

DESCRIPTION OF MAP UNITS

UNCONSOLIDATED CONTINENTAL SHELF SEDIMENTS

- Sa(s)m_rlu Soft, unconsolidated sediment (sand and mud), predominantly rippled
- Sa(s)m_h_u Depression in soft, unconsolidated sediment (sand and mud)
- Sa(s)m_mw_u Unconsolidated dynamic mound of sediment (sand and mud)
- Sa(s)_rlu Soft, unconsolidated sediment (sand), predominantly rippled
- Sa(s)_w_rlu Sediment waves in soft, unconsolidated, rippled sediment (sand)
- Sa(s)g/w_rlu Rippled scour depressions (sand and gravel)

MIXED SUBSTRATE ON CONTINENTAL SHELF

- Sme_cvu Mixed habitat of soft, unconsolidated sediment, overlying hard, consolidated sedimentary bedrock
- Sme_gvu Mixed habitat of soft, unconsolidated sediment, overlying hard, granitic bedrock

HARD SUBSTRATE ON CONTINENTAL SHELF

- She_g Bedrock outcrop of hard granitic rock
- Shd_cdf Faulted, fractured, deformed, and differentially eroded sedimentary bedrock
- Shb_p_g Boulder or pinnacle of hard granitic rock
- Shb_p_c Boulder or pinnacle of hard sedimentary bedrock

ANTHROPOGENIC FEATURES ON CONTINENTAL SHELF

- Shm_a? Hard mounds comprised of unidentified material, possibly marine debris (inferred)

UNCONSOLIDATED ESTUARY SEDIMENTS

- Es(s)m_rlu Soft, unconsolidated sediment, predominantly rippled (sand and mud)
- Es(s)m_h_u Soft, unconsolidated, hummocky sediment (sand and mud)
- Es(s)m_h_u Depression in soft, unconsolidated sediment (sand and mud)
- Es(s)m_u Mound in soft, unconsolidated sediment (sand and mud)
- Es(s)_rlu Soft, unconsolidated sediment, predominantly rippled (sand)
- Es(s)_su Current-scoured depression in soft, unconsolidated sediment (sand)
- Es(s)_tm_u Shoreline mound, or relic beach, composed of soft, unconsolidated sediment (sand)
- Es(s)_rsu Sediment waves and ripples in current-scoured soft, unconsolidated sediment (sand)
- Est_u Depression in soft, unconsolidated sediment

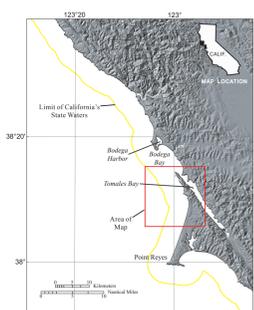
MIXED SUBSTRATE IN ESTUARY

- Eme_gvu Mixed habitat of soft, unconsolidated sediment overlying hard granitic bedrock

EXPLANATION OF MAP SYMBOLS

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- 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 grids. Contour interval: 10 m



DISCUSSION

This map shows "potential" marine benthic habitats in the Offshore of Tomales Point 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 Tomales Point 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 uSEABED bottom-sampling compilation by Reid and others (2006). The combination of remotely observed data (for example, multibeam bathymetry and backscatter, seismic-reflection profiles) and directly observed data (for example, corer 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 in 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-sonar 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 outcrop protruding through sediment cover (pinnacles 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" 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 erosional scars 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 Tomales Point map area contains 23 potential marine benthic habitat types, covering 126.97 km² from the interpreted data. These habitat types include unconsolidated continental shelf sediments (6 habitat types), mixed substrate on the continental shelf (2 habitat types), hard substrate on the continental shelf (4 habitat types), possible anthropogenic features on the continental shelf (1 habitat type), unconsolidated estuary sediments (9 habitat types), and mixed substrate in the estuary (1 habitat type). The habitat types mapped on the shelf cover an area of 117.22 km² (92.3 percent) while those in the estuary (Tomales Bay) cover 9.75 km² (7.7 percent). In the total area mapped, the dominant habitat type was soft unconsolidated sediment that covered 85.56 km² (67.2 percent) with hard rock covering 37.34 km² (29.4 percent), sediment covered bedrock covering 4.21 km² (3.3 percent), and hard unidentified anthropogenic features, possibly related to marine debris, covering 0.13 km² (0.1 percent).

Rock outcrops and rubble are considered the primary habitat type for rockfish and lingcod (Cass and others, 1990; Love and others, 2002), both recreationally and commercially important species. Dynamic bedforms such as sand waves are considered potential foraging habitat for juvenile lingcod (*Ophiodon elongatus*) and possibly migratory fishes (Brazner, 2005), as well as for forage fish such as Pacific sand lance.

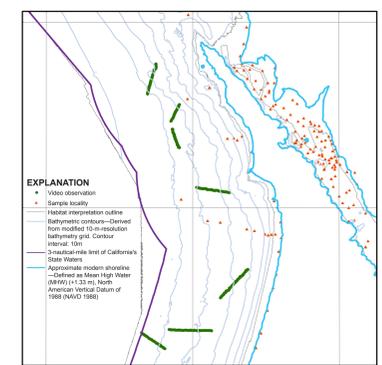


Figure 1. Map showing video-observation locations and sample localities for Offshore of Tomales Point map area.

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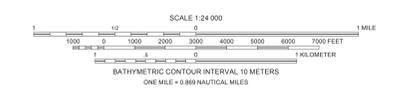
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Shoreline elevation data from California Coastal Commission, available at <http://www.ccc.ca.gov/gis/arcswater/coordinates/>, and from U.S. Geological Survey, National Elevation Dataset, available at <http://www.ogp.gov/>. California State Waters limit from NOAA Office of Coast Survey. Universal Transverse Mercator projection, Zone 10E. NOT INTENDED FOR NAVIGATIONAL USE.



Potential marine benthic habitats mapped by H. Gary Greene, Charles A. Endris and Bryan E. Dieter, 2012-2013. Bathymetric contours by Mercedes D. Erdey, 2013. GIS database and digital cartography by Charles A. Endris and Erik N. Lowe. Manuscript approved for publication May 4, 2015.

Potential Marine Benthic Habitats, Offshore of Tomales Point Map Area, California

By Charles A. Endris,¹ H. Gary Greene,¹ Bryan E. Dieter,¹ Erik N. Lowe,² and Mercedes D. Erdey² 2015

¹Marine Landing Marine Laboratories, Center for Habitat Studies, U.S. Geological Survey



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