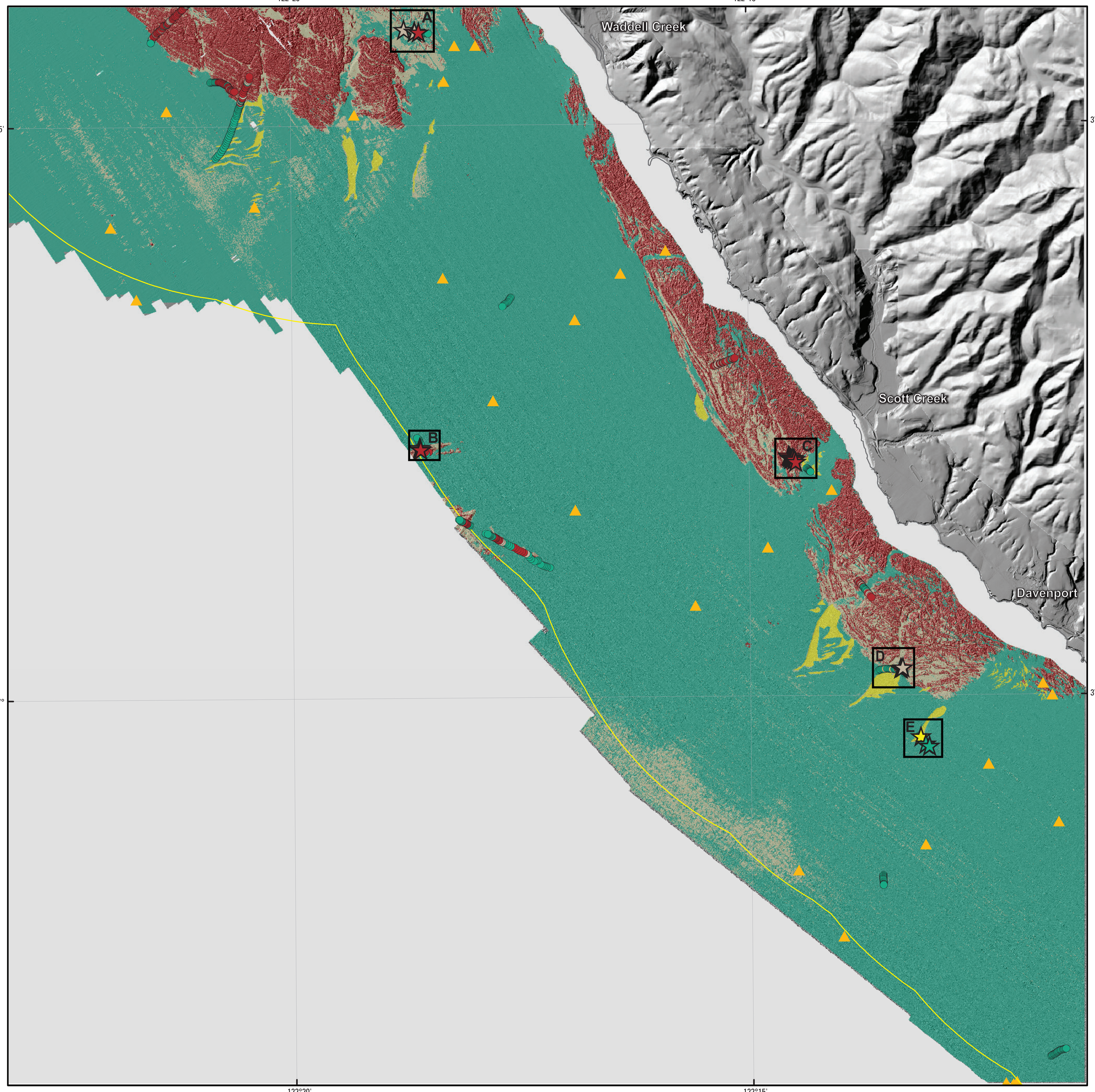
Open-File Report 2015–1191
Sheet 6 of 10
Pamphlet accompanies map



Onshore elevation data from California Coastal Conservancy (available from National Oceanic and Atmospheric Administration [NOAA] Coastal Service Center's Digital Coast 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/). 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 10N

NOT INTENDED FOR NAVIGATIONAL USE

TRUE NORTH / MAGNETIC NORTH 13½° APPROXIMATE MEAN DECLINATION, 2015

SCALE 1:50 000

2 1 0 2 MILES
7000 3500 0 7000 FEET
1 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 2007–2012. Sample localities from usSEABED (Reid and others, 2006)

