REVISION TO MARINE AND ESTUARINE HABITATS OF THE CALIFORNIA WILDLIFE HABITAT RELATIONSHIP SYSTEM

KEVIN SHAFFER
California Department of Fish and Game
1807 13th Street, Suite 104
Sacramento, California 95814
(916) 327-0713
kshaffer@dfg.ca.gov

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The California Wildlife Habitat Relationship (CWHR) System is a comprehensive information system for California's wildlife. Version 8.0 of CWHR maintains life history and range maps for 675 terrestrial amphibian, reptile, bird and mammal species and the ability to model habitat use. A critical component of CWHR is the habitat classification used for animal use and association. At present, only 4 of the 59 habitats described in CWHR are aquatic. Due to the heightened concern and interest in marine and estuarine species, their habitat associations, and the state of these habitats in California, a more detailed and useful classification of California's marine and estuarine habitats is needed by scientists, resource managers, and the general public for understanding and making decisions about marine wildlife and their environment. A revision of CWHR's single marine and single estuarine habitats has resulted in 22 marine and 19 estuarine habitats and a few additional habitats that will be added to the final revision. The classification is a hierarchy that includes ecological regions, habitats, habitat zones, micro-habitats, and substrata. This classification also includes crosswalks to the 6 other significant, fully or partially, marine classification systems relevant to California waters.

INTRODUCTION

Expanding the California Wildlife Habitat Relationship (CWHR) System

CWHR Version 8.0 currently defines, describes, and models the relationships of 675 species of regularly-occurring terrestrial mammals, birds, reptiles, and amphibians in California to 59 habitats in a standard classification scheme. With reference to aquatic habitats, there currently are four types: marine, estuarine, lacustrine, and riverine. With reference to marine fauna, the existing CWHR includes birds and mammals, although the system does not include models for fully marine taxa such as whales and dolphins.

In 1999, the Department of Fish and Game (DFG) and the California Interagency Wildlife Task Group (CIWTG) undertook a project to expand the marine and estuarine habitats into a more useful and realistic scheme for California. The goals of the expansion project were:

1. Better predict the presence, range and distribution, and use of marine and estuarine wildlife in California;
2. Better predict the changes in habitat use as habitats are altered or impacted (i.e., oil or other chemical contamination, El Nino, dredging);
3. Identify representative and unique marine and estuarine habitat for the purposes of improving conservation and protection;
4. Identify and map the range and distribution of priority species (e.g., sensitive, fisheries, recreational, ecologically significant) for the purposes of improving conservation and management;
5. Develop a wildlife habitat classification that would be appropriate for estuarine and marine fishes and invertebrates as well as birds and mammals.

The primary goal of the expansion is to better delineate and describe those regions that represent functional habitat to estuarine and marine wildlife.

The Draft Expansion of Marine and Estuarine Habitats under CWHR

The ensuing habitat classification and description represents the preliminary, marine-estuarine expansion of CWHR. Existing and developing classifications, scientific literature and data, and professional expertise and opinion were used to develop the expansion. Three review teams were established, and each sequential critiqued the draft classification as it was developed. The development and review took two years and six revisions, and over 70 scientists and marine resource managers, from universities, state and federal agencies, and fisheries and marine conversation organizations took part in the review.

Integrating CWHR with Other Classification and Modeling Systems

The expansion of CWHR was accomplished in such a way to ensure the expansion would be comparable or complimentary with several other schemes. Those schemes and their reference to CWHR are listed below:

1. Wetlands of the Central and Southern California Coast and Coastal Watersheds: A methodology for their classification and description. W.R. Ferren Jr., P.L. Fiedler, and

R.A. Leidy, 1996.

This publication was produced in 1996 for the United States Environmental Protection Agency and is a hydro-geomorphological classification for lacustrine, riverine, estuarine, and marine habitats, and geomorphic and hydromorphic phenomena in central and southern California.

Though it contains much detail regarding hydrology and geomorphology that may not pertain to functional habitat for wildlife, CWHR is integrating classification criteria, hierarchy, and terminology from this classification. Also, it should be noted that this classification is more appropriate than the CWHR system for objectives beyond wildlife relationships.

2. Bayland Ecosystem Habitat Goals: a report of habitat recommendations, 1999.

This report was prepared by the San Francisco Bay Area Wetlands Ecosystem Goals Project. It identifies habitats and species present in the greater San Francisco Bay-Delta area. Two of the report's primary focuses, habitat delineation and wildlife use, are identical to the goals of CWHR.

3. A classification scheme for deep sea floor habitats, 1999.

This scheme evaluates benthic habitat in deeper marine waters. It is arranged in 4 primary tiers: mega-, meso-, macro-, and micro-habitats. The classification incorporates geomorphology, substratum type and aspect, and chemical and biological modifying characteristics. It is the goal of CWHR to integrate its benthic habitats as much as possible with this classification. The outstanding issue is whether and how to incorporate moderate to large-scale geomorphological features into CWHR's marine benthic habitats.

4. The national scheme for marine and estuarine ecosystems and habitat classification, 2000.

The national scheme was published in July 2000 by the National Oceanographic and Atmospheric Administration. It is meant to be applicable to all the marine and estuarine waters of the United States and is a hierarchal system, incorporating thirteen "levels" ranging from life zone (i.e., temperate, tropical) to a region's local modifiers and eco-units.

Goals of this classification are: (1) provide a consistent system; (2) focus on distinguishing natural communities and their physical environment, (3) identify and map eco-types, and (4) accommodate limited data and available technology.

The expansion of CWHR was done is such a way to nest into the national scheme.

5. Habitat classification for habitats of the Channel Islands, drafted summer 2000.

The Channel Island National Marine Sanctuary (CINMS) developed a habitat classification for significant and unique habitats of and off the Channel Islands. One of the primary reasons for this effort was to aid in identifying and prioritizing areas for protection as reserves. The State of California and Department of Fish and Game, under the Marine Managed

Areas Act and Marine Life Protection Act, have the identical goal and responsibility of identifying and protecting marine habitats and their respective species.

6. Wildlife-Habitat Relationships in Oregon and Washington, 2001.

Thirty-three organizations worked for almost five years on this project. A book and CD-Rom version were published in 2001. Because this system is similar in content and purpose of CWHR, the three states may work to integrate the classifications, terminology, and hierarchies.

The publication includes information on 593 wildlife species and their relationships with the 32 terrestrial, freshwater, and marine habitats of Oregon and Washington. It includes photographs of each habitat, as well as hundreds of maps, diagrams, and other illustrations. The accompanying CD-ROM contains additional wildlife data and color maps, and seven matrixes that link wildlife species with their respective habitats.

Scale or Resolution

An important component for interpreting natural landscapes that has not been addressed for the marine and estuarine environments is a relatively complete range of scale (= resolution). Such systems do exist for other landscapes (e.g., terrestrial vegetation), and in California, one may use a system[1] that allows one to choose the scale that is of most interest or significance.

Different resolutions are important for different types of organisms and life-forms (see above), and scale is different and crucial for different efforts related to marine conservation, fisheries management, and scientific endeavors. Therefore, it is necessary to have a series of resolutions for marine and estuarine eco-regional and habitat delineation.

For marine classification, the national system is tackling the issue of a complete range of scale for all marine and estuarine ecosystems. Ferren et al. (1996) has done so for nearshore environments for central and southern California, while Greene et al. (1999) has done so for offshore benthic habitats. In addition, there is an effort, only now in its infant stages, to address appropriate scales for the marine and estuarine environments of California, Oregon, and Washington (personal communication, David Fox). The proposed habitat revision for CWHR does not include some of the resolutions other classifications.

Marine Ecological Regions

Oregonian (Oregon border to Point Arena)
Northern Californian (Point Arena to Año Nuevo)
Central Californian (Año Nuevo to Point Conception, including San Miguel and Santa Rosa islands)
Southern-Baja Californian (Point Conception to Mexican border, including all other Channel Islands)

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[1] One can use the Ecological Subregions of California: Section and Subsection Descriptions (1997) for broader resolution and A Manual of California Vegetation (1995) for finer resolution of plant communities.

Habitat:	A physical area characterized by a unique assemblage of species that constitute the biotic community that utilizes and/or inhabits area and which provides some subset of essential or preferred ecological and biological needs (i.e., reproduction, feeding/foraging, cover/shelter) for each of those species.
Habitat Zone	A vertical or horizontal subarea of a habitat representing a measurable change in physical or biological condition that results in the changes in species use or occurrence within that habitat.
Microhabitat	A unique or unusual biological or geological object or array within a habitat that is essential for either a species to be present or a particular ecological function of a species.
Substratum	A physical substance, defined by size-class and/or base material that comprises or contributes to the surface of a habitat.

KEY TO HABITATS

Water Body and Salinity

A. Body of sea water bounded landward by shoreline; no measurable influence of freshwater influx (=**Marine**)
B. Restricted body of a mixture of seawater and freshwater bounded (1) landward by shoreline and a daily or seasonal freshwater influx and (2) seaward by a salinity front from the marine environment (=**Estuarine**)

A. MARINE HABITATS:

1. Seaward of continental shelf-slope transition (=**Offshore**)
2. Landward of continental shelf-slope transition (=**Nearshore**)

1. Offshore

a. Habitat components are entirely aquatic; without a relationship to a benthic (substrate) environment (=**Pelagic**)
b. Habitat components are both aquatic and solid (substrate). This includes habitation (1) on the top of or associated with the benthic substrata (epibenthic) and (2) in or beneath the substrata (inbenthic) (=**Benthic**)

2. Nearshore

a. Ocean wave action has a varying effect, ranging from subtle to substantial, on shoreline form and composition; the arrangement of shoreline does not result in a semi-protected body of water with a more limited access to the ocean (=**Coast**)
b. Ocean wave action is not an essential component of the shoreline-water interface; the formation of the shoreline does result in a semi-protected water body with relatively restricted access to the open ocean (=**Embayment**)

Coast

i. Coastline relatively protected from direct wave-action; may be concave in shape or otherwise protected (i.e., buffered by headland, island, underwater reef) from the direct impact/effect of wave-action (**=Protected**)
ii. Coastline exposed to direct wave-action; usually linear or convex in shape, thus, affected directly by energy of wave- and wind-energy (=**Exposed**)

i. Protected

Inland of the effects of seawater and spray; no inundation by water (=Shores and beaches)
Seaward of the effects of seawater and spray; variable cycle of exposure-water inundation (=Inter- and subtidal)

a. Shorelines and beaches — Narrow strip of terrestrial environment between the intertidal and fully terrestrial habitats and is affected substantially by the marine or estuarine environment. Primary substrate components are sand, pebble, cobble, rock, and/or boulders.

b. Intertidal — Nearshore region where there are periods of water inundation and exposure to the air environment. The dynamic of water cover/exposure ranges from predominant exposure and rare inundation (e.g., supratidal) to rare exposure and predominant inundation (e.g., lower intertidal); upward displacement of the zonal characteristics occurs as a gradient with progression from protected to exposed coast.

c. Subtidal — Nearshore region below the intertidal, where water inundation is continuous, to the continental shelf-slope interface. Water depth reaches approximately 150-200 meters.

