USGS
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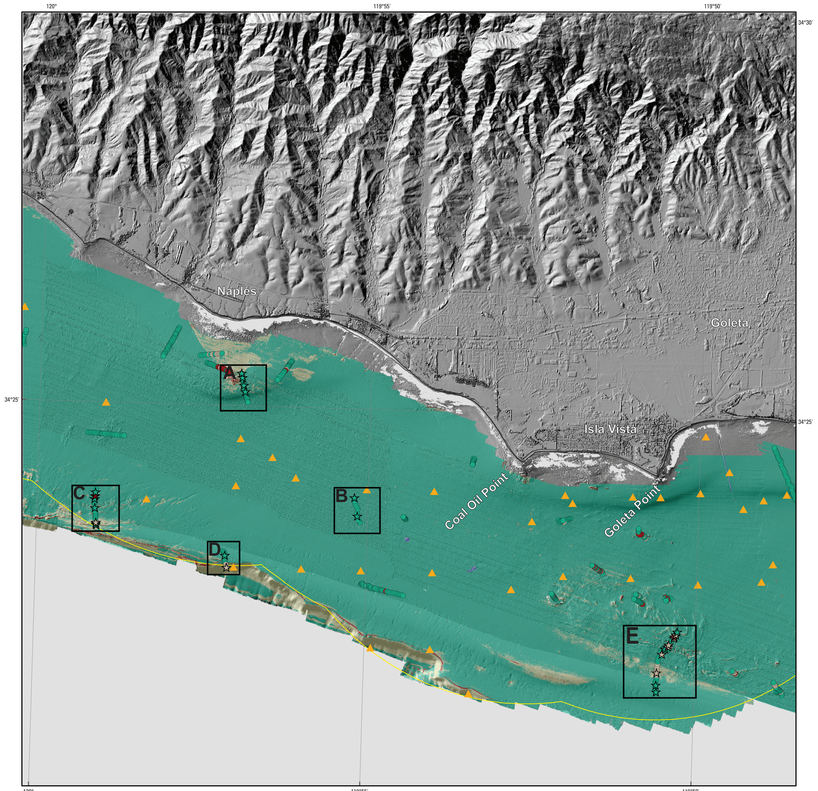
U.S. Department of the Interior
U.S. Geological Survey

Scientific Investigations Map 3302
Sheet 6 of 12
Pamphlet accompanies map



120° 119°55' 119°50'

Onshore elevation data from NOAA Coastal Services Center (data collected by EarthData International in 2002-2003) and from U.S. Army Corps of Engineers (data collected by Fugro Pelagos in 2009). Offshore shaded-relief bathymetry from map on sheet 2, this report. California's State Waters limit from NOAA Office of Coast Survey

Universal Transverse Mercator projection, Zone 11N

NOT INTENDED FOR NAVIGATIONAL USE

APPROXIMATE MEAN DECLINATION, 2014

SCALE 1:50 000

2 1 0 2 MILES

7000 3500 0 7000 FEET

0.5 0 1 KILOMETER

ONE MILE = 0.869 NAUTICAL MILES

CALIF.

MAP LOCATION

Seafloor-character map simplified from map on sheet 5, this report. Video observations recorded and digital still photographs taken in 2006-2009. Sample localities from usSEABED (Reid and others, 2006)

GIS database and digital cartography by Nadine E. Golden and Elayne L. Phillips

Edited by Taryn A. Lindquist

Manuscript approved for publication June 2, 2014

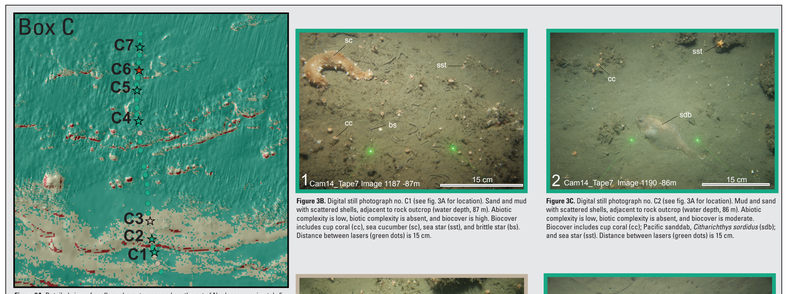


Figure 3A. Detailed view of seafloor character mapped southwest of Naples, approximately 5 km offshore (see Box C, on map, for location), showing locations of periodic real-time video observations (dots) and digital still photographs (stars; see figs. 3B through 3H) from camera line CAM14, cruise S–W1–09–SC.

