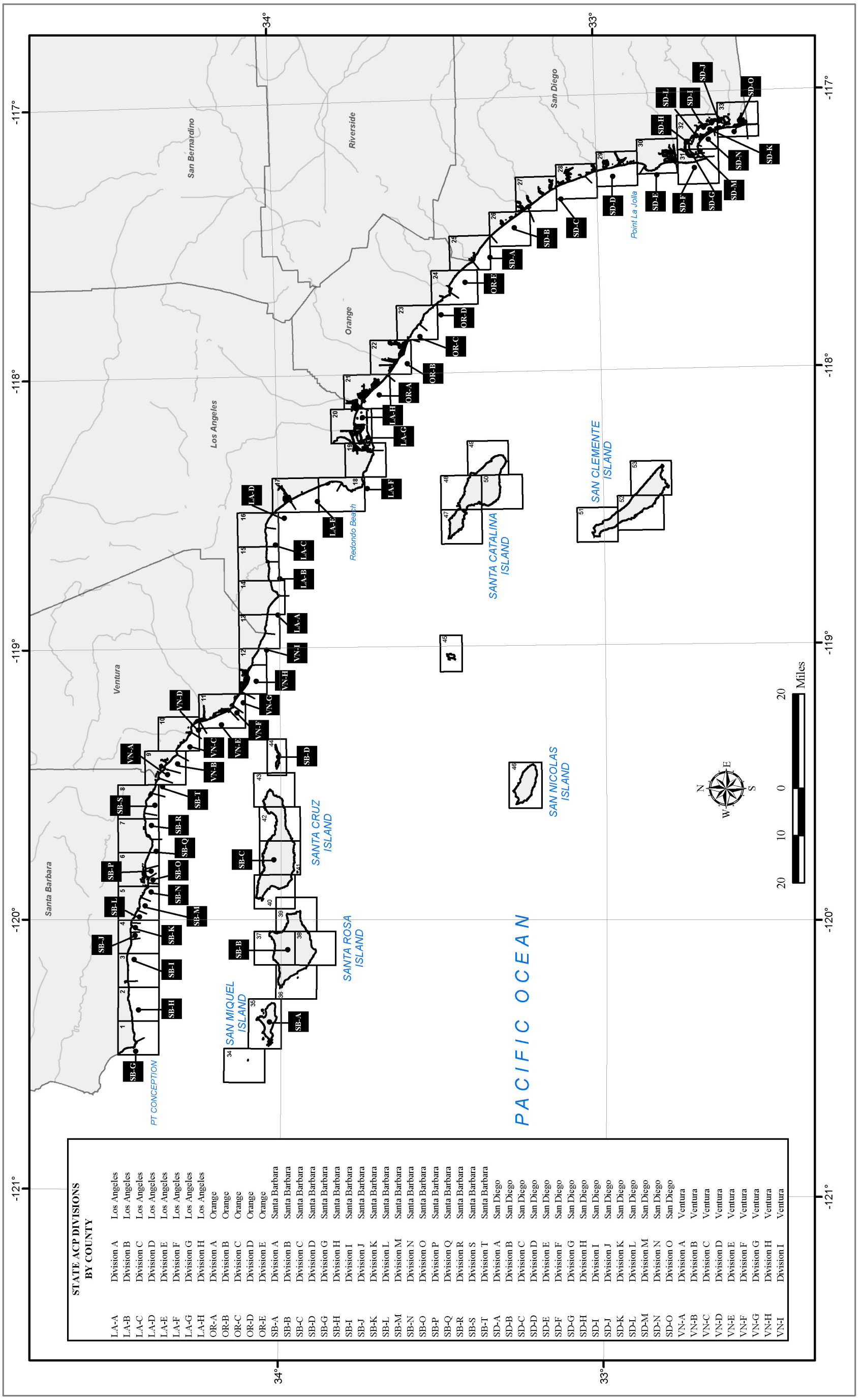


FIGURE 1. State ACP Divisions used for oil spill response and planning by county. Data provided by OSPR.