1. Habitat is totally aquatic (=Neritic)
Open waters of the marine, nearshore environment. It includes the surface zone and water column extending to the benthic environment.

2. Habitat components are both aquatic and solid (see above OFFSHORE)

d. Kelp forest — Nearshore region physically and ecologically defined and influenced by canopy-forest forming species of kelp (e.g., *Macrocystis integrifolia, M. pyrifera, Nereocystis luetkeana*)

e. Surf-grass bed

Nearshore, subtidal habitat physically and ecologically defined and characterized by the presence of *Phyllospadix* spp.

f. Eel-grass meadow

Nearshore, subtidal habitat physically and ecologically defined and characterized by the presence of *Zostera pacifica*.

ii. Exposed (see above PROTECTED COAST)

a. Shoreline and Beach

b Intertidal

c. Subtidal

1. Neritic
2. Benthic

d. Kelp Forest

e. Surf-grass Bed

iii. Embayment[2]

Nearshore, restricted body of marine water with restricted, yet continual, access seaward and where the energy of wave-action is lessened because of the restricted access. Embayment habitats are bordered landward by shoreline and/or estuarine habitats

a. Shoreline and Beach (see above)

b. Intertidal (see above)

c. Marine Shallow Waters

Inland marine water environment where water depths do not exceed 5.5-6 meters (18-20 feet).

- Neritic (see above)
- Benthic (see above)

[2] Some examples of embayments are Tomales, San Diego, Morro, San Francisco, and Humboldt.

Marine Deeper water bay

Inland marine water environment where water depth exceeds 5.5-6 meters.

- Neritic
- Benthic

B. ESTUARINE HABITATS:

1 Water body has constant exchange and interaction with ocean water or marine embayment. Separation from seawater may occur but is infrequent and unusual and never persists, breaching occurring within days or weeks from enclosure (= **Estuary, Tidal Flat, Tidal Marsh, and Eel-grass Meadow**)

2 Water body is often separated from ocean water exchange, and enclosure is a defining characteristic; breaching is infrequent and unusual and may not occur annually or for several years (= **Coastal Lagoon**)

For both Estuary and Tidal Marsh habitat designations:

Bay:

Enclosed estuarine waters associated with and inland from shallow marine embayment waters.

River mouth:

Coastal point of discharge of a river, stream, or creek; discharge may be into a marsh, estuary, bay, or directly into the ocean.

Canyon mouth:

The coastal opening of an incised chasm with steep cliff walls; runoff discharge may be into a marsh, estuary, bay, or directly into the ocean.

Coastal dune:

Coastal, terrestrial habitats characterized by exposed shoreline systems of one of more sand ridges derived from wind- and wave-transported material.

1 a. Habitat conditions not characterized by vascular plants; vascular plants absent (**Estuary** and **Tidal Flat**)
b. Habitat conditions dependent and characterized by vascular plants (**Tidal Marsh** and **Eel-grass Meadow**)

a. - Habitat characterized by inundation of water, except for rare exposure at the lowest tidal levels annually (= Estuary)
- Habitat characterized by daily cycle of water inundation and air exposure (= Tidal Flat)

i. Estuary

A semi-enclosed body of water that has a free connection with the open sea and within which seawater is diluted measurably with freshwater that is derived from land drainage(s); habitat occurring at freshwater-sea water interface, especially an arm of the sea at the lower end of a river, coastal canyon, coastal dune system, or bay.

ii. Tidal flat

Saltwater wetlands that are characterized low profile below water elevations that will support emergent plant communities, substratum usually of mud, sand, and/or detritus, and daily tidal cycling of inundation and exposure.

b - Frequently or continually inundated tidally influenced wetland characterized by emergent vegetation (grasses, cattails, and other monocotyledons) adapted to saturated soil conditions; salinities range from mixo- to euryhaline (= Tidal Marsh)
- Frequently or continually inundated, tidally influenced habitat defined by the presence of beds or meadows of eel-grass (*Zostera* spp.)(= Eel-grass Meadow)

Tidal Marsh habitats[3]:

i. Tidal Saltwater Marsh

Tidally influenced marsh that occurs along estuaries with salinities equal or approximate to sea water; a coastal habitat consisting of salt-resistant plants residing in an organic-rich sediment accreting toward sea level.

ii. Tidal Brackish Water Marsh

Tidally influenced marsh with mixohaline salinities; may be transitional between freshwater marshes or frequent freshwater source and saltwater marshes and tidal flats. Emergent vegetation not adapted to higher salinities found in saltwater marshes.

Eel-grass Meadow

Shallow water, bay-estuary habitat and community defined and ecologically influenced by the presence of many to thousands of *Zostera marina* (bay/estuary eel-grass).

2 Coastal Lagoon — Shallow lake or pond connected with the ocean; an area of shallow water of various and often fluctuating salinities separated from the sea by a

3 Freshwater tidal marsh will be added to the habitat classification.

strip of terrestrial substratum such as sand dunes, gravel or cobble beaches, or mud berm. This water body is infrequently breached and is temporarily contiguous with marine, coastal water.

DESCRIPTION OF HABITATS

Habitat 1 Marine Offshore Pelagic

Marine open-water habitat starting at continental shelf-slope interface; depth is usually 150 meters or greater. Zonation and microhabitat defined by ocean current, water temperature, nutrient concentration and availability, light-penetration, and water-column depth. Species and biotic communities are neither associated with nearshore waters nor the benthic environment.

Marine-Offshore-Pelagic Habitat; Surface Layer zone.
Marine-Offshore-Pelagic Habitat; Epipelagic zone.
Marine-Offshore-Pelagic Habitat; Mesopelagic Photic zone.
Marine-Offshore-Pelagic Habitat; Mesopelagic Aphotic zone.
Marine-Offshore-Pelagic Habitat; Bathypelagic zone.
Marine-Offshore-Pelagic Habitat; Abyssopelagic zone.

Surface layer	Layer of the ocean or estuary extending from the surface to a depth above which is homogeneous due to wind mixing;
Epipelagic	Of or relating to the ocean depth below the surface layer to 200 meters (m).
Mesopelagic	Of or relating to the ocean depths from 200-2,000 m.
Bathypelagic	Of or relating to the ocean depths between 2,000-4,000 m.
Abyssopelagic	Of or relating to the ocean depths between 4,000-6,000 m.
Photic zone	Surface layer to the compensation zone; where photosynthesis equals or exceeds respiration (≈800 m); the compensation zone occurs within the mesopelagic.
Aphotic zone	Below the compensation depth, where operative photosynthesis is absent

Significant Microhabitat considerations:

Surface currents/eddies.	Upwelling	Salinity
Water density	Water temperature	Turbidity
Plankton communities/blooms	Haloclines	Thermoclines

Habitat 2 Marine Offshore Benthic

Marine near-bottom or bottom habitat initiating at continental shelf-slope interface; water depth is 150 meters or greater. Zonation and microhabitat defined by water temperature, depth, and density, nutrient concentration and availability, substrate composition, and presence and type of geomorphic features. Photo-penetration is a factor to approximately 100 meters and is partially a function of turbidity. Species and biotic communities are associated with or dependent on the epibenthic and benthic conditions.

Marine-Offshore-Benthic Habitat; Archi-Epibenthic zone.
Marine-Offshore-Benthic Habitat; Archi-Inbenthic zone.
Marine-Offshore-Benthic Habitat; Abysso-Epibenthic zone.
Marine-Offshore-Benthic Habitat; Abysso-Inbenthic zone.

Archi-benthic	Related to the continental slope.

Abyssobenthic	Related to the rise and abyssal plan.
Benthic	The bottom (substrate and substance composition) of a water body.
Continental shelf	A shallow, submarine plain of varying width forming a border to a continent and typically ending in a steep slope (=continental) to the oceanic rise (=abyssal plain).
Continental slope	Steep-sloping bottom extending seaward from the edge of the continental shelf and downward toward the rise.
Epibenthic	Living attached or on the surface of the bottom.
Inbenthic	Buried just beneath or burrowed into the benthic surface.
Rise	Bottom of low relief at the base of the continental slope.

Significant microhabitat considerations:

Benthic rock-outcrops	Trenches	Caves
Ridges	Canyons	Sea mounts

Habitat 3 Marine Nearshore Exposed Coast Shoreline and Beach[4]

Terrestrial habitat adjacent to the supratidal zone of the intertidal habitat of the exposed coastline. Marine environment still has important ecological effect on this habitat. Wind energy has an important role in the composition and arrangement of this habitat. Wave and tidal action may affect indirectly the structure and composition of substrata, if only seasonally. This habitat is frequently or infrequently utilized by terrestrial vertebrates.

Significant microhabitat considerations:

cliffs and bluffs	sand dunes	vegetation types
boulders	ponds	

Habitat 4 Marine Nearshore Exposed Coast Intertidal[5]:

This coastline habitat is characterized by three primary factors: 1) exposure to full or moderate effects of wave and wind energy, 2) exposure to air, and 3) a proximate relationship to the shore. This region ranges from the shore to water depths of approximately 7 to 10 meters. Coastal marine waters between mean highest-high and mean lowest-low tide elevations and along coastline that is exposed to surf and wind. Such exposure may be due to the convex or straight-line shape of the coastline and lack of shielding by headlands, nearshore islands, or underwater reefs and bars. The time of exposure to drying factors such as wind, air, and sun varies greatly, ranging from perpetual except for the input of ocean spray only (supratidal) to exposed only on lowest low tides (lower). Species occupying the higher reaches of this habitat are capable of long-term and consistent exposure to air, while species nearing subtidal levels are capable of only minimal and infrequent exposure. The zonation scheme here is adopted from *Between Pacific Tides*. The numbers in parentheses represent this scheme.