Figure 3B. Digital still photograph no. C1 (see fig. 3A for location). Sand and mud with scattered shells, adjacent to rock outcrop (water depth, 87 m). Abiotic complexity is low, biotic complexity is absent, and biocover is high. Biocover includes cup coral (cc), sea cucumber (sc), sea star (sst), and brittle star (bs). Distance between lasers (green dots) is 15 cm.

Figure 3C. Digital still photograph no. C2 (see fig. 3A for location). Mud and sand with scattered shells, adjacent to rock outcrop (water depth, 86 m). Abiotic complexity is low, biotic complexity is absent, and biocover is moderate. Biocover includes cup coral (cc); Pacific sanddab, *Citharichthys sordidus* (sdb); and sea star (sst). Distance between lasers (green dots) is 15 cm.

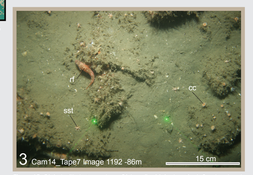


Figure 3D. Digital still photograph no. C3 (see fig. 3A for location). Sand and rock with scattered shells (water depth, 86 m). Abiotic complexity is low; biotic complexity is absent, and biocover is moderate. Biocover includes cup coral (cc); halfbanded rockfish, *Sebastes semicinctus* (rf); and sea star (sst). Distance between lasers (green dots) is 15 cm.

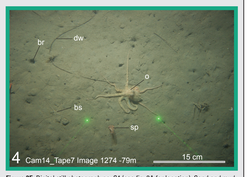


Figure 3E. Digital still photograph no. C4 (see fig. 3A for location). Sand and mud, adjacent to rock outcrop (water depth, 79 m). Abiotic complexity is low, biotic complexity is absent, and biocover is moderate. Biocover includes burrows (br), sea pen (sp), drift weed (dw), octopus (o), and brittle star (bs). Distance between lasers (green dots) is 15 cm.

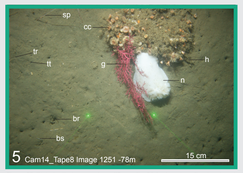


Figure 3F. Digital still photograph no. C5 (see fig. 3A for location). Sand and mud, adjacent to rock outcrop (water depth, 78 m). Abiotic complexity is low, biotic complexity is present, and biocover is moderate. Biocover includes burrows (br), cup coral (cc), brittle star (bs), gorgonian (g), hydroid (h), nudibranch (n), tracks (tr), trails (tt), and tall sea pen (sp). Distance between lasers (green dots) is 15 cm.

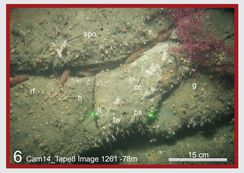


Figure 3G. Digital still photograph no. C6 (see fig. 3A for location). Layered and fractured rock (water depth, 78 m). Abiotic complexity is moderate, biotic complexity is present, and biocover is high. Biocover includes cup coral (cc); hydroid (h); halfbanded rockfish, *Sebastes semicinctus* (rf); sponge (spo); tubeworm (tw); brittle stars (bs); and gorgonian (g). Distance between lasers (green dots) is 15 cm.

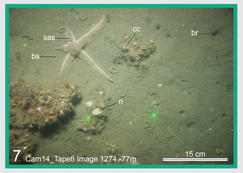


Figure 3H. Digital still photograph no. C7 (see fig. 3A for location). Sand and mud with isolated cobbles, adjacent to rock outcrop (water depth, 77 m). Abiotic complexity is low, biotic complexity is absent, and biocover is moderate. Biocover includes burrows (br), sand star (sas), cup coral (cc), nudibranch (n), and brittle star (bs). Distance between lasers (green dots) is 15 cm.

