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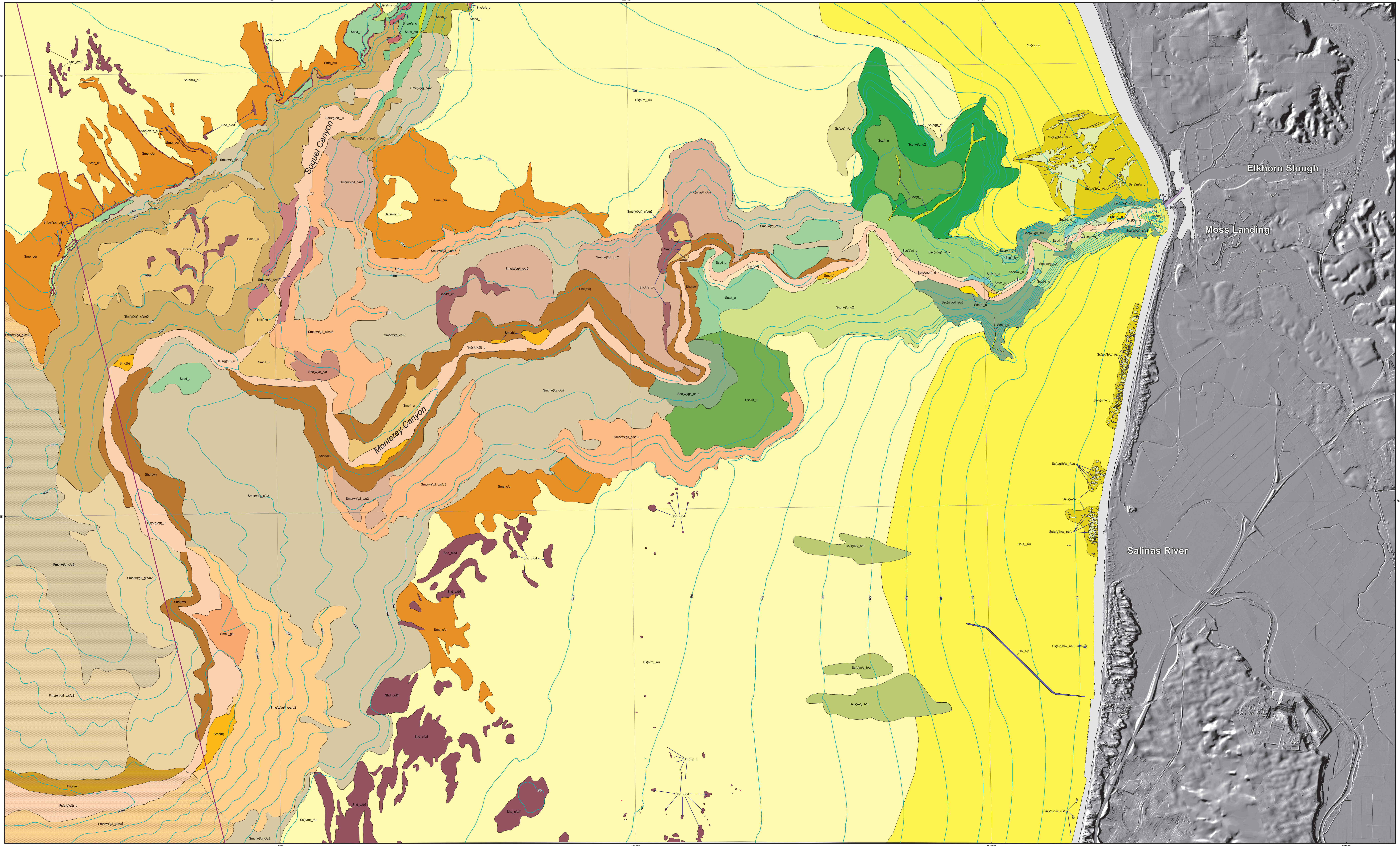
Open-File Report 2016–1072
Sheet 7 of 10
Pamphlet accompanies map



Onshore elevation data from National Oceanic and Atmospheric Administration (NOAA) Office for Coastal Management's Digital Coast (available at http://www.csc.noaa.gov/digitalcoast/data/coastallidar/) and from U.S. Geological Survey's National Elevation Dataset (available at http://ned.usgs.gov/). California's State Waters limit from NOAA Office of Coast Survey