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[4] Beach, Shorelines, Banks: Necessary to link terrestrial with aquatic habitats; most significant for mammals and birds coming down to the water and for shore and wading birds.

[5] No decision has been made regarding human-made structures, such as buoys (at sea or in bays), piers/docks (nearshore, bay, estuary), platforms (nearshore and offshore) with regard to habitat vs. microhabitat, etc.

Marine-Nearshore-Exposed Coast Intertidal; Supratidal zone (I).
Marine-Nearshore-Exposed Coast Intertidal; Upper Intertidal zone (II).
Marine-Nearshore-Exposed Coast Intertidal; Middle Intertidal zone (III).
Marine-Nearshore-Exposed Coast Intertidal; Lower Intertidal zone (IV).

Significant Microhabitat consideration:

tide pools	surf-grasses	coralline algae community
Laminarian algae community	caves	haul-out sites
rookeries	'other' algae community (to be determined)	

Habitat 5 Marine Nearshore Exposed Coast Subtidal Neritic

Open water habitat of nearshore, exposed coast environment constantly inundated, zero exposure to air. Begins at the lowest lower-low tidal elevations. These waters lie over the continental shelf. Laminarian algae and *Phyllospadix* spp. are good indicators of the transition from intertidal to subtidal habitats.

Marine-Nearshore-Exposed Coast Subtidal Neritic; Surface Layer zone.
Marine-Nearshore-Exposed Coast Subtidal Neritic; water column zone.

Significant Microhabitat considerations:

surf action	reefs	eddies
haloclines	thermoclines	rock outcrops
rookeries	haul-out sites	

Habitat 6 Marine Nearshore Exposed Coast Subtidal Benthic

Substrate or substrate-associated habitat of the nearshore, exposed coast extending out on the continental shelf up to the shelf-slope transition.

Marine-Nearshore-Exposed Coast Subtidal Benthic; Epibenthic zone.
Marine-Nearshore-Exposed Coast Subtidal Benthic; Inbenthic zone.

Significant microhabitat considerations:

reefs	caves	algal community X
rock outcrops	tidal elevation	Laminarian algae community
surf-grasses		coralline algae community

Habitat 7 Marine Nearshore Exposed Coast Kelp Forest

Unique biotic habitat of the subtidal exposed coast physically and ecologically defined by the presence of a kelp community (i.e., *Nereocystis*, *Macrocystis*).

Macrocystis integrifolia Oregon border to central coast; infrequent in tidal channels,

gently sloping, rocky ledges of lower intertidal to upper subtidal; perennial.

M. pyrifera Entire coast; dominant forest kelp, attached to rocky or even course sandy substrata 6-80 meters deeps.

Nereocystis luetkeana Common Monterey Peninsula north; attached to rock substratum 1-17 meters; annual to 18 month life-span.

Marine Nearshore Exposed Coast Kelp Forest; *Macrocystis pyrifera* community.
- Marine-Kelp Forest; forest surface zone.
- Marine- Kelp Forest; forest canopy zone.
- Marine-Kelp Forest; subcanopy zone.
- Marine- Kelp Forest; forest periphery zone.
- Marine- Kelp Forest; forest interior zone.
- Marine-Kelp Forest; holdfast zone.

Marine Nearshore Exposed Coast Kelp Forest; *Nereocystis luetkeana* community.
- Marine-Kelp Forest; forest surface zone.
- Marine- Kelp Forest; forest canopy zone.
- Marine-Kelp Forest; subcanopy zone.
- Marine- Kelp Forest; forest periphery zone.
- Marine- Kelp Forest; forest interior zone.
- Marine-Kelp Forest; holdfast zone.

Marine Nearshore Exposed Coast Kelp Forest; *Macrocystis integrifolia* community.
- Marine-Kelp Forest; forest surface zone.
- Marine- Kelp Forest; forest canopy zone.
- Marine-Kelp Forest; subcanopy zone.
- Marine- Kelp Forest; forest periphery zone.
- Marine- Kelp Forest; forest interior zone.
- Marine-Kelp Forest; holdfast zone.

Canopy	Upper reaches of forest where kelp species defining community is predominant or exclusively present.
Holdfast	Benthic environment of substrate (i.e., sand, rock) and holdfasts of kelp species.
Interior	Completely enclosed region of forest where forest algae are all-surrounding.
Periphery	Perimeter region of forest interfacing the open water with the forest.
Subcanopy	Middle to lower reaches of forest where intermix of algae predominates.

Significant microhabitat considerations:

Habitat 8 Marine Nearshore Exposed Coast Surf-grass Bed

Unique biotic habitat of the subtidal surf zones and rocky, exposed coast (just below low tide level) physically and ecologically defined by the presence of a surf-grass (*Phyllospadix* spp.) community.

Phyllospadix scouleri Surf zone and rocky shores below low-tide elevations; occurs along entire coast of California.

Phyllospadix torreyi	Surf zone and rocky shores below low-tide elevations; occurs along entire coast of California.

Marine Nearshore Exposed Coast Surf-grass Bed; *Phyllospadix scouleri* community.
- Marine-Exposed Coast Surf-grass Bed; bed surface zone.
- Marine-Exposed Coast Surf-grass Bed; bed zone.
- Marine-Exposed Coast Surf-grass Bed; periphery zone.
- Marine-Exposed Coast Surf-grass Bed; root mass zone.

Marine Nearshore Exposed Coast Surf-grass Bed; *Phyllospadix torreyi* community.
- Marine-Exposed Coast Surf-grass Bed; bed surface zone.
- Marine-Exposed Coast Surf-grass Bed; bed zone.
- Marine-Exposed Coast Surf-grass Bed; periphery zone.
- Marine-Exposed Coast Surf-grass Bed; root mass zone.

Significant microhabitat considerations:
- burrows

Habitat 9 Marine-Nearshore-Protected Coast Shoreline and Beach[6]

Terrestrial habitat adjacent to the supratidal zone of the intertidal habitat of the protected coastline. Marine environment still has important ecological effect on this habitat. Wind has a lesser role here than on exposed coastal areas. Wave and tidal action may affect indirectly the structure and composition of substrata, if only seasonally. This habitat is frequently or infrequently utilized by terrestrial vertebrates.

Significant microhabitat considerations:

cliffs and bluffs	sand dunes	vegetation types
boulders	ponds	

Habitat 10 Marine-Nearshore-Protected Coast Intertidal

This coastline habitat is characterized by three primary factors: 1) exposure to air, 2) some level of protection from the energy of wave-action, and 3) a proximate relationship to the shore. This region ranges from the shore to water depths of approximately 7 to 10 meters. Coastal marine waters between mean highest-high and mean lowest-low tide elevations and along coastline that is protected to semi-protected by the energy of direct wave-action. Such insulation may be due to the concave shape of the coastline or shielding by headlands, nearshore islands, or underwater reefs and bars. The time of exposure to drying factors such as wind, air, and sun varies greatly, ranging from perpetual except for the input of ocean spray only (supratidal) to exposed only on lowest

[6] Beach, Shorelines, Banks: Necessary to link terrestrial with aquatic habitats; most significant for mammals and birds coming down to the water and for shore and wading birds.

low tides (lower). Species occupying the higher reaches of this habitat are capable of long-term and consistent exposure to air, while species nearing subtidal levels are capable of only minimal and infrequent exposure. The zonation scheme here is adopted from *Between Pacific Tides*. The numbers in parentheses represent this scheme.

Marine-Nearshore-Protected Coast Intertidal; Supratidal zone (I).
Marine-Nearshore-Protected Coast Intertidal; Upper Intertidal zone (II).
Marine-Nearshore-Protected Coast Intertidal; Middle Intertidal zone (III).
Marine-Nearshore-Protected Coast Intertidal; Lower Intertidal zone (IV).

Significant Microhabitat consideration:

tide pool	surf- and eel-grasses	coralline algae community
Laminarian algae community	caves	haul-out sites
rookeries	'other' algae community (to be determined)	

Habitat 11 Marine-Nearshore-Protected Coast Subtidal Neritic

Protected subtidal habitat is primarily characterized by 1) total relationship to marine water, that is, no exposure to air and 2) protection from the energy of wave-action. This habitat starts at the edge of the intertidal zone and stretches from the shore to water depths of approximately 150-200 meters, up to the continental shelf-slope transition. The habitat spans vertically from the surface layer to the benthic environment. This habitat may be protected by a convex shaped shoreline or by headlands, nearshore islands, or underwater reefs and bars. Species or biotic communities are adapted to constant coverage by seawater and occur in the waters that are the predominant zone of marine photosynthesis and productivity.

Marine-Nearshore-Protected Coast Subtidal Neritic; surface layer zone.
Marine-Nearshore-Protected Coast Subtidal Neritic; water column zone.

Significant microhabitat considerations:

surf action	reefs	eddies
haloclines	thermoclines	rock outcrops
rookeries	haul-out sites	

Habitat 12 Marine Nearshore Protected Coast Subtidal Benthic

Substrate or substrate-associated habitat of the nearshore, protected coast along the continental shelf. The more protected and calmer water conditions result in, substrata that is finer or more transportable settling out in various locations, resulting in the presence of species and communities requiring one of more of these conditions. (see above, EXPOSED COAST)

Marine-Nearshore-Protected Coast Subtidal Benthic; Epibenthic zone.
Marine-Nearshore-Protected Coast Subtidal Benthic; Inbenthic zone.

Significant microhabitat considerations:

reefs	caves	Laminarian algae community
rock outcrops	tidal elevation	coralline algae community
surf- and eel-grasses	bars/benches	'other' algae community

Habitat 13 Marine Nearshore Protected Coast Kelp Forest

Unique biotic habitat of the subtidal protected coast defined by the presence of a kelp community (i.e., *Nereocystis*, *Macrocystis*) (see KELP FOREST HABITAT above)

Marine Nearshore Protected Coast Kelp Forest-*Macrocystis integrifolia* community
- Marine-Kelp Forest; forest surface zone.
- Marine- Kelp Forest; forest canopy zone.
- Marine-Kelp Forest; subcanopy zone.
- Marine- Kelp Forest; forest periphery zone.
- Marine- Kelp Forest; forest interior zone.
- Marine-Kelp Forest; holdfast zone.