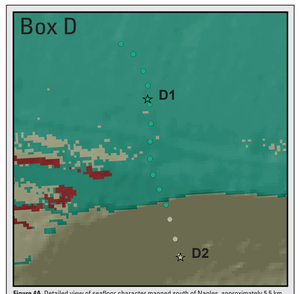


Figure 4A. Detailed view of seafloor character mapped south of Naples, approximately 5.5 km offshore (see Box D, on map, for location), showing locations of periodic real-time video observations (dots) and digital still photographs (stars; see figs. 4B, 4C) from camera line CAM15, cruise S–W1–09–SC.

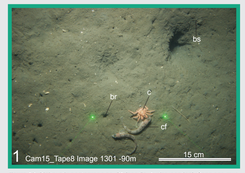


Figure 4B. Digital still photograph no. D1 (see fig. 4A for location). Sand and mud with scattered shells, on outer shelf (water depth, 90 m). Abiotic complexity is low, biotic complexity is absent, and biocover is low. Biocover includes burrows (br), crab (c), brittle star (bs), and cornfish (cf). Distance between lasers (green dots) is 15 cm.

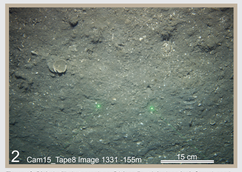
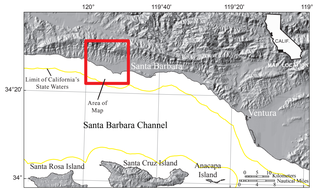


Figure 4C. Digital still photograph no. D2 (see fig. 4A for location). Gravel, sand, and shells, on failure surface of Goleta landslide complex (water depth, 155 m). Abiotic complexity is low, biotic complexity is absent, and biocover is low. Distance between lasers (green dots) is 15 cm.



DISCUSSION

Between 2006 and 2009, the seafloor in the Offshore of Coal Oil Point map area in southern California was mapped by California State University, Monterey Bay (CSUMB), and the U.S. Geological Survey (USGS), using both multibeam echosounders and bathymetric sidescan-sonar units (see sheets 1, 2, 3). These mapping missions combined to collect bathymetry and acoustic-backscatter data from about the 10-m isobath to out beyond the 3-nautical-mile limit of California's State Waters. In order to characterize the bathymetry and acoustic-backscatter data into geologically and biologically useful information, the USGS ground-truth-surveyed the data by towing camera sleds (fig. 6) over specific locations throughout the map area.

The ground-truth-surveys occurred on four separate cruises over a four-year period. The camera sleds were towed 1 to 2 m over the seafloor, at speeds of between 1 and 2 nautical miles/hour. During the 2006 and 2007 ground-truth cruises, a smaller USGS camera sled was used that housed two standard-definition (640×480 pixel resolution) video cameras; one was forward looking, and the other was downward looking. The video was relayed in real time to the research vessel, where USGS and National Oceanic and Atmospheric Administration (NOAA) scientists recorded both the geologic and biologic character of the seafloor once every minute, using programmable keypads. During the 2008 and 2009 ground-truth cruises, a larger camera sled was used that housed the two standard-definition video cameras (one forward looking, the other downward looking), as well as a high-definition (1,080×1,920 pixel resolution) video camera and an 8-megapixel digital still camera, which captured a digital still photograph once every 30 seconds. The location and directions of the camera-sled tracklines were chosen in order to visually inspect areas thought to represent the full range of bottom hardness and rugosity in the map area.