GIS database and digital cartography by Nadine E. Golden

Manuscript approved for publication September 30, 2015

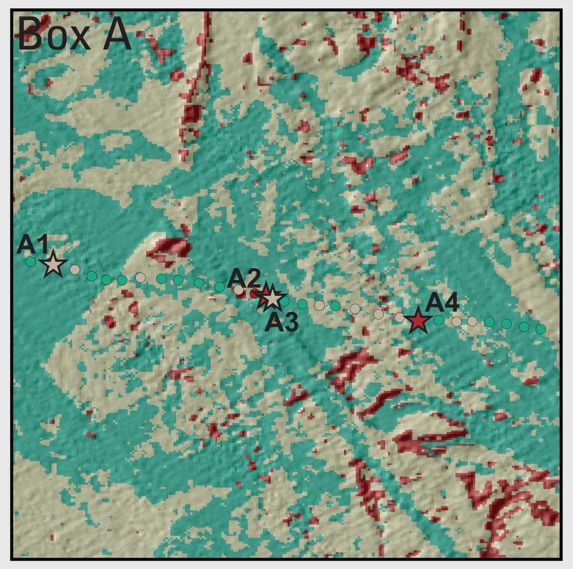


Figure 1A. Detailed view of seafloor character mapped west of Waddell Creek, approximately 2.1 km offshore (see Box A, on map, for location), showing locations of periodic real-time video observations (dots) and digital still photographs (stars; see figs. 1B through 1E) from camera line CAM112, cruise C–02–12–SC.

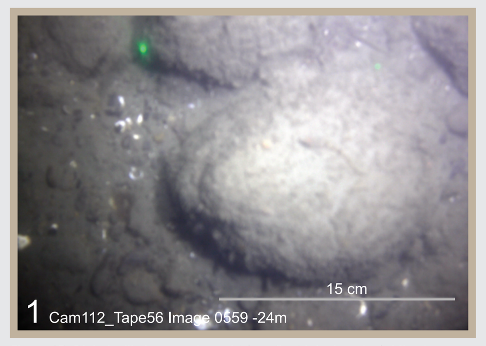


Figure 1B. Digital still photograph no. A1 (see fig. 1A for location). Mixed boulders, cobbles, gravel, sand, and shell hash (water depth, 24 m). Abiotic complexity is moderate, biotic complexity is present, and biocover is low. Distance between lasers (green dots) is 15 cm.

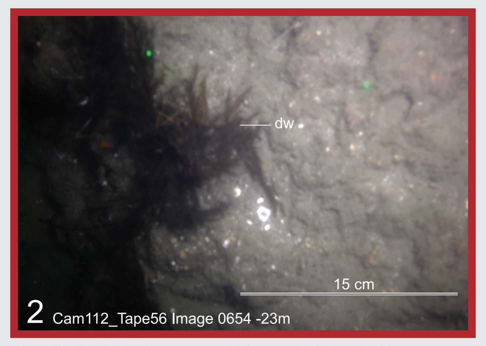


Figure 1C. Digital still photograph no. A2 (see fig. 1A for location). Rock outcrop and shell hash (water depth, 23 m). Abiotic complexity is moderate, biotic complexity is present, and biocover is moderate. Biocover includes drift weed (dw). Distance between lasers (green dots) is 15 cm.

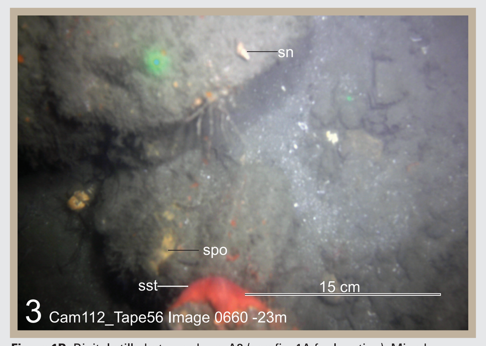


Figure 1D. Digital still photograph no. A3 (see fig. 1A for location). Mixed boulders, cobbles, gravel, sand, and shell hash (water depth, 23 m). Abiotic complexity is moderate, biotic complexity is absent, and biocover is moderate. Biocover includes sea star (sst), snail (sn), and encrusting sponge (spo). Distance between lasers (green dots) is 15 cm.