APPROPRIATE USE OF ATLAS AND DATA

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

SPECIES LIST

Common Name*	Scientific Name*
BIRDS	
DIVING BIRD	
Brandt's cormorant	*Phalacrocorax penicillatus*
Brown pelican	*Pelecanus occidentalis*
Clark's grebe	*Aechmophorus clarkii*
Common loon	*Gavia immer*
Cormorants	*Phalacrocorax spp.*
Diving birds	-
Double-crested cormorant	*Phalacrocorax auritus*
Eared grebe	*Podiceps nigricollis*
Grebes	-
Loons	*Gavia spp.*
Pacific loon	*Gavia pacifica*
Pelagic cormorant	*Phalacrocorax pelagicus*
Pelicans	*Pelecanus spp.*
Pied-billed grebe	*Podilymbus podiceps*
Red-throated loon	*Gavia stellata*
Western grebe	*Aechmophorus occidentalis*
GULL / TERN	
Black skimmer	*Rynchops niger*
Bonaparte's gull	*Larus philadelphia*
California gull	*Larus californicus*
California least tern	*Sternula antillarum browni*
Caspian tern	*Hydroprogne caspia*
Common tern	*Sterna hirundo*
Elegant tern	*Thalasseus elegans*
Forster's tern	*Sterna forsteri*
Glaucous-winged gull	*Larus glaucescens*
Gull-billed tern	*Gelochelidon nilotica*
Gulls	-
Heermann's gull	*Larus heermanni*
Least tern	*Sternula antillarum*
Mew gull	*Larus canus*
Ring-billed gull	*Larus delawarensis*
Royal tern	*Thalasseus maximus*
Terns	-
Western gull	*Larus occidentalis*
PASSERINE BIRD	
Belding's savannah sparrow	*Passerculus sandwichensis beldingi*
Belted kingfisher	*Ceryle alcyon*
California horned lark	*Eremophila alpestris actia*
Coastal California gnatcatcher	*Polioptila californica californica*
Common yellowthroat	*Geothlypis trichas*
Large-billed savannah sparrow	*Passerculus sandwichensis rostratus*
Least Bell's vireo	*Vireo bellii pusillus*
Marsh wren	*Cistothorus palustris*
Saltmarsh sharp-tailed sparrow	*Ammodramus caudacutus*
Willow flycatcher	*Empidonax traillii*
Yellow-billed cuckoo	*Coccyzus americanus*
RAPTOR	
American kestrel	*Falco sparverius*
Bald eagle	*Haliaeetus leucocephalus*
Burrowing owl	*Athene cunicularia hypugea*
Buteo hawks	*Buteo spp.*
Merlin	*Falco columbarius*
Northern harrier	*Circus cyaneus*
Osprey	*Pandion haliaetus*
Peregrine falcon	*Falco peregrinus*
Raptors	-
Red-tailed hawk	*Buteo jamaicensis*
Short-eared owl	*Asio flammeus*
White-tailed kite	*Elanus leucurus*
SEABIRDS	
-ALCID	
Alcids	
Cassin's auklet	*Ptychoramphus aleuticus*
Common murre	*Uria aalge*
Pigeon guillemot	*Cepphus columba*
Rhinoceros auklet	*Cerorhinca monocerata*
Xantus's murrelet	*Synthliboramphus hypoleucus*
-PELAGIC	
Ashy storm-petrel	*Oceanodroma homochroa*
Black storm-petrel	*Oceanodroma melania*
Black-legged kittiwake	*Rissa tridactyla*
Black-vented shearwater	*Puffinus opisthomelas*
Brown booby	*Sula leucogaster*
Buller's shearwater	*Puffinus bulleri*
Jaegers	*Stercorarius spp.*
Leach's storm-petrel	*Oceanodroma leucorhoa*
Northern fulmar	*Fulmarus glacialis*