In the context of marine-fisheries management, benthic-habitat complexity can be divided into abiotic (geologic) and biotic (biologic) components. Benthic-habitat complexity refers to the visual classification of local abiotic and biotic vertical relief and structure that may provide potential refuge for both juvenile and adult forms of various species. Only abiotic attributes (primary- and secondary-substrate composition) were used in the production of the seafloor-character map on sheet 5. Classifications of primary and secondary substrate are based on the Wentworth (1922) scale of sediment grain-size categories, and the sand, cobble, and boulder sizes are classified as in Wentworth (1922). However, the difficulty in distinguishing the finest divisions in the Wentworth (1922) scale during video observations made it necessary to aggregate some grain-size classes: the granule and pebble sizes have been grouped together into a class called "gravel," and the clay and silt sizes have been grouped into a class called "mud." In addition, hard bottom and clasts larger than boulder size are classified as "rock." Primary and secondary substrate, by definition, constitute greater than 50 and 20 percent of the seafloor during an observation, respectively.

This sheet contains a smaller, simplified (depth-zone symbology has been removed) version of the seafloor-character map (sheet 5), on which the camera-sled tracklines used to ground-truth-survey the sonar data are indicated by aligned colored dots, each dot representing the location of a recorded observation. Primary- and secondary-substrate compositions are shown by differently colored dots. The map also shows the locations of the detailed views of seafloor character along some of the tracklines (Boxes A through E) that are highlighted on this sheet (figs. 1A through 5A, respectively). Also shown are locations of samples (triangles) from usSEABED (Reid and others, 2006) that were used to supplement the ground-truth surveys. The seafloor-character map shows that this area is predominantly covered by sediment, but it also includes an oil platform and areas of rocky outcrops.

Each detailed view (figs. 1A through 5A) shows the locations of camera-sled tracklines (aligned colored dots), as well as of the photographs (colored stars) taken along the tracklines. These photographs, which are representative of the seafloor, are displayed with a description of the observed seafloor characteristics recorded by USGS and NOAA scientists (figs. 1B through 1E; 2B, 2C; 3B through 3H; 4B, 4C; 5B through 5L). Only primary and secondary substrates are reported, although individual photographs may show more substrate types. Organisms, when present, are labeled on the photographs.

Ground-truth surveys in the Offshore of Coal Oil Point map area include approximately 14.87 trackline kilometers of video and 333 still photographs, in addition to 615 seafloor observations of abiotic and biotic attributes. A visual estimate of slope also was recorded.

GLOSSARY

Rugosity—A GIS-derived characterization of seafloor roughness, calculated as the ratio of the three-dimensional surface area of seafloor to the two-dimensional planar-base area, for each cell in the bathymetry grid.

Backscatter intensity—The amplitude of the reflected sonar signal (see sheet 3) used to infer the hardness of the bottom, determined after sonar-data processing has removed (as much as possible) the effects of water depth, angle of reflection, and bottom roughness.

Biocomplexity—The assessment of the presence or absence of biological structures that have the potential of providing shelter for fauna, determined by estimating the scale, the amount, and the morphology of biological relief (as described by Tissot and others, 2006).

Biocover—The visual estimate of the proportion of biologic cover by encrusting organisms: high, greater than 50 percent; moderate, between 50 percent and 10 percent; low, less than 10 percent.

REFERENCES CITED

Reid, J.A., Reid, J.M., Jenkins, C.J., Zimmerman, M., Williams, S.J., and Field, M.E., 2006, usSEABED—Pacific Coast (California, Oregon, Washington) offshore surficial-sediment data release: U.S. Geological Survey Data Series 182, available at http://pubs.usgs.gov/ds/2006/182/.

Tissot, B.N., Yoklavich, M.M., Love, M.S., York, K., and Amend, M., 2006, Benthic invertebrates that form habitat on deep banks off southern California, with special reference to deep sea coral: Fishery Bulletin, v. 104, p. 167–181.

Wentworth, C.K., 1922, A scale of grade and class terms for clastic sediments: Journal of Geology, v. 30, p. 377–392.