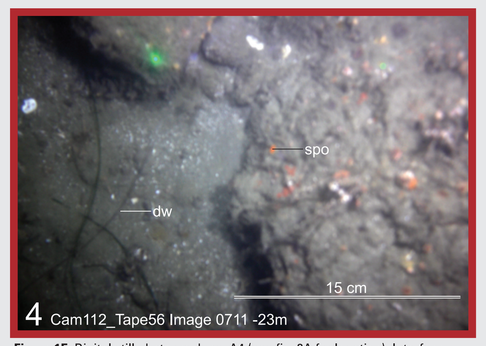


Figure 1E. Digital still photograph no. A4 (see fig. 2A for location). Interface between rock outcrop and fine sand and shell hash (water depth, 23 m). Abiotic complexity is moderate, biotic complexity is absent, and biocover is moderate. Biocover includes drift weed (dw) and encrusting sponge (spo). Distance between lasers (green dots) is 15 cm.

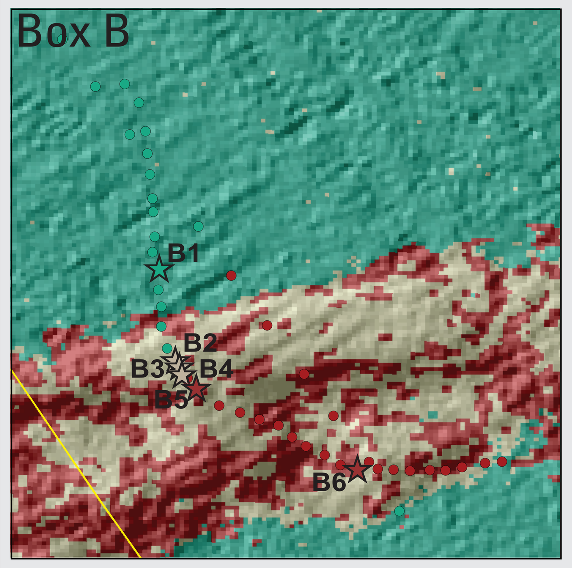


Figure 2A. Detailed view of seafloor character mapped west of Scott Creek, approximately 5.5 km offshore (see Box B, on map, for location), near 3-nautical-mile limit of California's State Waters (yellow line), showing locations of periodic real-time video observations (dots) and digital still photographs (stars; see figs. 2B through 2G) from camera line CAM113, cruise C–02–12–SC.

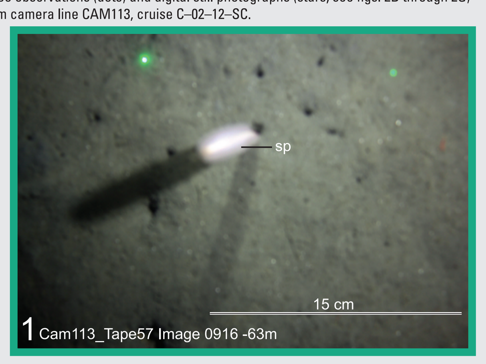


Figure 2B. Digital still photograph no. B1 (see fig. 2A for location). Unconsolidated, fine sand (water depth, 63 m). Abiotic complexity is low, biotic complexity is absent, and biocover is low. Biocover includes sea pen (sp). Distance between lasers (green dots) is 15 cm.

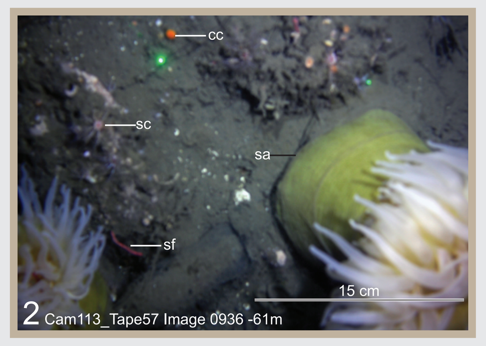


Figure 2C. Digital still photograph no. B2 (see fig. 2A for location). Rock outcrop that has veneer of fine sand and shell hash (water depth, 61 m). Abiotic complexity is low, biotic complexity is present, and biocover is high. Biocover includes solitary sea anemones (sa); sea cucumbers (sc); cup corals (cc); and sea fan, *Swiftia* spp. (sf). Distance between lasers (green dots) is 15 cm.