Universal Transverse Mercator projection, Zone 10N

NOT INTENDED FOR NAVIGATIONAL USE

13½° TRUE NORTH MAGNETIC NORTH
APPROXIMATE MEAN DECLINATION, 2016

SCALE 1:24 000
1 ½ 0 1 MILE
1000 0 1000 2000 3000 4000 5000 6000 7000 FEET
1 .5 0 1 KILOMETER
BATHYMETRIC CONTOUR INTERVALS 10 METERS, 50 METERS, AND 200 METERS
ONE MILE = 0.869 NAUTICAL MILES

MAP LOCATION

Potential marine benthic habitats mapped by Bryan E. Dieter, Charles A. Endris, and H. Gary Greene, 2014. Bathymetric contours by Mercedes D. Erdey, 2014

GIS database and digital cartography by Mercedes D. Erdey and Charles A. Endris

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Potential Marine Benthic Habitats, Monterey Canyon and Vicinity Map Area, California

By

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DESCRIPTION OF MAP UNITS

UNCONSOLIDATED CONTINENTAL SHELF SEDIMENTS

Ss(s/m)_r/u — Soft, unconsolidated sediment (fine sand and mud), predominantly rippled

Ss(s)_r/u — Soft, unconsolidated sediment (sand), predominantly rippled

Ss(s/g)_r/u — Soft, unconsolidated sediment (sand and gravel), predominantly rippled

Ss(s)m/y_h/u — Hummocky mounds (lobes) of unconsolidated deltaic sediment

Ss(s)m/w_u — Unconsolidated, dynamic mound of soft sediment (sand)

Ss(s/g)h/w_r/s/u — Soft, mobile sediment window that has unconsolidated and rippled sediment waves, overlying scoured lag pavement of sand and gravel (sorted bedforms)

MIXED SUBSTRATE ON CONTINENTAL SHELF

Sme_c/u — Mixed habitat of soft, unconsolidated sediment, overlying hard, consolidated sedimentary bedrock

HARD SUBSTRATE ON CONTINENTAL SHELF

Shd_c/d/f — Faulted, fractured, deformed, and differentially eroded sedimentary bedrock

Sh(b)/p_c — Hard, consolidated boulders or pinnacles of sedimentary rock

ANTHROPOGENIC FEATURES ON CONTINENTAL SHELF

Ss(s)_a-dg — Dredged channel in soft, unconsolidated sediment

Sh_a-g — Hard anthropogenic feature (jetty and riprap)

Sh_a-p — Hard anthropogenic feature (pipeline)

UNCONSOLIDATED CONTINENTAL SHELF AND CANYON SEDIMENTS

Ssc(b)_u — Bar within canyon thalweg; composed of soft, unconsolidated sediment

Ssc(h)_u — Canyon head; composed of soft, unconsolidated sediment

Ssc(t)_u — Canyon thalweg; composed of soft, unconsolidated sediment

Ssc(t)/w_u — Sediment waves within canyon thalweg; composed of soft, unconsolidated sediment

Ss(s/g)c(t)_u — Canyon thalweg; composed of soft, unconsolidated sediment (sand and gravel)

Ssc(t/w)_u — Wall adjacent to canyon thalweg; composed of soft, unconsolidated sediment

Ssc(w)_u — Canyon wall; composed of soft, unconsolidated sediment

Ssc(w)/g_u2 — Canyon wall and gullies, moderately sloping; composed of soft, unconsolidated sediment

Ssc(w)/g/l_u2 — Canyon wall and gullies, possible ancient landslide, moderately sloping; composed of soft, unconsolidated sediment

Ssc(w)/g/l_s/u2 — Canyon wall and gullies, predominantly landslide scoured and moderately sloping; composed of soft, unconsolidated sediment

Ssc(w)/g/l_s/u3 — Canyon wall and gullies, predominantly landslide scoured and steeply sloping; composed of soft, unconsolidated sediment

Ssc/l_s/u — Scouring from landslides and mass wasting in canyon; composed of soft, unconsolidated sediment

Ssc/l/s_u — Landslide scarp; composed of soft, unconsolidated sediment

Ssc/l_u — Landslide deposits; composed of soft, unconsolidated sediment

Ssc/l/t_u — Terrace within zone of possible ancient landslide; composed of soft, unconsolidated sediment

Ssc/t_u — Terrace; composed of soft, unconsolidated sediment

Ssc/s_u — Canyon scarp; composed of soft, unconsolidated sediment

MIXED SUBSTRATE INSIDE CANYON ON CONTINENTAL SHELF

Smc(b) — Bar within canyon thalweg; composed of soft, unconsolidated sediment

Smc(w)/g/l_c/s/u3 — Canyon wall and gullies, predominantly landslide scoured and steeply sloping; composed of soft, unconsolidated sediment