EXPLANATION

Substrate class

Fine- to medium-grained smooth sediment—Low backscatter, low rugosity; typically mud to medium-grained sand; often rippled and (or) burrowed

Mixed smooth sediment and rock—Moderate to very high backscatter, low rugosity; typically coarse-grained sand, gravel, cobbles, and bedrock

Rock and boulder, rugose—High backscatter, high rugosity; typically boulders and rugose bedrock

Anthropogenic material—Related to development by humans

Location of real-time video observation and interpreted substrate class of seafloor

Fine- to medium-grained smooth sediment—Low backscatter, low rugosity; typically mud to medium-grained sand; often rippled and (or) burrowed

Mixed smooth sediment and rock—Moderate to very high backscatter, low rugosity; typically coarse-grained sand, gravel, cobbles, and bedrock

Rock and boulder, rugose—High backscatter, high rugosity; typically boulders and rugose bedrock

Location of digital still photograph and interpreted substrate class of seafloor

Fine- to medium-grained smooth sediment—Low backscatter, low rugosity; typically mud to medium-grained sand; often rippled and (or) burrowed

Mixed smooth sediment and rock—Moderate to very high backscatter, low rugosity; typically coarse-grained sand, gravel, cobbles, and bedrock

Rock and boulder, rugose—High backscatter, high rugosity; typically boulders and rugose bedrock

Interpreted substrate class depicted in digital still photograph—Indicated by colored frame around photograph (not shown on map; shown in figures only)

Fine- to medium-grained smooth sediment—Low backscatter, low rugosity; typically mud to medium-grained sand; often rippled and (or) burrowed

Mixed smooth sediment and rock—Moderate to very high backscatter, low rugosity; typically coarse-grained sand, gravel, cobbles, and bedrock

Rock and boulder, rugose—High backscatter, high rugosity; typically boulders and rugose bedrock

Sample localities

From usSEABED (Reid and others, 2006)

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

Figure 1A. Detailed view of seafloor character mapped south of Naples, approximately 1 km offshore (see Box A, on map, for location), showing locations of periodic real-time video observations (dots) and digital still photographs (stars; see figs. 1B through 1E) from camera line CAM10, cruise Z–1–07–SC.

Figure 1B. Digital still photograph no. A1 (see fig. 1A for location). Sand with slightly degraded wave ripples (water depth, 16 m). Abiotic complexity is low, biotic complexity is absent, and biocover is low. Biocover includes minor cover of algae (a). Distance between lasers (green dots) is 15 cm.

Figure 1C. Digital still photograph no. A2 (see fig. 1A for location). Sand with wave ripples (water depth, 20 m). Abiotic complexity is low, biotic complexity is absent, and biocover is low. Distance between lasers (green dots) is 15 cm.

Figure 1D. Digital still photograph no. A3 (see fig. 1A for location). Sand and mud, at edge of shelf terrace (water depth, 25 m). Abiotic complexity is low, biotic complexity is absent, and biocover is low. Distance between lasers (green dots) is 15 cm.

Figure 1E. Digital still photograph no. A4 (see fig. 1A for location). Sand and mud, at edge of shelf-terrace flank (water depth, 36 m). Abiotic complexity is low, biotic complexity is absent, and biocover is low. Distance between lasers (green dots) is 15 cm.

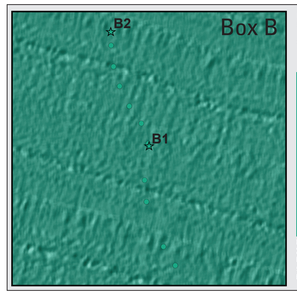


Figure 2A. Detailed view of seafloor character mapped between Naples and Coal Oil Point, approximately 3 km offshore (see Box B, on map, for location), showing locations of periodic real-time video observations (dots) and digital still photographs (stars; see figs. 2B, 2C) from camera line CAM48, cruise S–1C–08–SC.

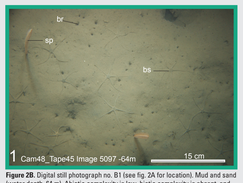


Figure 2B. Digital still photograph no. B1 (see fig. 2A for location). Mud and sand (water depth, 64 m). Abiotic complexity is low, biotic complexity is absent, and biocover is moderate. Biocover includes burrows (br), sea pen (sp), and brittle star (bs). Distance between lasers (red dots are just out of view in this image but are visible in previous video frame) is 15 cm.