* Threatened and endangered species are designated by underlining

Common Name*	Scientific Name*
BIRDS, cont.	
SEABIRDS, cont.	
Pelagic birds	-
Pink-footed shearwater	*Puffinus creatopus*
Seabirds	-
Shearwaters	-
Sooty shearwater	*Puffinus griseus*
Storm-petrels	*Oceanodroma spp.*
SHOREBIRD	
American avocet	*Recurvirostra americana*
American oystercatcher	*Haematopus palliatus*
Black oystercatcher	*Haematopus bachmani*
Black turnstone	*Arenaria melanocephala*
Black-bellied plover	*Pluvialis squatarola*
Black-necked stilt	*Himantopus mexicanus*
Dowitchers	*Limnodromus spp.*
Dunlin	*Calidris alpina*
Greater yellowlegs	*Tringa melanoleuca*
Killdeer	*Charadrius vociferus*
Least sandpiper	*Calidris minutilla*
Long-billed curlew	*Numenius americanus*
Long-billed dowitcher	*Limnodromus scolopaceus*
Marbled godwit	*Limosa fedoa*
Phalaropes	*Phalaropus spp.*
Red knot	*Calidris canutus*
Red phalarope	*Phalaropus fulicaria*
Red-necked phalarope	*Phalaropus lobatus*
Ruddy turnstone	*Arenaria interpres*
Sanderling	*Calidris alba*
Semipalmated plover	*Charadrius semipalmatus*
Shorebirds	-
Short-billed dowitcher	*Limnodromus griseus*
Surfbird	*Aphriza virgata*
Wandering tattler	*Heteroscelus incanus*
Western sandpiper	*Calidris mauri*
Western snowy plover	*Charadrius alexandrinus nivosus*
Whimbrel	*Numenius phaeopus*
Willet	*Catoptrophorus semipalmatus*
Wilson's phalarope	*Phalaropus tricolor*
WADING BIRD	
Black-crowned night-heron	*Nycticorax nycticorax*
Egrets	-
Great blue heron	*Ardea herodias*
Great egret	*Ardea alba*
Green heron	*Butorides virescens*
Herons	-
Light-footed clapper rail	*Rallus longirostris levipes*
Little blue heron	*Egretta caerulea*
Rails	-
Reddish egret	*Egretta rufescens*
Sandhill crane	*Grus canadensis*
Snowy egret	*Egretta thula*
Sora	*Porzana carolina*
Virginia rail	*Rallus limicola*
Wading birds	-
WATERFOWL	
American coot	*Fulica americana*
American wigeon	*Anas americana*
Brant	*Branta bernicla*
Bufflehead	*Bucephala albeola*
Canada goose	*Branta canadensis*
Canvasback	*Aythya valisineria*
Cinnamon teal	*Anas cyanoptera*
Common goldeneye	*Bucephala clangula*
Dabbling ducks	-
Diving ducks	-
Ducks	-
Gadwall	*Anas strepera*
Geese	-
Greater scaup	*Aythya marila*
Greater white-fronted goose	*Anser albifrons*
Green-winged teal	*Anas crecca*
Lesser scaup	*Aythya affinis*
Mallard	*Anas platyrhynchos*
Northern pintail	*Anas acuta*
Northern shoveler	*Anas clypeata*
Red-breasted merganser	*Mergus serrator*
Redhead	*Aythya americana*
Ross's goose	*Chen rossii*
Ruddy duck	*Oxyura jamaicensis*
Scaup	*Aythya spp.*

* Threatened and endangered species are designated by underlining

Common Name*	Scientific Name*

BIRDS, cont.