Marine Nearshore Protected Coast Kelp Forest-*Macrocystis pyrifera* community
- Marine-Kelp Forest; forest surface zone.
- Marine- Kelp Forest; forest canopy zone.
- Marine-Kelp Forest; subcanopy zone.
- Marine- Kelp Forest; forest periphery zone.
- Marine- Kelp Forest; forest interior zone.
- Marine-Kelp Forest; holdfast zone.

Marine Nearshore Protected Coast Kelp Forest-*Nereocystis leutkeana* community
- Marine-Kelp Forest; forest surface zone.
- Marine- Kelp Forest; forest canopy zone.
- Marine-Kelp Forest; subcanopy zone.
- Marine- Kelp Forest; forest periphery zone.
- Marine- Kelp Forest; forest interior zone.
- Marine-Kelp Forest; holdfast zone.

Significant microhabitat considerations:

Habitat 14 Marine Nearshore Protected Coast Surf-grass Bed

Unique biotic habitat of the subtidal protected coast defined by the presence of a surfgrass (*Phyllospadix* spp.) community. (see SURF-GRASS BED HABITAT above)

Marine Nearshore Protected Coast Surf-grass Bed; *Phyllospadix scouleri* community.
- Marine-Protected Coast Surf-grass Bed; bed surface zone.
- Marine-Protected Coast Surf-grass Bed; bed zone.
- Marine-Protected Coast Surf-grass Bed; periphery zone.
- Marine-Protected Coast Surf-grass Bed; root mass zone.

Marine Nearshore Protected Coast Surf-grass Bed; *Phyllospadix torreyi* community.
Marine-Protected Coast Surf-grass Bed; bed surface zone.
Marine-Protected Coast Surf-grass Bed; bed zone.
Marine-Protected Coast Surf-grass Bed; periphery zone.
Marine-Protected Coast Surf-grass Bed; root mass zone.

Significant microhabitat considerations:
burrows

Habitat 15 Protected Coast Eel-grass Meadow

Subtidal water (5-17 meters below mean low tide), marine community physically and ecologically defined by the presence of a *Zostera pacifica* (subtidal eel-grass) community. Range spans the entire coast of California.

Marine Nearshore Protected Coast Eel-grass Meadow; *Zostera pacifica* community.
Marine-Protected Coast Eel-grass Meadow; bed surface zone.
Marine-Protected Coast Eel-grass Meadow; bed zone.
Marine-Protected Coast Eel-grass Meadow; periphery zone.
Marine-Protected Coast Eel-grass Meadow; root mass zone.

Significant microhabitat considerations:
burrows

Habitat 16 Marine Nearshore Embayment Shoreline and Beach

Terrestrial habitat adjacent to the supratidal zone of the intertidal habitat of the bays. The marine bay environment still has important ecological effect on this habitat. Wind has a lesser role here than on exposed coastal areas. Wave and tidal action may affect indirectly the structure and composition of substrata, if only seasonally. This habitat is frequently utilized by terrestrial vertebrates, especially shore and wading birds.

Significant microhabitat considerations:

cliffs and bluffs	sand dunes	vegetation types
boulders	ponds	mud banks

Habitat 17 Marine Nearshore Embayment Intertidal

Marine intertidal habitat along protected bay but not affected by freshwater influx as would be present in an estuary (see INTERTIDAL habitats above).

Marine-Nearshore-Embayment-Intertidal; supratidal zone.
Marine-Nearshore-Embayment-Intertidal; upper intertidal zone.
Marine-Nearshore-Embayment-Intertidal; middle intertidal zone.
Marine-Nearshore-Embayment-Intertidal; lower intertidal zone.

Significant Microhabitat consideration:

tide pool	eel-grass	caves
algae community X	haul-out sites	rookeries

Habitat 18 Marine Nearshore Embayment Eel-grass Meadow

Subtidal water, marine bay community physically and ecologically defined by the presence of a *Zostera pacifica* (subtidal eel-grass) community.

Marine Nearshore Embayment Eel-grass Meadow; *Zostera pacifica* community.
Marine-Embayment Eel-grass Meadow; bed surface zone.
Marine-Embayment Eel-grass Meadow; bed zone.
Marine-Embayment Eel-grass Meadow; periphery zone.
Marine-Embayment Eel-grass Meadow; root mass zone.

Significant microhabitat considerations:
burrows

Habitat 19 Marine Nearshore Embayment Shallow Water Neritic

Subtidal open, marine waters within an embayment adjacent to intertidal or estuarine waters and up to 5.5-6 meters (18-20 feet) in depth.

Marine-Nearshore-Embayment-Shallow Water Neritic; Surface Layer zone.
Marine-Nearshore-Embayment-Shallow Water Neritic; water column[5] zone.

Significant Microhabitat considerations:

haloclines	thermoclines	rock outcrop
haul-out sites	rookeries	

Habitat 20 Marine Nearshore Embayment Shallow Water Benthic

Substrate or substrate-associated habitat of the marine, shallow waters of a bay. Bottom is predominantly silt, mud, sand, or mixed.
Marine-Nearshore-Embayment-Shallow Water-Benthic; Epibenthic zone.
Marine-Nearshore-Embayment-Shallow Water-Benthic; Inbenthic zone.

Significant Microhabitat considerations:

boulders/rock outcrops	algae community X	channels
reefs	bars/benches	

Habitat 21 Marine Nearshore Embayment Deeper Water Neritic

Subtidal open waters within an embayment deeper than 5.5-6 meters (18-20 feet).

Marine-Nearshore-Embayment-Deeper Water-Neritic; surface layer zone.
Marine-Nearshore-Embayment-Deeper Water-Neritic; water column zone.

Significant Microhabitat considerations:

haloclines	thermoclines	rock outcrop
haul-out sites	rookeries	

Habitat 22 Marine Nearshore Embayment Deeper Water Benthic

Substrate or substrate-associated habitat of the marine, deeper waters of a bay. Bottom is predominantly silt, mud, sand, or mixed.

Marine-Nearshore-Embayment Deeper Water Benthic; Epibenthic zone.
Marine-Nearshore-Embayment-Deeper Water Benthic; Inbenthic zone.

Significant Microhabitat considerations:

boulders/rock outcrops	algae community X	channels
reefs	bars/benches	

Habitat 23 Estuarine Bay Estuary

Embayment with a mixture of fresh and saltwater where there is not water mass/ component that is fully seawater, such as with shallow or deepwater marine embayments.

Estuarine-Bay Estuary; surface layer zone.
Estuarine-Bay Estuary; water column zone.
Estuarine-Bay Estuary; channel epibenthic zone.
Estuarine-Bay Estuary; channel inbenthic zone.

Channel Component of aquatic environment that contains continuously or periodically flowing water that is confined by banks and a substrate bed; excavation created and maintained by the flow of water.

Significant microhabitat considerations:

rookeries	haul-out sites	sloughs
boulder/rock-out crops	bars/benches	burrows

Habitat 24 Estuarine Bay Tidal Flat

Tidal flats are characterized by low aspect and the cycle of tidal exposure-inundation. Substrate composition is predominantly silt, mud, and sand. The flats are intermixed with channels at lower elevations and marshes at higher elevations.

Significant microhabitat considerations:

eel-grass	oyster beds	channels
sloughs	burrows	

Habitat 25 Estuarine Bay Eel-grass Meadow

Shallow water (0-2 meters below mean low tide), bay-estuary habitat physically and ecologically defined by the presence of a *Zostera marina* (bay/estuary eel-grass) community. Range spans the entire coast of California and the Channel Islands.

Estuarine Bay Eel-grass Meadow; *Zostera marina* community.
- Estuarine Bay Eel-grass Meadow; bed surface zone.
- Estuarine Bay Eel-grass Meadow; bed zone.
- Estuarine Bay Eel-grass Meadow; periphery zone.
- Estuarine Bay Eel-grass Meadow; root mass zone.

Significant microhabitat considerations:
- burrows

Habitat 26 Estuarine Bay Tidal Saltwater Marsh[7]

Bay estuarine habitat at higher tidal elevations where emergent, hydrophilic, vascular plants occur that can tolerate higher concentrations of salinity. This habitat is affected both by fresh- and brackish water marshes and more saline regimes from adjacent estuarine and marine waters.

Estuarine-Bay Tidal Saltwater Marsh; upper marsh zone.
Estuarine-Bay Tidal Saltwater Marsh; lower marsh zone.

Significant microhabitat considerations:

Habitat 27 Estuarine Bay Tidal Brackish Water Marsh

Bay estuarine habitat at higher tidal elevations where emergent, hydrophilic, vascular plants occur that cannot tolerate higher concentrations of salinity. This habitat has a seasonal to continual source(s) of freshwater influx.

Estuarine-Bay Tidal Brackish Marsh; upper marsh zone.
Estuarine-Bay Tidal Brackish Marsh; lower marsh zone.

Significant microhabitat considerations:

Habitat 28 Estuarine River Mouth Estuary

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[7] I have not yet depicted marshes by vegetation types latitudinally. If/when I do, there is likely to be 2 to 3 habitats from south to north based on the unique plant species. Vertical zonation may also change. I have used 2 vertical zones, where others (i.e., Ferren et al. 1996) have used 3.

Coastal habitat of river or stream discharge, where fresh and saltwater mixing occurs.

Estuarine-River Mouth Estuary; surface layer zone.
Estuarine-River Mouth Estuary; water column zone.
Estuarine-River Mouth Estuary; channel epibenthic zone.
Estuarine-River Mouth Estuary; channel inbenthic zone.

Significant microhabitat considerations:

rookeries	haul-out sites	sloughs
boulder/rock-out crops	bars/benches	burrows

Habitat 29 Estuarine River Mouth Tidal Flat

Tidal region of river-mouth estuary characterized by low aspect and a cycle of exposure-inundation due to the tides. Substrate composition is predominantly silt, mud, and sand. The flats are intermixed with channels at lower elevations and marshes at higher elevations.

Significant microhabitat considerations:

eel-grass	oyster beds	burrows
channels	sloughs	

Habitat 30 Estuarine River Mouth Tidal Saltwater Marsh.

River mouth estuarine habitat at higher tidal elevations where emergent, hydrophilic, vascular plants occur and that tolerate higher concentrations of salinity. This habitat is affected both by fresh- and brackish water marshes and more saline regimes from adjacent estuarine and marine waters.