Figure 2C. Digital still photograph no. B2 (see fig. 2A for location). Mud and sand (water depth, 61 m). Abiotic complexity is low, biotic complexity is absent, and biocover is low. Biocover includes burrows (br). Distance between lasers (red dots are just out of view in this image but are visible in previous video frame) is 15 cm.

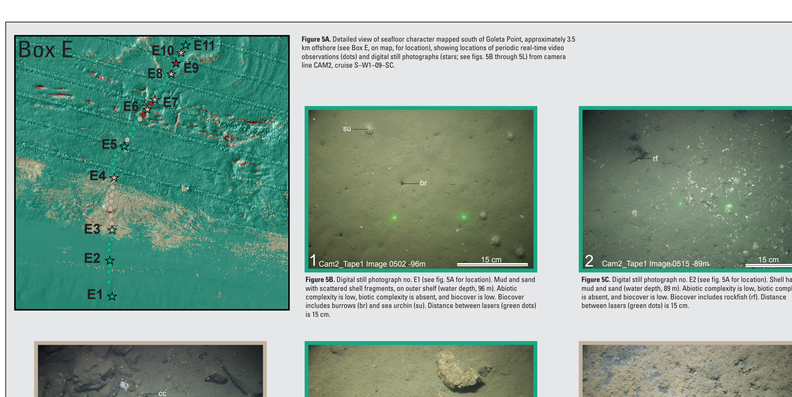


Figure 5A. Detailed view of seafloor character mapped south of Goleta Point, approximately 3.5 km offshore (see Box E, on map, for location), showing locations of periodic real-time video observations (dots) and digital still photographs (stars; see figs. 5B through 5L) from camera line CAM2, cruise S–W1–09–SC.

Figure 5B. Digital still photograph no. E1 (see fig. 5A for location). Mud and sand with scattered shell fragments, on outer shelf (water depth, 96 m). Abiotic complexity is low, biotic complexity is absent, and biocover is low. Biocover includes burrows (br) and sea urchin (su). Distance between lasers (green dots) is 15 cm.

Figure 5C. Digital still photograph no. E2 (see fig. 5A for location). Shell hash, in mud and sand (water depth, 89 m). Abiotic complexity is low, biotic complexity is absent, and biocover is low. Biocover includes rockfish (rf). Distance between lasers (green dots) is 15 cm.

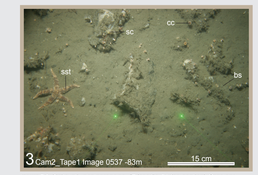


Figure 5D. Digital still photograph no. E3 (see fig. 5A for location). Sand and cobbles, adjacent to rock outcrop (water depth, 83 m). Abiotic complexity is low, biotic complexity is absent, and biocover is moderate. Biocover includes cup coral (cc), sea cucumber (sc), brittle star (bs), and sea star (sst). Distance between lasers (green dots) is 15 cm.

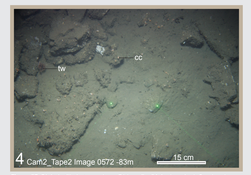


Figure 5E. Digital still photograph no. E4 (see fig. 5A for location). Sand and cobbles, adjacent to rock outcrop (water depth, 83 m). Abiotic complexity is low, biotic complexity is absent, and biocover is low. Biocover includes cup coral (cc) and tubeworm (tw). Distance between lasers (green dots) is 15 cm.

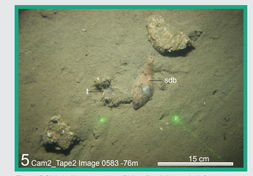


Figure 5F. Digital still photograph no. E5 (see fig. 5A for location). Sand and mud with isolated cobbles (water depth, 76 m). Abiotic complexity is low, biotic complexity is absent, and biocover is low. Biocover includes Pacific sanddab, *Citharichthys sordidus* (sdb); and tunicate (t). Distance between lasers (green dots) is 15 cm.