WATERFOWL, cont.	
Scoters	*Melanitta spp.*
Sea ducks	-
Snow goose	*Chen caerulescens*
Surf scoter	*Melanitta perspicillata*
Teals	*Anas sp.*
Waterfowl	-

FISH

FISH	
Arroyo chub	*Gila orcuttii*
California grunion	*Leuresthes tenuis*
Pacific seahorse	*Hippocampus ingens*
Rocky intertidal fish	-
Steelhead	*Oncorhynchus mykiss*
Tidewater goby	*Eucyclogobius newberryi*

HABITATS

KELP	
Giant kelp	*Macrocystis pyrifera*
PLANT	
Brand's star phacelia	*Phacelia stellaris*
Gaviota tarplant	*Deinandra increscens ssp. Villosa*
Nuttall's lotus	*Lotus nuttallianus*
Red sand verbena	*Abronia maritima*
Rocky intertidal plants	-
SAV	
Eelgrass	*Zostera marina*
Surfgrass	*Phyllospadix sp.*
UPLAND	
Beach morning glory	*Ipomoea pescaprea*
WETLAND	
Salt marsh bird's-beak	*Cordylanthus maritimus maritimus*
Ventura marsh milkvetch	*Astragalus pycnostachyus var. lanosissimus*

INVERTEBRATES

BIVALVE	
California mussel	*Mytilus californianus*
Chione spp.	*Chione spp.*
Nuttall cockle	*Clinocardium nuttallii*
Pacific littleneck	*Protothaca staminea*
Pismo clam	*Tivela stultorum*
GASTROPOD	
Abalone	*Haliotis spp.*
Black abalone	*Haliotis cracherodii*
Pink abalone	*Haliotis corrugata*
Red abalone	*Haliotis rufescens*
White abalone	*Haliotis sorenseni*
INSECT	
Globose dune beetle	*Coelus globosus*
Monarch butterfly	*Danaus plexippus*
Point Mugu dune weevil	*Trigonoscuta muguensis*
Wandering skipper	*Panoquina errans*
Western beach tiger beetle	*Cicindela latesignata*
INVERTEBRATE	
Rocky intertidal invertebrates	-
SHRIMP	
Riverside fairy shrimp	*Streptocephalus woottoni*
San Diego fairy shrimp	*Branchinecta sandiegonensis*

MARINE MAMMALS

DOLPHIN / PORPOISE	
Bottlenose dolphin	*Tursiops truncatus*
Dall's porpoise	*Phocoenoides dalli dalli*
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*
Striped dolphin	*Stenella coeruleoalba*
PINNIPED	
California sea lion	*Zalophus californianus*
Guadalupe fur seal	*Arctocephalus townsendi*

* Threatened and endangered species are designated by underlining

Common Name*	Scientific Name*

MARINE MAMMALS, cont.

PINNIPED, cont.	
Northern elephant seal	*Mirounga angustirostris*
Northern fur seal	*Callorhinus ursinus*
Pacific harbor seal	*Phoca vitulina richardii*
SEA OTTER	
Sea otter	*Enhydra lutris*
WHALE	
Baird's beaked whale	*Berardius bairdii*
Blue whale	*Balaenoptera musculus*
Bryde's whale	*Balaenoptera edeni*
Cuvier's beaked whale	*Ziphius cavirostris*
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*
North Pacific right whale	*Eubalaena japonica*
Short-finned pilot whale	*Globicephala macrorhynchus*
Sperm whale	*Physeter macrocephalus*
Whales	-

REPTILES / AMPHIBIANS

AMPHIBIAN	
Arroyo toad	*Anaxyrus californicus*
California red-legged frog	*Rana draytonii*
Coast range newt	*Taricha torosa*
LIZARD	
Island night lizard	*Xantusia riversiana*
SNAKE	
Two-striped garter snake	*Thamnophis hammondii*
TURTLE	
Green sea turtle	*Chelonia mydas*
Leatherback sea turtle	*Dermochelys coriacea*
Loggerhead sea turtle	*Caretta caretta*
Southwestern pond turtle	*Actinemys marmorata pallida*