Estuarine- River Mouth Tidal Saltwater Marsh; upper marsh zone.
Estuarine- River Mouth Tidal Saltwater Marsh; lower marsh zone.

Significant microhabitat considerations:
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Habitat 31 Estuarine River Mouth Tidal Brackish Water Marsh

River mouth estuarine habitat at higher tidal elevations where emergent, hydrophilic, vascular plants occur that cannot tolerate higher concentrations of salinity. This habitat has a seasonal to continual source(s) of freshwater influx.

Estuarine-River Mouth Tidal Brackish Marsh; upper marsh zone.
Estuarine-River Mouth Tidal Brackish Marsh; lower marsh zone.

Significant microhabitat considerations:

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Habitat 32 Estuarine Canyon Mouth Estuary

Open-water habitat at coastal discharge of a canyon creating a mixture of fresh and saltwater.

Estuarine-Canyon Mouth Estuary; surface layer zone.
Estuarine-Canyon Mouth Estuary; water column zone.
Estuarine-Canyon Mouth Estuary; channel epibenthic zone.
Estuarine-Canyon Mouth Estuary; channel inbenthic zone.

Significant microhabitat considerations:

rookeries	haul-out sites	sloughs
boulder/rock-out crops	bars/benches	burrows

Habitat 33 Estuarine Canyon Mouth Tidal Flat

Tidal region of canyon-mouth characterized by low aspect and a cycle of exposure-inundation due to the tides. Substrate composition is predominantly silt, mud, and sand. The flats are intermixed with channels at lower elevations and marshes at higher elevations.

Significant microhabitat considerations:

burrows	eel-grass

Habitat 34 Estuarine Canyon Mouth Tidal Saltwater Marsh

Canyon mouth estuarine habitat at higher tidal elevations where emergent, hydrophilic, vascular plants occur can occur that can also tolerate higher concentrations of salinity. This habitat is affected both by fresh- and brackish water marshes and more saline regimes from adjacent estuarine and marine waters.

Estuarine-Canyon Mouth Estuary-Tidal Saltwater Marsh; upper marsh zone.
Estuarine- Canyon Mouth Estuary-Tidal Saltwater Marsh; lower marsh zone.

Significant microhabitat considerations:
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Habitat 35 Estuarine Canyon Mouth Tidal Brackish Water Marsh

Canyon-mouth estuarine habitat at higher tidal elevations where emergent, hydrophilic, vascular plants occur that cannot tolerate higher concentrations of salinity. This habitat

has a seasonal to continual source(s) of freshwater influx.

Estuarine-Canyon Mouth-Tidal Brackish Marsh; upper marsh zone.
Estuarine-Canyon Mouth-Tidal Brackish Marsh; lower marsh zone.

Habitat 36 Estuarine Coastal Dune Estuary

Dune system-coastal stream discharge resulting in an open water body/mixture of fresh and saltwater.

Estuarine-Coastal Dune Estuary; surface layer zone.
Estuarine-Coastal Dune Estuary; water column zone.
Estuarine-Coastal Dune Estuary; channel epibenthic zone.
Estuarine-Coastal Dune Estuary; channel inbenthic zone.

Significant microhabitat considerations:

rookeries	haul-out sites	sloughs
boulder/rock-out crops	bars/benches	burrows
saline pond		

Habitat 37 Estuarine Coastal Dune Tidal Flat

Tidal region of canyon-mouth characterized by low aspect and a cycle of exposure-inundation due to the tides. Substrate composition is predominantly silt, mud, or sand. Tidal flats are intermixed with channels at lower elevations and marshes at higher elevations.

Significant microhabitat considerations:

burrows	eel-grass

Habitat 38 Estuarine Coastal Dune Tidal Saltwater Marsh

Coastal dune estuarine habitat at higher tidal elevations where emergent, hydrophilic, vascular plants occur can occur that can also tolerate higher concentrations of salinity. This habitat is affected both by fresh- and brackish water marshes and more saline regimes from adjacent estuarine and marine waters.

Estuarine-Coastal Dune-Tidal Saltwater Marsh; upper marsh zone.
Estuarine- Coastal Dune-Tidal Saltwater Marsh; lower marsh zone.

Significant microhabitat considerations:
Saline pond

Habitat 39 Estuarine Coastal Dune Tidal Brackish Water Marsh

Coastal dune estuarine habitat at higher tidal elevations where emergent, hydrophilic,

vascular plants occur that cannot tolerate higher concentrations of salinity. This habitat has a seasonal to continual source(s) of freshwater influx.
Estuarine-Coastal Dune-Tidal Brackish Marsh; upper marsh zone.
Estuarine-Coastal Dune-Tidal Brackish Marsh; lower marsh zone.

Significant microhabitat considerations:
Brackish-water dune pond

Habitat 40 Estuarine Lagoon Shoreline and Beach

Terrestrial habitat adjacent to and affected by lagoons.

Significant microhabitat considerations:
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Habitat 41 Estuarine Lagoon

Shallow lake or pond connected with ocean water; an area of shallow water of various and often fluctuating salinity separated from the sea by a strip of terrestrial substratum such as sand dunes, gravel/cobble beaches or mud berms; this water body is infrequently breached such that (1) what was lagoon waters are now freely influenced by the tide, (2) beach and berm materials are completely or partially washed out to sea, and (3) there existed an estuary environment of freshwater source(s) interfacing with marine tidal waters until the beach or berm begins to reform. This habitat is frequented by terrestrial vertebrates, and when breached and upon initial re-closure (until, and if, reaching hypersaline conditions), is occupied by marine and estuarine aquatic species.

Estuarine-Lagoon; surface layer zone.
Estuarine-Lagoon; water column zone.
Estuarine-Lagoon; epibenthic zone.
Estuarine-Lagoon; inbenthic zone.

Significant microhabitat considerations:
boulders/rock outcrops emergent vegetation community X
hypersaline regime

Habitat	Zone	Substratum

APPENDIX I. ***Habitat-zone-substratum hierarchy***

Habitat	Zone	Substratum

Marine

Offshore

Pelagic

Surface layer
Epipelagic
Mesopelagic
Photic
Aphotic
Bathypelagic
Abyssopelagic

Benthic ..... bedrock gravel silt
Archibenthic boulder sand detritus
Archi-epibenthic cobble mud sand
Archi-inbenthic
Abyssobenthic
Abysso-epibenthic
Abysso-inbenthic

Nearshore

Exposed Coast

Shoreline and Beach sandy rocky mixed

Intertidal ..... for all: bedrock gravel silt
Supratidal boulder sand detritus
Upper intertidal cobble mud
Middle intertidal

Lower intertidal

Habitat	Zone	Substratum			
	Subtidal				
	-Neritic				
	Surface layer				
	Water column				
	-Benthic .....for both:	bedrock	gravel	silt	
	Epibenthic	boulder	sand	detritus	
	Inbenthic	cobble	mud		
	Kelp Forest				
	Surf-grass Bed				
	Eel-grass Meadow				
Protected Coast					
	Shoreline and Beach	sandy	rocky	mixed	
	Intertidal ..... for all:	bedrock	gravel	silt	
	Supratidal	boulder	sand	detritus	
	Upper intertidal	cobble	mud		
	Middle intertidal				
	Lower intertidal				
	Subtidal				
	-Neritic				
	Surface layer				
	Water column				
	-Benthic .....for both:	bedrock	gravel	silt	
	Epibenthic	boulder	sand	detritus	
	Inbenthic	cobble	mud		
	Kelp forest				
	Surf-grass Bed				
	Eel-grass Meadow				
Marine					

Habitat	Zone	Substratum		
Embayment				
Shoreline and Beach		sandy	rocky	mixed
Intertidal	for all:	bedrock	gravel	silt
	Supratidal	boulder	sand	detritus
	Upper intertidal	cobble	mud	
	Middle intertidal			
	Lower intertidal			
Inland Marine Shallow Waters				
-Neritic				
	Surface layer			
	Water column			
-Benthic	for both:	bedrock	gravel	silt
	Epibenthic	boulder	sand	detritus
	Inbenthic	cobble	mud	
Inland Marine Deeper Waters				
-Neritic				
	Surface layer			
	Water column			
-Benthic	for both:	bedrock	gravel	silt
	Epibenthic	boulder	sand	detritus
	Inbenthic	cobble	mud	
Estuarine				
Bay Estuary				
	Surface layer			
	Water column			
	Channel-	for both:	cobble	gravel	sand
	Epibenthic	silt	mud	detritus
	Inbenthic			
Bay Tidal Flat		sand	silt	clay

Habitat	Zone	Substratum		
		mud	detritus	mixed
Bay Eel-grass Meadow				
Bay Tidal Saltwater Marsh				
	Upper marsh			
	Lower marsh			
Bay Tidal Brackish Water Marsh				
	Upper marsh			
	Lower marsh			
River Mouth Estuary				
	Surface layer			
	Water column			
	Channel-.....for both:	cobble	gravel	sand
	Epibenthic	silt	mud	detritus
	Inbenthic			
River Mouth Tidal Flat		sand	silt	clay
		mud	detritus	mixed
River Mouth Tidal Saltwater Marsh				
	Upper marsh			
	Lower marsh			
River Mouth Tidal Brackish Water Marsh				
	Upper marsh			
	Lower marsh			
Canyon Mouth Estuary				
	Surface layer			
	Water column			
	Channel-.....for both:	cobble	gravel	sand
	Epibenthic	silt	mud	detritus
	Inbenthic			
Canyon Mouth Tidal Flat		sand	silt	clay
		mud	detritus	mixed

Habitat	Zone	Substratum			
Canyon Mouth Tidal Saltwater Marsh					
	Upper marsh				
	Lower marsh				
Canyon Mouth Tidal Brackish Water Marsh					
	Upper marsh				
	Lower marsh				
Coastal Dune Estuary					
	Surface layer				
	Water column				
	Channels	for both:	cobble	gravel	sand
	Epibenthic		silt	mud	detritus
	Inbenthic				
Coastal Dune Tidal Flat			sand	silt	clay
			mud	detritus	mixed
Coastal Dune Tidal Saltwater Marsh					
	Upper marsh				
	Lower marsh				
Coastal Dune Tidal Brackish Water Marsh					
	Upper marsh				
	Lower marsh				
Lagoon Shoreline and Beach			mud	sandy	rocky
Lagoon					
	Surface layer				
	Water column				
	Epibenthic	for both:	cobble	gravel	sand
	Benthic		silt	mud	detritus
			clay	mixed	

APPENDIX II. *Crosswalks to existing marine and estuarine schemes applicable to California*

Ferren, W.R., Jr., P.L. Fiedler, and R.A. Leidy. 1996. Wetlands of the Central and Southern California Coast and Coastal Watersheds: a methodology for their classification and description. Final Report for United States Environmental Protection Agency (EPA). February 6, 1995; revised August 1996. A detailed classification and description using water system, water regime and chemistry, hydro-geomorphology, and type characteristics for classifying wetlands in central and southern California.