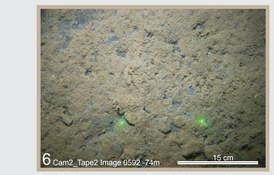


Figure 5G. Digital still photograph no. E6 (see fig. 5A for location). Mud and sand (water depth, 74 m). Abiotic complexity is low, biotic complexity is absent, and biocover is low. Distance between lasers (green dots) is 15 cm.

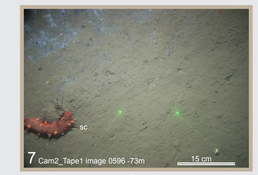


Figure 5H. Digital still photograph no. E7 (see fig. 5A for location). Mud and sand (water depth, 73 m). Abiotic complexity is low, biotic complexity is absent, and biocover is low. Biocover includes sea cucumber (sc). Distance between lasers (green dots) is 15 cm.

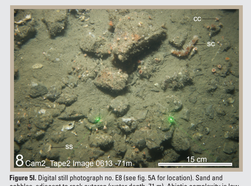


Figure 5I. Digital still photograph no. E8 (see fig. 5A for location). Sand and cobbles, adjacent to rock outcrop (water depth, 71 m). Abiotic complexity is low, biotic complexity is absent, and biocover is moderate. Biocover includes cup coral (cc); California sea cucumber, *Parastichopus californicus* (sc); and scattered shells (ss). Distance between lasers (green dots) is 15 cm.

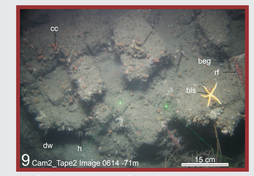


Figure 5J. Digital still photograph no. E9 (see fig. 5A for location). Fractured, blocky rock outcrop (water depth, 71 m). Abiotic complexity is moderate, biotic complexity is absent, and biocover is high. Biocover includes cup coral (cc); blood star, *Henricia leviuscula* (bls); halfbanded rockfish, *Sebastes semicinctus* (rf); blackeye goby, *Rhinogobiops nicholsii* (beg); hydroid (h); and drift weed (dw). Distance between lasers (green dots) is 15 cm.

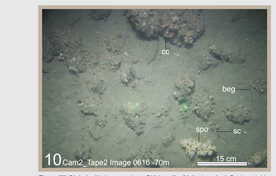


Figure 5K. Digital still photograph no. E10 (see fig. 5A for location). Rock and thin sand, adjacent to rock outcrop (water depth, 70 m). Abiotic complexity is low, biotic complexity is absent, and biocover is moderate. Biocover includes cup coral (cc); sponge (spo); blackeye goby, *Rhinogobiops nicholsii* (beg); and sea cucumber (sc). Distance between lasers (green dots) is 15 cm.

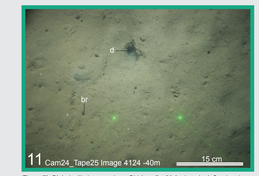


Figure 5L. Digital still photograph no. E11 (see fig. 5A for location). Sand and mud (water depth, 40 m). Abiotic complexity is low, biotic complexity is absent, and biocover is low. Biocover includes burrows (br). Also labeled on photo is depression (d). Distance between lasers (green dots) is 15 cm.

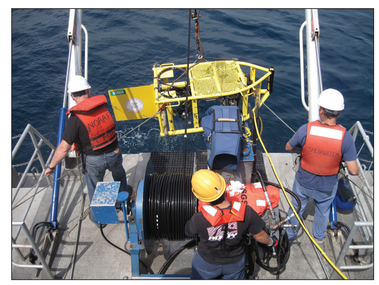


Figure 6. USGS-designed camera sled being launched off research vessel for ground-truth studies. Components onboard sled include four digital video camcorders, one 8-megapixel digital SLR camera, lasers for scale, and various strobe and video lights, as well as telemetry instrumentation that records depth, altitude, and compass heading.

Ground-Truth Studies, Offshore of Coal Oil Point Map Area, California

By

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