TERRESTRIAL MAMMALS

CANINE	
San Miguel island fox	*Urocyon littoralis littoralis*
Santa Catalina island fox	*Urocyon littoralis catalinae*
Santa Cruz island fox	*Urocyon littoralis santacruzae*
Santa Rosa island fox	*Urocyon littoralis santarosae*
SMALL MAMMAL	
Anacapa deermouse	*Peromyscus maniculatus anacapae*
Black-tailed jackrabbit	*Lepus californicus bennettii*
Channel Islands spotted skunk	*Spilogale gracilis amphialus*
Pacific pocket mouse	*Perognathus longimembris pacificus*
Western harvest mouse	-

* 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.
- Regular exposure to high wave energy, with strong wave reflection patterns
- Impermeable substrate with no potential for subsurface penetration
- Seldom found in combination with another shoreline type, however they are often interspersed along the shore with wave-cut platforms and gravel beaches
- Rocky intertidal zones in California are extremely ecologically valuable habitats often composed of keystone species. They support diverse communities of algae, invertebrates and fish and have been intensively studied by numerous researchers for many decades.
- There is strong vertical zonation of intertidal biological communities
- Attached organisms are hardy and accustomed to strong hydraulic impacts and pressures
- Offshore islands are important for marine mammal haulouts
- Common along the Channel Islands

PREDICTED OIL BEHAVIOR

- Oil is held offshore by wave 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

RESPONSE CONSIDERATIONS

- Cleanup is usually not required because 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
- They are built to protect the shore from erosion by waves, boat wakes, and currents, and thus are exposed to relatively high-energy processes
- 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
- Organisms, such as barnacles, mussels, and algae, may be common on the lower levels, whereas biota along the upper intertidal zones is sparse
- Present in highly developed industrial and port areas and scattered along residential waterfronts

PREDICTED OIL BEHAVIOR

- Generally oil is held offshore by waves reflecting off the steep, hard surface in exposed settings
- Oil readily adheres to the dry, rough surfaces, but it does not adhere to wet substrates
- The most resistant oil would remain as a patchy band at or above the high-tide line
- Oil tends to persist as a band along the high-tide line
- Oil can penetrate into the joints of the structures
- Biota would be impacted under heavy accumulations

RESPONSE CONSIDERATIONS

- Cleanup is usually not required
- High-pressure water spraying may be conducted to:
  - remove oil;
  - prepare substrate for recolonization of barnacle and mussel 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
- Rocky intertidal zones in California are extremely ecologically valuable habitats often composed of keystone species. They support diverse communities of algae, invertebrates and fish and have been intensively studied by numerous researchers for many decades. These habitats can support large populations of encrusting animals and plants, with rich tidal pool communities.
- Attached organisms are hardy and used to strong hydraulic impacts and pressures
- Common in Southern California, especially along the Channel Islands

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

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
- Access can be difficult and dangerous

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

DESCRIPTION

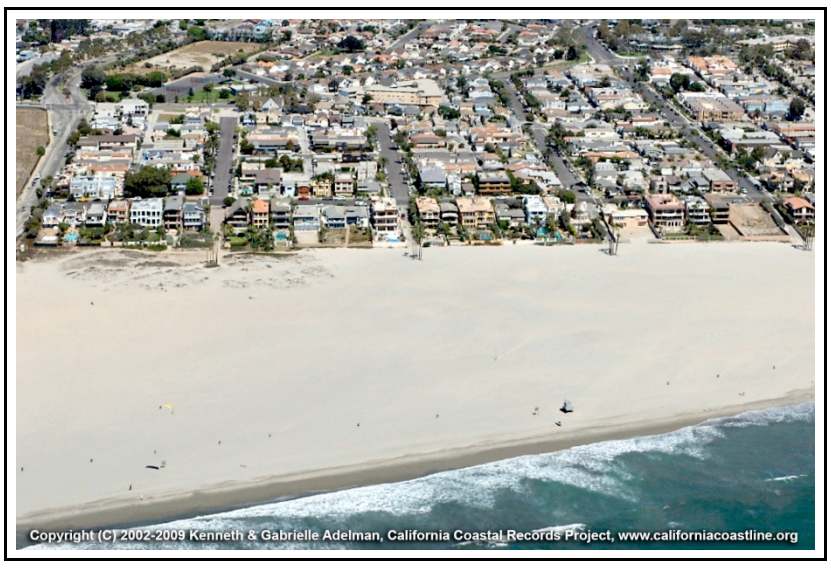
- These beaches are generally flat, wide, and hard-packed
- They can occur at the upper intertidal zone on wave-cut platforms
- There can be significant seasonal changes in the beach sediments
- Upper beach fauna are scarce; lower beach fauna can be dense, but are highly variable
- Very common in Southern 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; 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 week after a spill typically will be less than 30 cm along the upper beach face
- Organisms living in the beach sediment may be killed by smothering or lethal oil concentrations in the interstitial water
- Biological impacts include temporary declines in infauna, which can affect important shorebird foraging areas

