

DESCRIPTION OF MAP UNITS

UNCONSOLIDATED CONTINENTAL SHELF SEDIMENTS

- Se(s)m_ru: Soft, unconsolidated sediment (sand and mud), predominantly rippled
- Se(s)m_p_eu: Pockmarks or depressions, in soft, unconsolidated sediment (sand and mud)
- Se(s)y_ru: Terrace, or possibly delta or fan, composed of soft, unconsolidated sediment (sand and mud) and far deposits, predominantly rippled
- Se(s)y_hu: Hummocky mounds of soft, unconsolidated delta sediment
- Sam_u: Soft, unconsolidated sediment mound

MIXED SUBSTRATE ON CONTINENTAL SHELF

- Sme_cu: Mixed habitat of soft, unconsolidated sediment, overlying hard, consolidated sedimentary bedrock
- Sme_chu: Hummocky, soft, unconsolidated sediment, overlying hard, consolidated sedimentary bedrock

HARD SUBSTRATE ON CONTINENTAL SHELF

- Shr_m_eh: Hard mound made up of carbonate rock within pockmark
- Shd_crd: Deformed and differentially eroded sedimentary-bedrock outcrop

UNCONSOLIDATED CONTINENTAL SLOPE SEDIMENTS

- Fsg_u: Gully, in soft, unconsolidated sediment
- Faj(s)m_ru: Soft, unconsolidated sediment (sand and mud), rippled

MIXED SUBSTRATE ON CONTINENTAL SLOPE

- Fme_cu: Mixed habitat of soft, unconsolidated sediment, overlying hard, consolidated sedimentary bedrock

HARD SUBSTRATE ON CONTINENTAL SLOPE

- Fhd_crd: Deformed and differentially eroded sedimentary-bedrock outcrop
- Fhm_eh: Hard mound made up of carbonate rock within pockmark

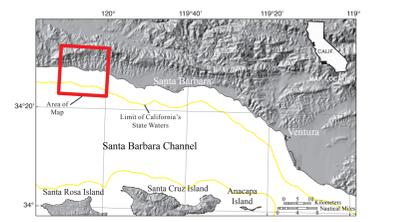
ANTHROPOGENIC FEATURES

- Smh_a_pu: Linear depression, in soft, unconsolidated sediment overlying hard anthropogenic feature (pipeline) on continental shelf
- Fmh_a_pu: Linear depression, in soft, unconsolidated sediment overlying hard anthropogenic feature (pipeline) on continental slope

EXPLANATION OF MAP SYMBOLS

Contact

- Area of "no data"—Areas near shoreline not mapped owing to insufficient high-resolution seafloor mapping data; areas beyond 3 nautical-mile limit of California's State Waters were not mapped as part of California Seafloor Mapping Program
- 3-nautical-mile limit of California's State Waters
- Bathymetric contour (in meters)—Derived from modified 10-m-resolution bathymetry grid. Contour interval: 10 m



DISCUSSION

This map shows "potential" marine benthic habitats in the Offshore of Refugio Beach map area. Marine benthic habitats represent a particular type of substrate, geomorphology, seafloor process, or any other attribute that may provide a habitat for a specific species or an assemblage of organisms. Such maps are based largely on seafloor geology, and this map integrates seafloor geology (sheet 10) with information depicted on several other thematic maps of the Offshore of Refugio Beach map area: high-resolution bathymetry (sheet 1), shaded-relief imagery (sheet 2), backscatter (sheet 3), seafloor character (sheet 5), and ground-truth information (sheet 6). This map also uses information from the usSEABED bottom-sampling compilation by Reed and others (2006). The combination of remotely observed data (for example, camera transects, sediment samples) translates to higher confidence in the ability to interpret broad areas of the seafloor.

To avoid any possible misunderstanding of the term "habitat," the term "potential habitat" (as defined by Greene and others, 2005) is used herein to describe a set of distinct seafloor conditions that the future may qualify as an "actual habitat." Once habitat associations of a species are determined, they can be used to create maps that depict actual habitats, which then need to be confirmed by "ground-truth" surveying using in situ observations, video, and/or photographic documentation.

Marine benthic habitats are classified using the Benthic Marine Potential Habitat Classification Scheme, a mapping-attribute code developed by Greene and others (1999, 2007). In this map series, habitat-classification codes are based on the deepwater habitat-characterization scheme developed by Greene and others (1999), which was created to not only easily distinguish marine benthic habitats but also to facilitate ease of use and queries within GIS and database programs. The code, which is summarized in chapter 6 in the accompanying pamphlet, is derived from several categories of the Benthic Marine Potential Habitat Classification Scheme (Greene and others, 1999, 2007), and it can be subdivided on the basis of the spatial scale of the data.