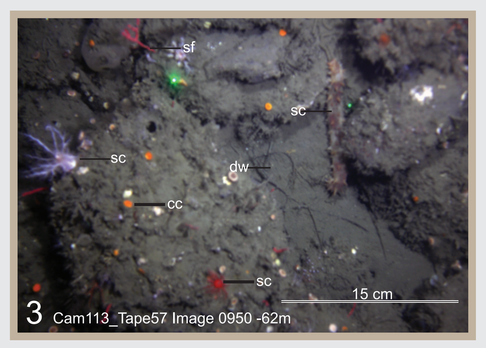


Figure 2D. Digital still photograph no. B3 (see fig. 2A for location). Mixed boulders, cobbles, gravel, fine sand, and shell hash (water depth, 62 m). Abiotic complexity is moderate, biotic complexity is absent, and biocover is high. Biocover includes sea cucumbers (sc); cup corals (cc); sea fan, *Swiftia* spp. (sf); and drift weed (dw). Distance between lasers (green dots) is 15 cm.

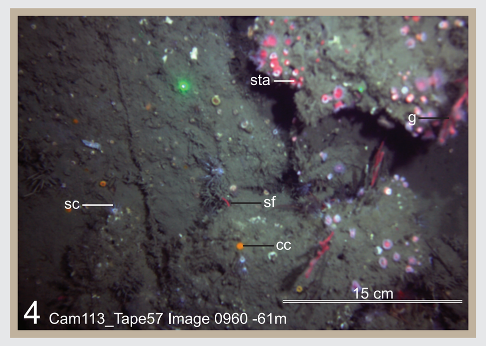


Figure 2E. Digital still photograph no. B4 (see fig. 2A for location). Rock outcrop that has veneer of mud (water depth, 61 m). Abiotic complexity is moderate, biotic complexity is present, and biocover is high. Biocover includes strawberry anemones, *Corynactis californica* (sta); cup corals (cc); sea cucumber (sc); sea fan, *Swiftia* spp. (sf); and gorgonians (g). Distance between lasers (green dots) is 15 cm.

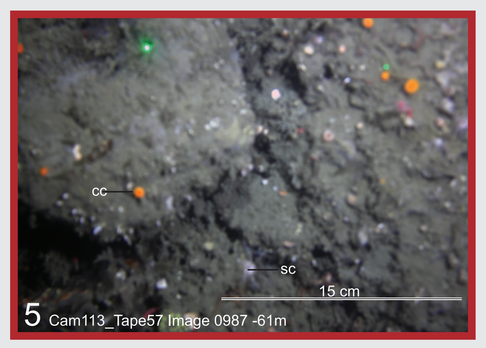


Figure 2F. Digital still photograph no. B5 (see fig. 2A for location). Rock outcrop that has veneer of mud (water depth, 61m). Abiotic complexity is moderate, biotic complexity is present, and biocover is moderate. Biocover includes cup corals (cc) and sea cucumbers (sc). Distance between lasers (green dots) is 15 cm.

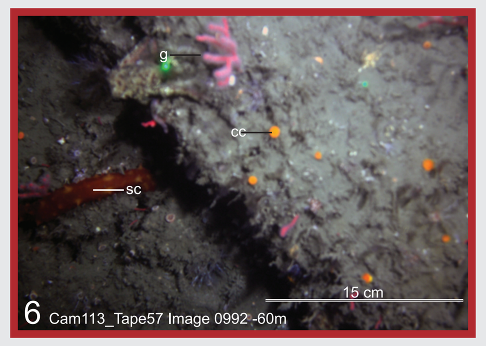


Figure 2G. Digital still photograph no. B6 (see fig. 2A for location). Rock outcrop that has veneer of mud (water depth, 60 m). Abiotic complexity is moderate, biotic complexity is present, and biocover is moderate. Biocover includes gorgonians (g), cup corals (cc), and sea cucumber (sc). Distance between lasers (green dots) is 15 cm.

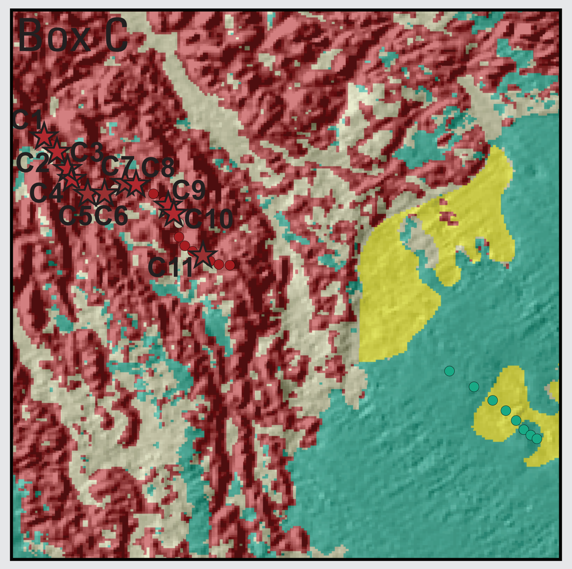


Figure 3A. Detailed view of seafloor character mapped west of Scott Creek, approximately 0.7 km offshore (see Box C, on map, for location), showing locations of periodic real-time video observations (dots) and digital still photographs (stars; see figs. 3B through 3L) from camera line 114, cruise C–02–12–SC.