RESPONSE CONSIDERATIONS

- These beaches are among the easiest shoreline types to clean, because hard substrate can support vehicular and foot traffic and depths of oil burial and penetration are minimal



- Cleanup should concentrate on removing oil and oily debris from the upper swash zone once oil has come ashore
- Traffic 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 mixing of oil deeper into the sediments by vehicular and foot traffic
- Mechanical reworking of lightly oiled sediments from the high-tide line to the upper intertidal zone can be effective along outer beaches

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SCARPS AND STEEP SLOPES IN SAND ESI = 3B

DESCRIPTION

- This shoreline type occurs where sandy bluffs are undercut by waves or currents and slump
- Some scarps are fronted by narrow beaches, if the erosion rates are moderate and episodic
- Trees growing at the top of these slopes are eventually undercut and the logs can accumulate at the base of the scarp
- Biological utilization by birds and infauna is low
- Uncommon in Southern California

PREDICTED OIL BEHAVIOR

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

RESPONSE CONSIDERATIONS

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

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

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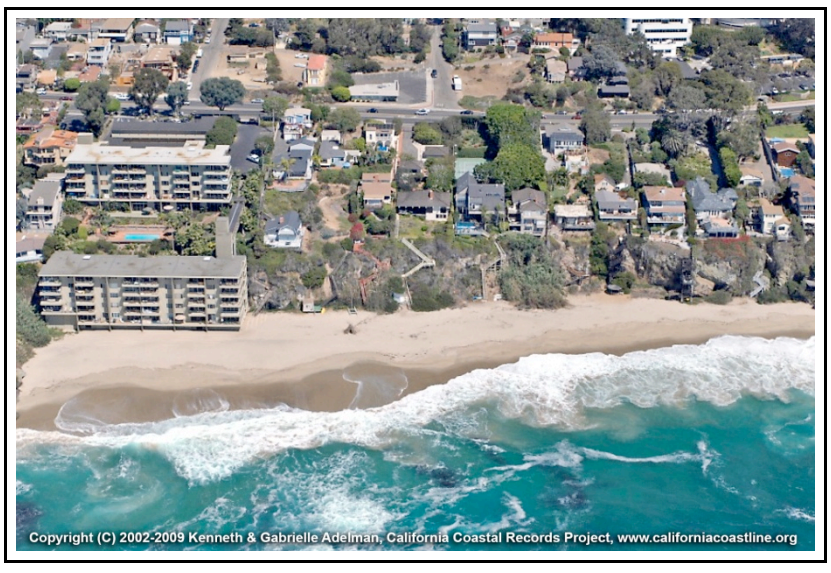
COARSE-GRAINED SAND BEACHES ESI = 4

DESCRIPTION

- These beaches are moderate-to-steep sloping, 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 along the outer shores

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 as rapid as one tidal cycle 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
- Organisms living in the beach may be killed by smothering or lethal oil concentrations in interstitial water