Goals Project. 1999. Baylands Ecosystem Habitat Goals: A report of habitat recommendations. Prepared by the San Francisco Bay Area Wetlands Ecosystem Goals Project. United States EPA and San Francisco Bay Regional Water Quality Control Board; 295 pages. An assessment of past and present conditions of the San Francisco baylands ecosystem, with a detailed habitat description, including geo-referenced maps.

Greene, H.G., M.M. Yoklavich, R.M. Starr, V.M. O'Connell, W.W. Wakefield, D.E. Sullivan, J.E. McRea, and G.M. Cailleit. 1999. A classification scheme for deep sea floor habitats. Oceanologica Acta 22(6):663-678. A classification system for marine benthic habitats in deepwater using geophysical data in situ biological and geologic observations.

Allee, R., M. Dethier, D. Brown, L, Deegan, R.G. Ford, T.F. Hourigan, J. Maragos, C. Schoch, K. Sealey, R. Twilley, M.P. Weinstein, and M. Yoklavich. 2000. Marine and Estuarine Ecosystem and Habitat Classification. National Oceanic and Atmospheric Administration Technical Memorandum NMFS-F/SPO-43, July 2000; 43 pages. A hierarchal system including 13 levels and encompassing life zones (i.e., polar, temperate, tropical) to ecotypes and biotic communities. Number/character codes are NOAA's and are described in the publication.

Proposed CWHR	South/Central California (1996)	Baylands Report (1999)	Deepwater Benthic (1999)	National (2000)
MARINE				1a-temperate; 2a-terrestrial or b-water; 3a-marine
Offshore	System Marine-Subsystem Subtidal	NA[8]		2b; 4b-non-continental
Pelagic	Marine-Subtidal; Ocean	-	NA	5b-water column; 6a-shallow, b-mid-depth, or c-deep; 10a-photic or b-

[8] NA: Not applicable

Proposed CWHR	South/Central California (1996)	Baylands Report (1999)	Deepwater Benthic (1999)	National (2000)
				aphotic
Benthic	Marine-Subtidal; Ocean	-	System: Marine Benthic Subsystems (mega- and meso- habitat levels as defined within paper): · continental shelf-outer · continental slope-upper, -intermediate, and -lower · continental rise · abyssal plain · trenches · submarine canyons · sea mounts	5a-bottom; 6b or c
Nearshore Exposed Coast	System Marine-Subsystems Inter- and Subtidal	NA		4a-continental; 5a or b; 6a; 7a-exposed/open
Shoreline & Beach	Marine-Intertidal-Classes rocky- and unconsolidated shore; Ocean: (a) -beach; (b) -shore; (c) -bench	-	NA	2a-terrestrial; 8a-shoreline; 11-beach face, dunes; 12b (ecotype)-beach
Intertidal	Marine-Intertidal; Classes rocky- and unconsolidated shore; a) ocean, (b) cove, and (c) tide pool	-	Subsystem continental shelf-intertidal	2b; 5b; 8a-nearshore; 9a-supratidal or b-intertidal
Subtidal Pelagic	Marine-Subtidal; a) Ocean, (b) cove, and (c) sea cave	-	NA	2b; 5b; 8a-inshore; 9c-subtidal or d-circulation features; 10a or 10b
Subtidal Benthic	Marine-Subtidal; Classes rocky-, unconsolidated-,	-	Subsystem continental shelf-shallow subtidal	2b; 5a; 8a; 9c or 9d; 10a or 10b

Proposed CWHR	South/Central California (1996)	Baylands Report (1999)	Deepwater Benthic (1999)	National (2000)
	aquatic bed- and reef; a) Ocean, (b) cove, (c) tide pool, (d) sea cave			
Kelp Forest	Marine-Subtidal; Class aquatic bed; a) Ocean, (b) cove, and (c) tide pool	-	Subsystem continental shelf-shallow subtidal; Modifiers for biological process-kelp understory, -kelp forest	2b; 5a; 8a; 9c or d; 10a or b; 12b-kelp bed
Surf-grass Bed	Marine-Subtidal; Class aquatic bed; a) Ocean, (b) cove, and (c) tide pool	-	Subsystem continental shelf-shallow subtidal; Modifier for biological process-sea grasses	2b; 5a; 8a; 9c or d; 10a or b; 12b-seagrass bed
Eel-grass Meadow	Marine-Subtidal; Class aquatic bed; a) Ocean, (b) cove, and (c) tide pool		Subsystem continental shelf-shallow subtidal; Modifier for biological process-sea	2b; 5a; 8a; 9c or 9d; 10a or b; 12b-seagrass bed
Nearshore Protected Coast	System Marine	NA		4a-continental; 5a or b; 6a; 7b-protected/bounded
Shoreline & beach	Marine-Intertidal; Classes rocky- and unconsolidated shore; Ocean: a) -beach, (b) -shore, and (c) -bench	-	NA	2a; 8a-shoreline; 11-beach face, dunes; 12b (ecotype)-beach
Intertidal	Marine-Intertidal Classes rocky- and unconsolidated shore; a) Ocean, (b) cove, (c) tide pool, (d) surge channel, (e) fissure, and (f) sea cave	-	Subsystem continental shelf-intertidal	2b; 5b; 8a-nearshore; 9a or b
Subtidal Pelagic	Marine-Subtidal; a) Ocean, (b) cove, and (c) sea cave	-		2b; 5b; 8a-inshore; 9c or d; 10a or b
Subtidal Benthic	Marine-Subtidal; Classes rocky-, unconsolidated-,	-	Subsystem continental shelf-	2b; 5a; 8a; 9c or d; 10a or b

Proposed CWHR	South/Central California (1996)	Baylands Report (1999)	Deepwater Benthic (1999)	National (2000)
	aquatic bed- and reef; a) Ocean, (b) cove, (c) tide pool, (d) surge channel, (e) fissure, and (f) sea cave		shallow subtidal	
Kelp Forest	Marine-Subtidal; Class aquatic bed; a) ocean and (b) cove	-	Subsystem continental shelf-shallow subtidal; Modifiers for biological process-kelp understory, -kelp forest	2b; 5a; 8a; 9c or d; 10a or b; 12b-kelp bed
Surf-grass Bed	Marine-Subtidal; Class aquatic bed; a) ocean, (b) cove, (c) tide pool, (d) surge channel, (e) fissure, and (f) sea cave	-	Subsystem continental shelf-shallow subtidal; Modifier for biological process-sea	2b; 5a; 8a; 9c or d; 10a or b; 12b-seagrass bed
Eel-grass Meadow	Marine-Subtidal; Class aquatic bed; a) ocean, (b) cove, (c) tide pool, (d) surge channel, (e) fissure, and (f) sea cave		Subsystem continental shelf-shallow subtidal; Modifier for biological process-sea	2b; 5a; 8a; 9c or d; 10a or b; 12b-seagrass bed
Nearshore Embayment	System Marine	-variable-		2a or b; 3a; 4a; 5a or b; 6a; 7b
Shoreline & Beach	Marine-Intertidal; Exposed Bay: (a) -shores, (b) -beaches, (c) -benches	1. Rocky Shore, 2. Beach	NA	8a-shorelines; 11-beach face; 12b-beach
Intertidal	Marine-Intertidal; Exposed Bay;	Tidal Flat	Subsystem continental shelf-intertidal	5b; 8a-embayment; 9a or b
Shallow Water Pelagic	Marine-Intertidal; (a) Exposed Bay, (b) Harbors/Ports	Shallow Bay & Channel	NA	5b; 8a-embayment; 9c; 10a

Proposed CWHR	South/Central California (1996)	Baylands Report (1999)	Deepwater Benthic (1999)	National (2000)
Eel-grass Meadow	Marine-Subtidal; (a) Exposed Bay, (b) Harbors/Ports			5b; 8a-embayment; 9c; 10a; 12b-seagrass bed
Shallow Water Benthic	Marine-Intertidal; (a) Exposed Bay, (b) Harbors/Ports	Shallow Bay and Channel	Subsystem continental shelf-shallow subtidal	5a; 8a-embayment; 9c; 10a
Deeper Water Pelagic	Marine-Intertidal; (a) Exposed Bay, (b) Harbors/Ports	Deep Bay & Channel	NA	5b; 8a-embayment; 9c; 10a or b
Deeper Water Benthic	Marine-Intertidal; (a) Exposed Bay, (b) Harbors/Ports	Deep Bay & Channel	Subsystem continental shelf-shallow subtidal	5a; 8a-embayment; 10 a or b
ESTUARINE	System Estuarine			1a; 2a or b; 3a; 4a-continental; 5a or b; 6a; 7b-protected/bounded
Bay Estuary	Estuarine-Subtidal; Estuaries; (a) Bay-estuaries, (b) Surge channels, (c) estuarine channels; Exposed bay: (d) -shores, (e) -beaches, (f) -banks, (g) -benches, (h) -terraces	Shallow Bay and Channel	NA	2b; 8a-estuary; 9b or c; 10 a or b
Bay Eel-grass Meadow	Estuarine-Intertidal; (a) flats, (b) deltas	Tidal Flats	NA	2b; 9c; 10a; 12b-seagrass bed
Bay Tidal Flats	Estuarine-Intertidal; (a) flats, (b) deltas	Tidal Flats	NA	2b; 8a-estuary or delta; 9b; 10a; 12b-mud flat
Bay Tidal Saltwater Marsh	Estuarine-Intertidal; (a) tidal marsh channel, (b) salt marshes	Tidal Marsh	NA	2b; 8a-estuary; 9b; 10a; 12b-salt marsh
Bay Tidal Brackish Water Marsh	Estuarine-Intertidal; (a) tidal marsh channel, (b) brackish	Tidal Marsh	NA	2b; 8a-estuary; 9b; 10a;