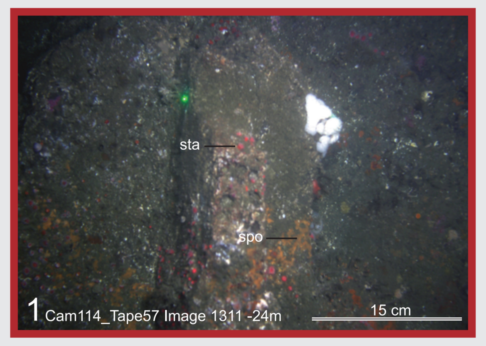


Figure 3B. Digital still photograph no. C1 (see fig. 3A for location). Sand channel in rugose rock outcrop (water depth, 24 m). Abiotic complexity is moderate, biotic complexity is absent, and biocover is moderate. Biocover includes strawberry anemones, *Corynactis californica* (sta); and encrusting sponge (spo). Distance between lasers (green dots) is 15 cm.

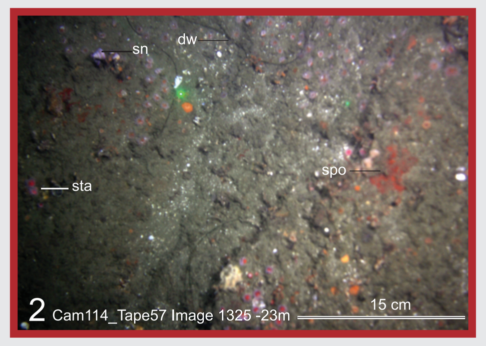


Figure 3C. Digital still photograph no. C2 (see fig. 3A for location). Rock outcrop (water depth, 23 m). Abiotic complexity is moderate, biotic complexity is absent, and biocover is high. Biocover includes encrusting sponge (spo); strawberry anemones, *Corynactis californica* (sta); drift weed (dw); and snail (sn). Distance between lasers (green dots) is 15 cm.

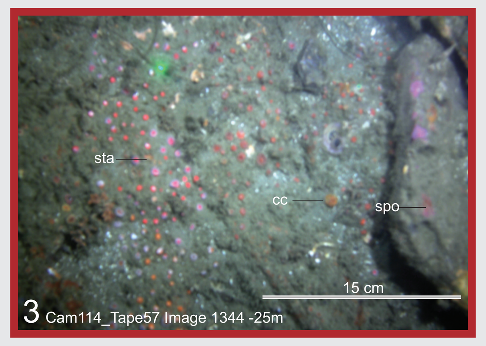


Figure 3D. Digital still photograph no. C3 (see fig. 3A for location). Rock outcrop (water depth, 25 m). Abiotic complexity is low, biotic complexity is absent, and biocover is high. Biocover includes encrusting sponge (spo); cup corals (cc); and strawberry anemones, *Corynactis californica* (sta). Distance between lasers (green dots) is 15 cm.

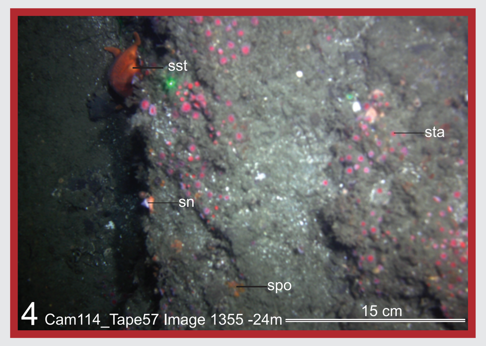


Figure 3E. Digital still photograph no. C4 (see fig. 3A for location). Interface between rock outcrop and sand channel (water depth, 24 m). Abiotic complexity is high, biotic complexity is absent, and biocover is high. Biocover includes sea star (sst); strawberry anemones, *Corynactis californica* (sta); snail (sn); and encrusting sponges (spo). Distance between lasers (green dots) is 15 cm.