Smc(w)/g/l_g/s/u2 — Canyon wall and gullies, predominantly landslide scoured and moderately sloping; composed of mix of granitic bedrock and soft, unconsolidated sediment

Smc(w)/g/l_g/s/u3 — Canyon wall and gullies, predominantly landslide scoured and steeply sloping; composed of mix of granitic bedrock and soft, unconsolidated sediment

Smc(w)/g_c/u2 — Canyon wall and gullies, moderately sloping; composed of mix of sedimentary bedrock and soft, unconsolidated sediment

Smc(w)/g/l_c/u2 — Canyon wall and gullies, possible ancient landslide, moderately sloping; composed of mix of sedimentary bedrock and soft, unconsolidated sediment

Smc/l_u — Landslide deposits in canyon; composed of soft, unconsolidated sediment

Smc/l_g/u — Landslide deposits in canyon; consists of blocks of hard bedrock mixed with soft, unconsolidated sediment

Smc(w)/e_u/v — Sediment-covered volcanic bedrock within canyon wall

HARD SUBSTRATE INSIDE CANYON ON CONTINENTAL SHELF

Shc/e/s_c — Scarp of exposed hard sedimentary rock

Shb/c/e/s_c/i — Scarp of hard sedimentary rock exposed along interface with relict shoreline

Shc/l/s_c/u — Landslide scarp in canyon; composed of hard sedimentary bedrock

Shc(t/w) — Wall adjacent to canyon thalweg; composed of hard substrate

Shc(w)/e_c/d — Exposed sedimentary-bedrock outcrop in canyon wall

Shc(w)/g/l_c/s/u3 — Canyon wall and gullies, predominantly landslide scoured and steeply sloping; composed of soft, unconsolidated sediment

UNCONSOLIDATED CONTINENTAL SLOPE SEDIMENTS

Fs(s/g)c(t)_u — Canyon thalweg; composed of soft, unconsolidated sediment (sand and gravel)

MIXED SUBSTRATE ON CONTINENTAL SLOPE

Fmc(w)/g_c/u2 — Canyon wall and gullies, moderately sloping; composed of mix of sedimentary bedrock and soft, unconsolidated sediment

Fmc(w)/g/l_g/s/u2 — Canyon wall and gullies, predominantly landslide scoured and moderately sloping; composed of mix of granitic bedrock and soft, unconsolidated sediment

Fmc(w)/g/l_g/s/u3 — Canyon wall and gullies, predominantly landslide scoured and steeply sloping; composed of mix of granitic bedrock and soft, unconsolidated sediment

HARD SUBSTRATE ON CONTINENTAL SLOPE

Fhc(t/w) — Wall adjacent to canyon thalweg; composed of hard substrate

EXPLANATION OF MAP SYMBOLS

Contact

Area of "no data"—Areas near shoreline not mapped owing to insufficient high-resolution seafloor mapping data; areas beyond limit of California's State Waters were not mapped as part of California Seafloor Mapping Program

Limit of California's State Waters

20 **Bathymetric contour (in meters)**—Derived from modified 2- and 5-m-resolution bathymetry grids. Contour intervals: 1–100 m water depth, 10 m; 100–200 m water depth, 50 m; >200 m water depth, 200 m

DISCUSSION

This map shows "potential" marine benthic habitats in the Monterey Canyon and Vicinity 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 Monterey Canyon and Vicinity 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 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, camera transects, sediment samples) translates to higher confidence in the ability to interpret broad areas of the seafloor (fig. 1).

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, as is shaded-relief imagery (sheet 2), which allows for visualization of seafloor terrain and provides 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.

Backscatter maps (sheet 3) also are essential for developing potential benthic habitat maps. 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 erosional 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 Monterey Canyon and Vicinity map area includes the nearshore and inner continental shelf areas directly west of Moss Landing, Elkhorn Slough, and the mouth of the Salinas River, and it also includes part of the Monterey Canyon system (including Soquel Canyon). Delineated on the map are 49 potential marine benthic habitat types: 44 types are located on the continental shelf ("Shelf" megahabitat), and 5 are located on the continental slope ("Flank" megahabitat) within the submarine canyons. The meso- and macrohabitats on the continental shelf include soft, unconsolidated sediment (23 habitat types) such as fine sand and mud and also just sand, as well as dynamic features, such as mobile sand sheets, sediment waves, and rippled sediment depressions; mixed substrate (10 habitat types) such as soft sand and gravels that overlie hard consolidated sedimentary bedrock or granitic basement rocks; hard substrate (8 habitat types) such as deformed and differentially eroded bedrock, granitic outcrops, pinnacles, and boulders; and anthropogenic features (3 habitat types) such as riprap and a jetty, a pipeline, and a dredged channel.