Proposed CWHR	South/Central California (1996)	Baylands Report (1999)	Deepwater Benthic (1999)	National (2000)
	marshes			12b-wetland
River Mouth Estuary	Estuarine-Subtidal; (a) Estuaries; River-Mouth; (b) tidal-river channels: main stem and tributary	Shallow Bay and Channel	NA	2b; 8a-estuary; 9b; 10a; 11-riverine
River Mouth Tidal Flats	Estuarine-Intertidal; (a) flats, (b) deltas	Tidal Flats	NA	2b; 8a-estuary or delta; 9b; 10a; 11-riverine; 12b-mud flat
River Mouth Tidal Saltwater Mar	Estuarine-Intertidal; (a) tidal marsh channel; (b) salt marshes	Tidal Marsh	NA	2b; 8a-estuary; 9b; 10a; 11-riverine; 12b-salt marsh
River Mouth Tidal Brackish Wat	Estuarine-Intertidal; (a) tidal marsh channel, (b) brackish marshes	Tidal Marsh	NA	2b; 8a-estuary; 9b; 10a; 11-riverine; 12b-wetland
Canyon Mouth Estuary	Estuarine-Subtidal; (a) Estuaries; Canyon-Mouth, (b) tidal-stream channel: canyon stream	Shallow Bay and Channel	NA	2b; 8a-estuary; 9b; 10a; 11-riverine
Canyon Mouth Tidal Flats	Estuarine-Intertidal; (a) flats, (b) deltas	Tidal Flats	NA	2b; 8a-estuary or delta; 9b; 10a; 11-riverine; 12b-mud flat
Canyon Mouth Tidal Saltwater	Estuarine-Intertidal; (a) tidal marsh channel; (b) salt marshes	Tidal Marsh	NA	2b; 8a-estuary; 9b; 10a; 11-riverine; 12b-salt marsh
Canyon Mouth Tidal Brackish W	Estuarine-Intertidal; (a) tidal marsh channel; (b) brackish marshes	Tidal Marsh	NA	2b; 8a-estuary; 9b; 10a; 11-riverine; 12b-wetland

Proposed CWHR	South/Central California (1996)	Baylands Report (1999)	Deepwater Benthic (1999)	National (2000)
Coastal Dunes Estuary	Estuarine-Subtidal; (a) Estuaries; Dune-Stream, (b) tidal-stream channel: dune stream	Shallow Bay and Channel	NA	2b; 8a-estuary; 9b; 10a; 11-dunes; 12b-wetland
Coastal Dunes Tidal Flats	Estuarine-Intertidal; (a) flats, (b) deltas	Tidal Flats	NA	2b; 8a-estuary or delta; 9b; 10a; 11-dunes; 12b-wetland or mud flat
Coastal Dunes Tidal Saltwater Marsh	Estuarine-Intertidal; (a) tidal marsh channel; (b) salt marshes	Tidal Marsh	NA	2b; 8a-estuary; 9b; 10a; 11-dune; 12b-salt marsh
Coastal Dunes Tidal Brackish Wa	Estuarine-Intertidal; (a) tidal marsh channel; (b) brackish marshes	Tidal Marsh	NA	2b; 8a-estuary; 9b; 10a; 11-riverine; 12b-wetland
Lagoon Shoreline & Beach	Estuarine- Intertidal; Lagoon: (a)-shores, (b) -beaches, (c) -benches	Lagoon	NA	2a; 8a-lagoon or shoreline
Lagoon	Estuarine-Intertidal; Lagoons	Lagoon	NA	2b; 8a-lagoon; 9b; 10a; 11-riverine, beach face, or dune; 12b-wetland

APPENDIX III. *Crosswalks to draft marine and estuarine habitat schemes applicable to California*

Channel Island National Marine Sanctuary. Drafted in the summer 2000. The number codes are CINMS's.

Wildlife-Habitat Relationships in Oregon and Washington. D.H. Johnson and T.A. O'Neil. 2001. Oregon Press. A final version [classification scheme, habitat descriptions, animal assemblages, model, and CD] was released in February 2001. The publication compiles and synthesizes a vast amount of diverse information on 593 wildlife species and their relationships with the 32 terrestrial, freshwater, and marine habitats of Oregon and Washington. It includes photographs of each habitat, as well as hundreds of maps, diagrams, and other illustrations. The accompanying CD-ROM contains additional wildlife data and color maps, and seven matrixes that link wildlife species with their respective habitats. The 88 contributing authors include experts in wildlife, botany, fisheries, conservation biology, vegetation mapping, and the ecology of forest, rangeland, and marine environments. The information is intended for use by natural resource managers and planners, scientists, conservationists, educators, and other individuals with a deep interest in wildlife species and their habitats.

Proposed CWHR	CINMS (2000) (habitat number/name)	Oregon/Washington WHR (2001)
MARINE		
Offshore		*Oceanic*
Pelagic	15 Open Water Zone	Oceanic
Benthic	13 Canyon 14 Continental Slope/Basin	Oceanic
Nearshore Exposed Coast	NA	-variable-
Shoreline & beach	1 Exposed Rocky Cliffs-Steep Intertidal	Marine Nearshore (MN)
Intertidal	1 Exposed Rocky Cliffs-Steep Intertidal	Marine Nearshore
Subtidal Pelagic	8 Shallow Rocky Shelf 10 Deep Rocky Shelf	Marine Shelf

Proposed CWHR	CINMS (2000) (habitat number/name)	Oregon/Washington WHR (2001)
	11 Shallow Non-Rocky Shelf 12 Deep Non-Rocky Shelf	
Subtidal Benthic	8 Shallow Rocky Shelf 10 Deep Rocky Shelf 11 Shallow Non-Rocky Shelf 12 Deep Non-Rocky Shelf	Marine Shelf
Kelp Forest	9 Kelp Forest	MN or Marine Shelf
Surf-grass Bed	7 Seagrass Beds	Marine Nearshore
Eel-grass Meadow	7 Seagrass Beds	Marine Nearshore
Nearshore Protected Coast	NA	-variable-
Shoreline & Beach	2 Sandy Beaches 3 Rocky Beaches	Marine Nearshore
Intertidal	2 Sandy Beaches 3 Rocky Beaches	Marine Nearshore
Subtidal Pelagic	8 Shallow Rocky Shelf 10 Deep Rocky Shelf 11 Shallow Non-Rocky Shelf 12 Deep Non-Rocky Shelf	Marine Shelf
Subtidal Benthic	8 Shallow Rocky Shelf 10 Deep Rocky Shelf 11 Shallow Non-Rocky Shelf 12 Deep Non-Rocky Shelf	Marine Shelf
Kelp Forest	9 Kelp Forest	MN or Marine Shelf
Surf-grass Bed	7 Seagrass Beds	Marine Nearshore

Proposed CWHR	CINMS (2000) (habitat number/name)	Oregon/Washington WHR (2001)
Eel-grass Meadow	7 Seagrass Beds	Marine Nearshore
Nearshore Embayment	NA	-variable-
Shoreline & Beach	6 Estuaries	Bays & Estuaries
Intertidal	6 Estuaries	Bays & Estuaries
Eel-grass Meadow	7 Seagrass Beds -or- 6 Estuaries	Bays & Estuaries
Shallow Water Pelagic	6 Estuaries	Inland Marine Deeper Water
Shallow Water Benthic	6 Estuaries	Inland Marine Deeper Water
Deeper Water Pelagic	6 Estuaries	Inland Marine Deeper Water
Deeper Water Benthic	6 Estuaries	Inland Marine Deeper Water
ESTUARINE		
Bay Estuary	6 Estuaries	Bays & Estuaries
Bay Eel-grass Meadow	7 Seagrass Beds -or- 6 Estuaries	Bays & Estuaries
Bay Tidal Flats	4 Tidal Flats	Bays & Estuaries
Bay Tidal Saltwater Marsh	5 Marshes	Bays & Estuaries
Bay Brackish Water Marsh	5 Marshes	Bays & Estuaries
River Mouth Estuary	6 Estuaries	Bays & Estuaries
River Mouth Tidal Flats	4 Tidal Flats	Bays & Estuaries
River Mouth Tidal Saltwater Marsh	5 Marshes	Bays & Estuaries
River Mouth Tidal Brackish Water Marsh	5 Marshes	Bays & Estuaries

Proposed CWHR	CINMS (2000) (habitat number/name)	Oregon/Washington WHR (2001)
Canyon Mouth Estuary	6 Estuaries	Bays & Estuaries
Canyon Mouth Tidal Flats	4 Tidal Flats	Bays & Estuaries
Canyon Mouth Tidal Saltwater Marsh	5 Marshes	Bays & Estuaries
Canyon Mouth Tidal Brackish Water Marsh	5 Marshes	Bays & Estuaries
Coastal Dunes Estuary	6 Estuaries	Bays & Estuaries
Coastal Dunes Tidal Flats	4 Tidal Flats	Bays & Estuaries
Coastal Dunes Tidal Saltwater Marsh	5 Marshes	Bays & Estuaries
Coastal Dunes Tidal Brackish Water Marsh	5 Marshes	Bays & Estuaries
Lagoon Shoreline & Beach	6 Estuaries	Bays & Estuaries
Lagoon	6 Estuaries	Bays & Estuaries