RESPONSE CONSIDERATIONS

- Remove oil primarily from the upper swash lines
- Removal of sediment should be limited to avoid erosion problems; however, the common occurrence of multiple buried oil layers in these types of beaches increases the amount of sediment to be handled and disposed of
- Mechanical reworking of lightly oiled 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
- Sediment mobility is very high during storms, but considerably less than sand beaches during normal conditions
- Substrate has medium-to-high permeability
- 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

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
- Sediment replenishment rates are the lowest of all beach types
- Most permeable of all beach sediments
- Attached biota are usually restricted to the lowest parts of the beach, where the sediments are less mobile
- The presence of attached biota indicates beaches that are relatively sheltered, with the more stable substrate supporting richer biological communities
- Common adjacent to cliffs and platforms

PREDICTED OIL BEHAVIOR

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

RESPONSE CONSIDERATIONS

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

RIPRAP **ESI = 6B**

DESCRIPTION

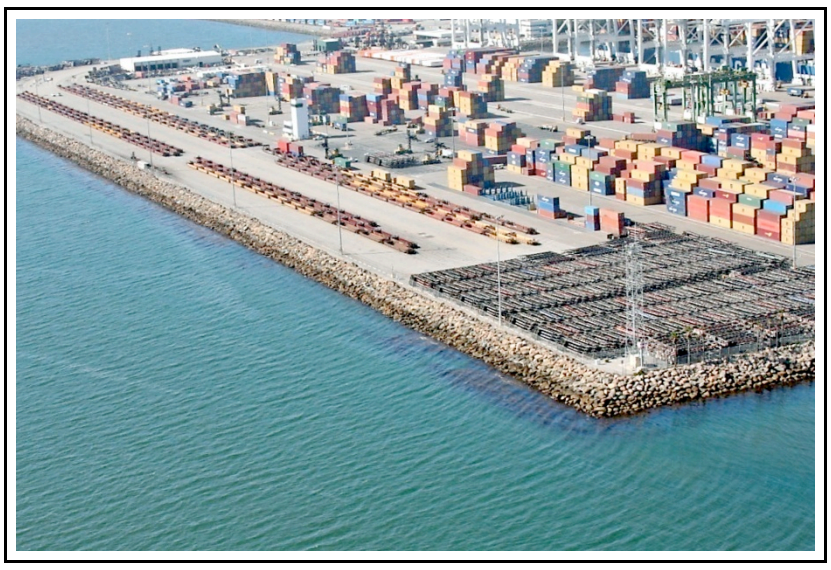
- Riprap structures are composed of cobble- to boulder-sized rock fragments
- Riprap structures are placed for shoreline protection and inlet stabilization
- Attached biota may be common at lower intertidal levels, whereas biota along the upper intertidal zones are sparse
- Common along highly developed industrial areas and residential waterfronts

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

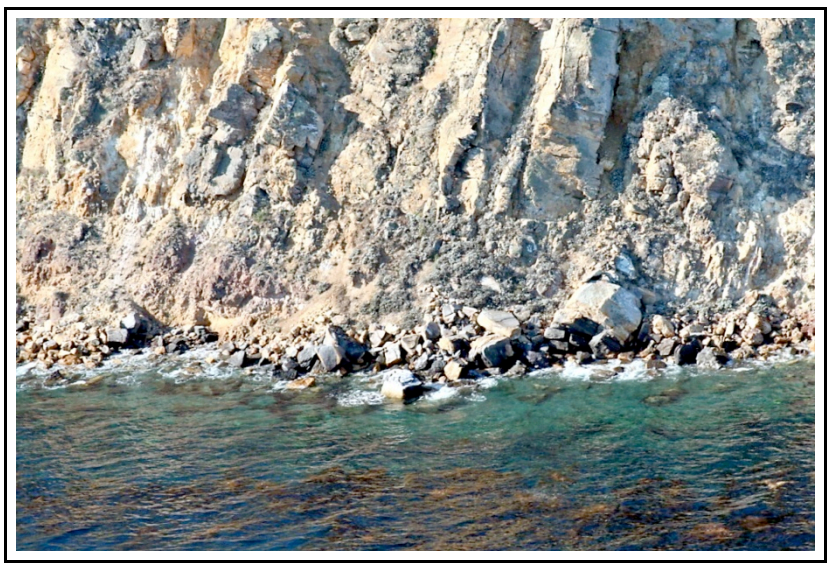
- Relatively steep rocky shores with accumulations of angular boulder rubble displaying limited evidence of re-working by waves or sediment transport
- Attached biota may be common at lower intertidal levels, whereas biota along the upper intertidal zones are sparse
- Can co-occur with gravel beaches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