Acoustic-backscatter data show that most of area is underlain by "soft" materials, consistent with the interpretation that unconsolidated sediments dominate the seafloor in the map area. Sedimentary processes are quite active, especially on the inner shelf near the head of Monterey Canyon, and, thus, habitats are highly dynamic. Coastal sediment transport is primarily to the south-southeast on the north side of Monterey Canyon; south of the canyon, transport is primarily to the north. Bedrock exposures are found on the canyon's rim, walls, and thalwegs, as well as in local isolated areas on the continental shelf. These rocky exposures potentially provide good habitat for rockfish (*Sebastes* spp.), as well as sessile organisms and other attached invertebrates. Additionally, the submarine canyons provide a conduit for the upwelling of deep, nutrient-rich waters that support an abundant variety of marine life, including pelagic fishes and marine mammals. The Monterey Canyon system is well known as a significant biological "hot spot" for marine life.

Of the total of 410 km² mapped in the Monterey Canyon and Vicinity map area, 385.64 km² (94.1 percent) is mapped on the continental shelf, and 24.36 km² (5.9 percent) is mapped on the flank or continental slope. On the continental shelf, soft, unconsolidated sediment is the dominant habitat type, covering 242.36 km² (59.1 percent). Mixed hard-soft substrate covers 109.63 km² (26.7 percent), and hard rock covers 33.52 km² (8.2 percent). Anthropogenic substrate covers only 0.13 km² (0.03 percent) and, thus, is not significant. On the continental slope, mixed hard-soft substrate is the dominant habitat type, covering 21.43 km² (5.2 percent). Soft, unconsolidated sediment covers 1.76 km² (0.4 percent), and hard rock covers 1.17 km² (0.3 percent).

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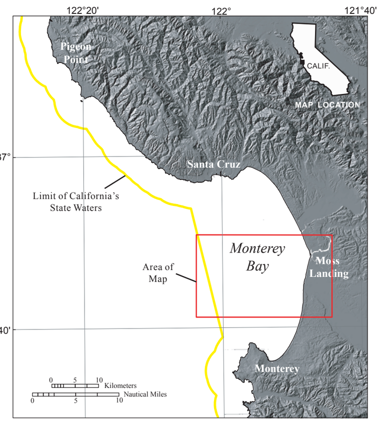

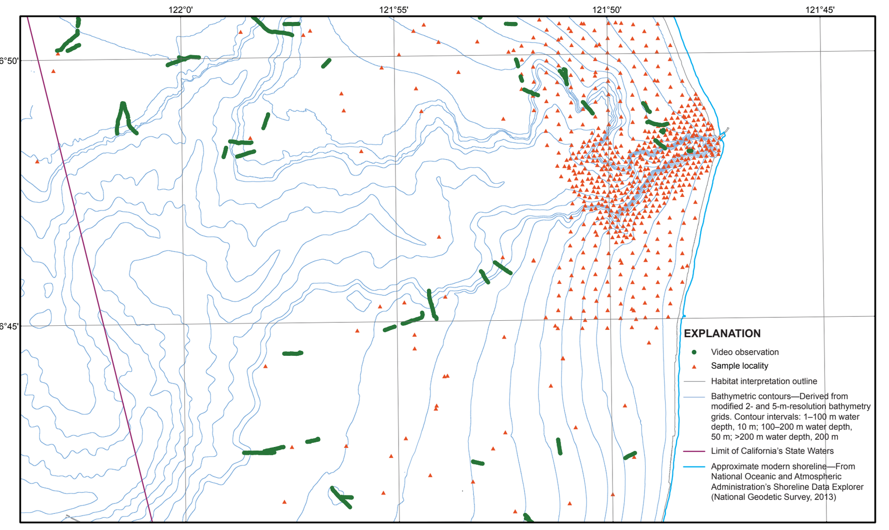

Figure 1. Map showing video-observation locations and sample localities for Monterey Canyon and Vicinity map area.

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