APPENDIX V. ***Glossary***

Abyssal plain	The deep ocean floor, an expanse of low relief at depths of 4,000-6,000 meters.
Abyssopelagic	Of or relating to the ocean depths between 4,000-6,000 meter depth zone, seaward of the continental shelf-slope break.
Bathypelagic	Of or relating to the ocean depths between 1,000-4,000 meter depth zone, seaward of the continental shelf-slope zone.
Bay	- SEE Embayment-
Beach	Terrestrial habitat adjacent to estuarine and marine tidal environments.
Bedrock	Solid rock that lies beneath mud, sand, boulder, loose sediments, or other unconsolidated substrate material- may be exposed and thus the direct benthic substratum in some circumstances.
Benthic	Living on, under, or in the solid materials at the bottom of a body of water.
Boulder	A large substrate particle that is larger than cobble (> ≈ 250 mm in diameter).
Brackish water	Generally, water containing dissolved minerals in amounts that exceed normally acceptable standards for municipal, domestic, and irrigation uses. Considerably less saline that sea water; waters with mixohaline salinity (.5-30 due to ocean water). Water containing 1,000-4,000 ppm total dissolved solids (TDS).
Brackish water marsh	Tidally influenced marsh with mixohaline salinities; transitional between freshwater marsh and/or frequent freshwater source and saltwater marsh and tidal flats. Emergent vegetation not adapted to higher salinities found in saltwater marshes.
Canyon	A water-cut, narrow chasm, the sides of which rise from the stream bed to a cliff or series of cliffs (= gorge).
Channel	Component of aquatic environment that contains continuously or periodically flowing water that is confined by banks and a substrate bed; excavation created and maintained by the flow of water.
Clay	Sedimentary substratum smaller than silt and generally less than 0.2 mm in diameter; fine-grained earth material that is plastic when wet and hardens when dried, consisting primarily of hydrated silicates of aluminum.
Coastal dune	Coastal, terrestrial habitat dominated by sand; wind energy dictates composition and arrangement of dune structure and substructure.
Cobble	Rock-fragment substratum between 7.6-25.4 cm (3-10 inches); smaller than boulder and larger than gravel.
Community	A naturally occurring aggregation of organisms belonging to a number of different species occupying a common habitat and interacting with each other within that habitat; a naturally occurring, distinct group of different organisms which inhabit a common environment, interact with each other, and are relatively independent of other community groups.
Continental plate	Major section of the earth's crust, bounded by such features as mid-ocean ridges.
Continental shelf	A shallow, submarine plain of varying width forming a border to a continent and typically ending in a steep slope (=continental) to the oceanic abyssal plain; a broad expanse of ocean bottom sloping gently and seaward from the shoreline to the continental shelf-slope break a depth ranging form 100-200 meters; the submerged shelf of land the slopes gradually form the exposed edge of a continent for a variable distance to the point where the steeper descent (slope) to the ocean bottom begins.
Continental slope	The region between the continental shelf and oceanic abyssal plain; 2) a steep-

	sloping bottom extending seaward from the edge of the continental shelf and downward toward the rise.
Deeper water	In reference to embayments: bay marine water starting at the contour of greater than 5.5-6 meters' deep.
Detritus	Undissolved detritus and inorganic matter, such as small pieces of vegetation, and animal remains, that result from decomposition and that form the base of the food chain; particulate material that enters into a marine or aquatic system. If derived from decaying organic matter, it is organic detritus;
Eelgrass bed	Aquatic estuarine community defined by the presence and ecological contribution of species of *Zostera*.
El Nino-Southern oscillation (ENSO)	Condition in which warm surface water moves into the eastern Pacific, collapsing upwelling and increasing surface-water temperatures and precipitation along the west coast of North and South America.
Embayment	Inlet of the sea usually smaller than a gulf; a portion of the ocean indenting the coastline where wave and tidal energy are reduced but there is the predominant influence of seawater and complete association with the marine environment.
Emergent vegetation	
Epibenthic	Living on, attached, or in association with the surface of the bottom of a body of water.
Epipelagic	Of or relating to the ocean depth just below the surface to 200 meters (600 feet); usually in reference to seaward of the continental shelf-slope interface.
Epipelic	Relating to organisms that inhabit the surfaces of water or substrate.
Estuarine	Large coastal water regions that have geographic continuity, are bordered landward by a stretch of coastline with freshwater input, and are bounded seaward by a salinity front.
Estuary	A water passage where the tide meets a freshwater source, especially an arm of the sea at the lower end of a river; a semi-enclosed body of water that has a free connection with the open sea and within which seawater is diluted measurably with freshwater that is derived from land drainage part of the marine coast over which the tide ebbs and flows.
Exposed coast	Coastline characterized by exposure to full or moderate wind and surf energy
Gravel	Rock-fragment substratum between 2-7.6 cm (0.08-3 inches), usually occurring as a mixture with sand.
Gulf	A part of the ocean extending into the land.
Habitat	The locality or external environment, and its existing physical and ecological conditions, in which an organism lives.
Halocline	Depth zone within which salinity changes maximally.
Human structures	Habitat or habitat surrogate of human origin. Examples include piers and docks, ocean platforms, boat hulls, jetties, buoys, artificial reefs, pilings.
Inlet	A narrow water passage between two peninsulas and/or islands.
Inbenthic	Of or related to living in or under the benthic substratum of a body of water.
Intertidal	Nearshore region where tidal fluctuation results in periods of water inundation and exposure to the air environment. The dynamic of water cover/exposure ranges from predominant exposure and rare inundation (e.g., supratidal) to rare exposure and predominant inundation (e.g., lower intertidal). Note: Upward displacements of the zonal characteristics occur as an area progresses from protected to exposed coast (see Ricketts et al. 1968).
Kelp forest	Marine subtidal biotic community characterized by the presence and ecological influence of species of kelp (i.e., *Macrocystis*, *Nereocystis*).

Lagoon	Shallow lake or pond connected with ocean water; an area of shallow water of various and often fluctuating salinity separated from the sea by a strip of terrestrial substratum such as sand dunes, gravel/cobble beaches or mud berms; this water body is infrequently breached such that (1) what was lagoon waters are now freely influenced by the tide, (2) beach and berm materials are completely or partially washed out to sea, and (3) there existed an estuary environment of freshwater source(s) interfacing with marine tidal waters until the beach or berm begins to reform.
Lower intertidal	Intertidal zone from 0 to -0.6 meter tide levels. Below is the subtidal. This zone is exposed only a few hours per month. Corresponds to Zone 4: low intertidal of Ricketts et al., 1968. This represents the upper limits of *Phyllospadix* and the Laminarian algae zone, as well as some subtidal animals.
Mainstream flow	The flow in a part of the fluid that is well above the bottom or well away from a surface and essentially not under the influence of the boundary layer.
Marine	Of or pertaining to the sea and saltwater.
Mesopelagic	Of or relating to the ocean depths from 200-2,000 meter depth zone (600-6,500 feet), seaward of the continental shelf-slope break.
Middle intertidal	Intertidal zone from higher low to mean lower-low tide, approximately +0.8-0m. This zone is typically exposed twice a day and corresponds to Zone 3: middle intertidal of Ricketts et al., 1968. This zone represents the lower reach of balanoid barnacles and the upper reach of *Mytilis* beds.
Mud	Earthen substratum composed predominantly of clay and fine silt.
Nearshore	Marine waters and benthic environment contiguous with the terrestrial environment extending to the continental shelf-slope interface; the belt or region of shallow water adjoining the coast; of or associated with marine environments and habitats landward of the continental shelf-slope break.
Neritic	Of or relating to aquatic organisms that live in the nearshore, open ocean water, without direct dependence on the shore or bottom; living in the water column landward of the continental shelf-slope break.
Oceanic	- SEE Offshore -
Oceanic ridge	A sinuous ridge rising from the deep-sea floor.
Offshore	Of or associated with marine environment and habitats seaward of the continental shelf-slope break; (=oceanic).
Organic	Unconsolidated substratum composed predominantly of organic versus mineral material and with a radius smaller than cobble and gravel.
Pelagic	Of or relating to aquatic organisms that live in the offshore, open ocean waters, without direct dependence on the shore or bottom; living in the water column seaward of the continental shelf-slope break.
Photic zone	The depth zone in the ocean extending from the surface to that depth permitting photosynthesis, extending from the surface to approximately 30meters, depending on turbidity.
Plankton	Organisms living suspended in the water column and incapable of moving against water currents.
Pond	A body of standing water smaller than a lake.
Protected coast	Marine coast characterized by semi-enclosure or underwater topography (i.e., reef, bar) that results in protection from the wind- and/or surf-energy.
Pycnocline	Depth zone within which sea-water density changes maximally.
Rise	Bottom of low relief at the base of the continental slope.

Saltwater marsh	Tidal saltwater wetland that occurs along ocean coastline; a coastal habitat consisting of salt-resistant plants residing in organically rich sediment accreting toward sea level.
Sand	Predominantly coarse-grained, mineral substratum larger than silt and smaller than gravel and is less than 2mm and greater than 0.07 mm in diameter.
Sessile	Attached or stationary; immobile because of an attachment to a substratum.
Shallow water	In reference to embayment environment: bay marine environment from the mean lower low tide contour to the 18' contour.
Shelf-slope break	Interface demarcating the change from the gently inclined continental shelf to the much steeper depth gradient of the continental slope.
Shoreline	The narrow strip of terrestrial environment (1) between the intertidal and fully terrestrial habitats and (2) that is affected substantially by the marine or estuarine environment.
Silt	Sedimentary substratum larger than clay (.2mm) and smaller than sand.
Slough	Estuarine region of deep mud or mire; sluggish channel; swamp, bog, or marsh, especially one that is part of an inlet or backwater.
Sublittoral zone	- SEE Subtidal-
Submerged plants	Plants growing with their root, stems, and leaves completely under the surface of the water.
Subtidal	The aquatic environment from the extreme low-water level of the intertidal zone to approximately 200 meters; from the edge of the lowest tide level to the edge of the continental shelf; (= Sublittoral).
Supratidal	Of or relating to the shore area adjoining and just above the high-tide level of the intertidal zone; predominantly an exposed environment receiving the minimalist of salt water contribution from the tide; (≈ spray zone; splash zone; supralittoral; uppermost horizon).
Surface layer	Layer of the ocean or estuary extending from the surface to a depth above which is homogeneous due to wind mixing.
Temperate	Pertaining to the latitudinal belt between 23°27' and 66°33' north or south latitude.
Thermocline	Depth zone within which temperature changes maximally.
Tidal current	A water current generated by regularly varying tidal forces.
Tidal flat	Saltwater wetlands that are characterized low profile, by substratum usually of mud or sand, and daily tidal cycling of inundation and exposure.
Trench	Deep and sinuous depression in the ocean floor, usually seaward of a continental margin or a group of volcanic islands.
Turbidity	The weight of particulate matter per unit volume of sea water.
Upper Intertidal	Intertidal zone from mean high to the mean higher of the 2 daily low tide levels, approximately +1.5-0.8m. It corresponds to Zone 2: high intertidal of Ricketts et al., 1968. This zone is the upper reach of balanoid barnacles and is above the zone of *Mytilis* beds [≈ high intertidal].
Upwelling	The movement of nutrient-rich water from a specified depth to the surface.
Wash zone	The depth zone in which sediments are distributed by wave action near the shoreline.
Watershed	The land area that is drained by a river or estuary and its tributaries.

APPENDIX IV. Key References

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