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
- Located along exposed sections of bays

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

- On sand flats, oil will often be removed naturally from the flat and deposited on the adjacent beaches where cleanup is more feasible
- 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 Southern California; mostly associated with high-relief areas along estuaries and rivers

PREDICTED OIL BEHAVIOR

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

RESPONSE CONSIDERATIONS

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

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

DESCRIPTION

- These structures are solid man-made structures such as seawalls, groins, revetments, piers, and port facilities
- Most of the structures are designed to protect a single lot, thus their composition, design, and condition are highly variable
- 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
- Present in highly developed industrial areas and scattered along residential waterfronts

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
- Oil may seep into joints or crevices along the structure and become a source of chronic leaching
- The lower intertidal zone usually stays wet (particularly if algae covered), preventing oil from adhering to the surface

RESPONSE CONSIDERATIONS

- Cleanup of seawalls is usually conducted for aesthetic reasons or to prevent leaching of oil

- Low- to high-pressure spraying at ambient water temperatures is most effective when the oil is fresh

SHELTERED RIPRAP — ESI = 8C

DESCRIPTION

- Riprap structures are composed of cobble- to boulder-sized blocks of bedrock or concrete
- These structures are found inside harbors and bays in developed areas, sheltered from direct exposure to waves
- High densities of attached biota may be present at lower tidal elevations
- Present in highly developed industrial areas and scattered along residential waterfronts

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
- Typically associated with salt- and brackish-water marshes in protected areas

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

VEGETATED LOW BANKS — ESI = 9B

DESCRIPTION

- These habitats are either low banks with grasses or trees and tree roots exposed to the water
- They are flooded occasionally by high water
- Uncommon is Southern California

PREDICTED OIL BEHAVIOR

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

RESPONSE CONSIDERATIONS

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

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

HYPERSALINE TIDAL FLATS — ESI = 9C

DESCRIPTION

- These are shallow, impounded brine ponds
- They are artificially inundated and contain waters with high salinity levels
- Dykes are heavily utilized by nesting birds
- Located within the southern portion of San Diego Bay

PREDICTED OIL BEHAVIOR

- Sheltered from wave energy and tidal currents
- During high water events, such as El Niño, some areas may be naturally flood. Oiling could occur if a spill coincides with a high water event
- Oil will permeate into sediments and persist
- Damage to bird communities may be severe

RESPONSE CONSIDERATIONS

- Artificial flooding practices should be stopped during foreseeable threats of contamination
- Sorbents booms may be used to prevent oil from entering this area

- Contaminated water must be collected and significantly oiled sediments should be removed
- Impacts to biological resources should be evaluated when considering clean up operations

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
- Located within most bays and estuaries

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 Southern 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
- Relatively uncommon in Southern California

PREDICTED OIL BEHAVIOR

- Though generally not a risk of oiling from marine spills because of their position above normal high tides, they could become oiled during very high water levels, from land-based spills, or during cleanup of adjacent areas
- Oil behavior depends on whether the swamp is flooded or not
- During floods, most of the oil passes through the forest, coating the vegetation at the waterline, which changes levels throughout the flood event

- 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 Southern 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 coating
- 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