High-resolution, multibeam-soundar data, converted to bathymetric depth grids (seafloor digital elevation models, sheet 1), are essential to development of the habitat map. Shaded-relief imagery (sheet 2) allows for visualization of seafloor terrain, providing a foundation for interpretation of submarine landforms. Areas of seafloor bedrock exposures are identified by their common sharp edges and high relative relief; these may be contiguous outcrops, isolated parts of outcrops protruding through sediment cover (spineles or knobs), or isolated boulders. High backscatter is further indication of "hard" bottom, consistent with interpretation as rock or coarse sediment. In many locations, areas within or around a rocky feature appear to be covered by a thin veneer of sediment, identified on the habitat map as "mixed" induration (in other words, containing both rock and sediment). Broad, generally smooth areas of the seafloor that lack sharp and angular edge characteristics are mapped as "sediment" and are further defined by various sedimentary features such as crossbedded scours and depressions, as well as depositional features such as dunes, mounds, or sand waves. Low backscatter, indicative of a "soft" bottom, also significantly aids identification and classification of sedimentary habitats.

The Offshore of Refugio Beach map area contains 16 potential marine benthic habitat types within two megahabitat settings: Shelf (continental shelf), and Flank (basin flank or continental slope). On the shelf, these habitat types range from predominantly soft, unconsolidated sediment (sand and mud) to areas of hard bedrock exposures, including differentially eroded, well-bedded sedimentary-bedrock outcrops. Some sedimentary-bedrock outcrops are partly covered with soft, unconsolidated sediment to produce a hard-soft mixed habitat type. Pockmarks and carbonate mounds complete the variety of habitats identified on the continental shelf in the map area. Minor anthropogenic features associated with oil production, such as pipelines, traverse both the shelf and slope. In the narrow band of basin-flank or continental-slope megahabitat, predominantly soft, unconsolidated sediment and some well-layered sedimentary-bedrock outcrops and carbonate mounds have been mapped. Along the distal edge of the continental shelf, stringers and mounds of carbonate outcrops provide good potential habitat for rockfish (Sebastes spp.), lingcod (*Ophiodon elongatus*), and other demersal fish.

The soft, unconsolidated sediment habitat in the Shelf megahabitat, which includes pockmarks and nearshore bars, covers 86.9 km² of the total 114.6 km² area mapped, representing 75.8 percent of all the potential habitat types identified. Sediment-covered bedrock on the continental shelf, which includes the mixed hard-soft habitat type, covers 17.5 km² (15.2 percent), whereas hard bedrock exposures on the continental shelf cover 2.6 km² (2.3 percent). In the Flank megahabitat, mixed substrate on the continental slope covers 2.3 km² (2.0 percent) whereas soft, unconsolidated sediment on the continental slope covers 4.9 km² (4.3 percent). Hard bedrock exposures, which include carbonate mounds at the top of the continental slope, cover 0.16 km² (0.1 percent). Anthropogenic features on both the shelf and slope cover nearly 0.23 km² (0.2 percent).

Fluid flow to the seafloor from petroleum reservoirs at depth resulted in the formation of hard carbonate mounds and pockmarks. Exposed carbonate mounds and hard ground, locally covered with sediment, provide potential habitat for sessile organisms. Sedimentary-bedrock exposures in the nearshore provide the hard, irregular substrate that makes suitable habitat for rockfish and other groundfish. This mix of potential marine benthic habitat types provides the varied relief, in addition to the rugosity and substrate hardness, that contribute to the concentration of a diverse marine ecosystem within an otherwise homogeneous, soft, unconsolidated sediment habitat.

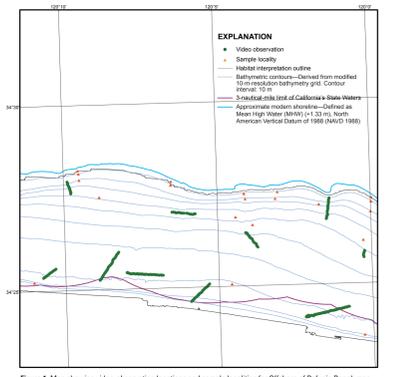


Figure 1. Map showing video observation locations and sample localities for Offshore of Refugio Beach map area.

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SCALE 1:24,000

0 1000 2000 3000 4000 5000 6000 7000 FEET

0 1 2 3 4 5 6 7 8 9 10 KILOMETER

BATHYMETRIC CONTOUR INTERVAL: 10 METERS

ONE MILE = 0.869 NAUTICAL MILES

Potential marine benthic habitats mapped by Charles A. Endris and H. Gary Greene, 2011. Bathymetric contours by Andrew C. Richin, 2011. GIS database and digital cartography by Nadine E. Golden, Mercedes D. Erdey, and Charles A. Endris. Edited by Sarah E. Naggsman. Manuscript accepted for publication February 4, 2015.

Potential Marine Benthic Habitats, Offshore of Refugio Beach Area, California
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