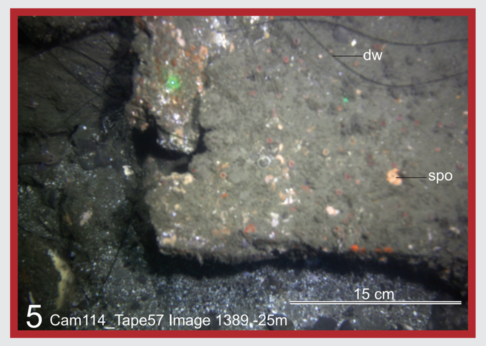


Figure 3F. Digital still photograph no. C5 (see fig. 3A for location). Rock outcrop (water depth, 25 m). Abiotic complexity is moderate, biotic complexity is absent, and biocover is low. Biocover includes encrusting sponge (spo) and drift weed (dw). Distance between lasers (green dots) is 15 cm.

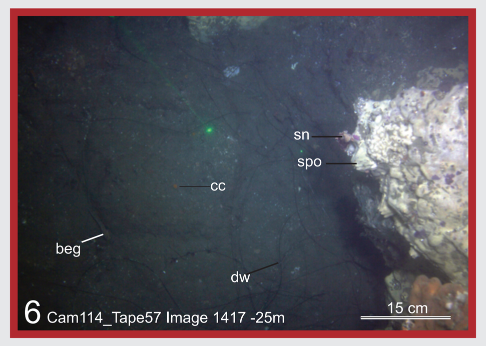


Figure 3G. Digital still photograph no. C6 (see fig. 3A for location). Rock outcrop (water depth, 25 m). Abiotic complexity is high, biotic complexity is absent, and biocover is moderate. Biocover includes blackeye goby, *Rhinogobiops nicholsii* (beg); snail (sn); sponge (spo); drift weed (dw); and cup coral (cc). Distance between lasers (green dots) is 15 cm.

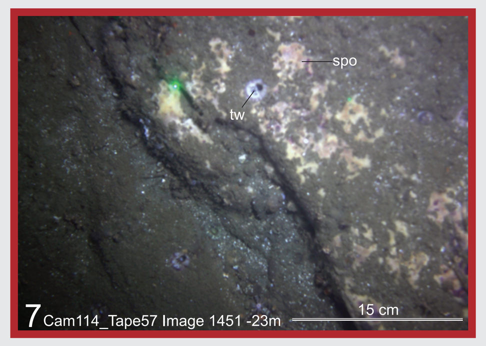


Figure 3H. Digital still photograph no. C7 (see fig. 3A for location). Rock outcrop (water depth, 23 m). Abiotic complexity is high, biotic complexity is absent, and biocover is moderate. Biocover includes tubeworm holes (tw) and encrusting sponge (spo). Distance between lasers (green dots) is 15 cm.

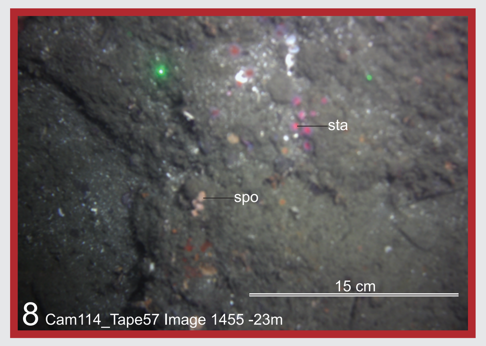


Figure 3I. Digital still photograph no. C8 (see fig. 3A for location). Rock outcrop (water depth, 23 m). Abiotic complexity is high, biotic complexity is absent, and biocover is moderate. Biocover includes encrusting sponge (spo); and strawberry anemones, *Corynactis californica* (sta). Distance between lasers (green dots) is 15 cm.

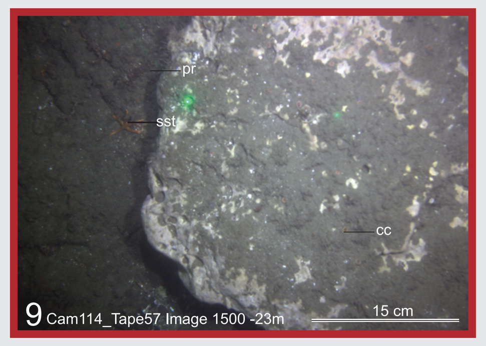


Figure 3J. Digital still photograph no. C9 (see fig. 3A for location). Rock outcrop (water depth, 23 m). Abiotic complexity is high, biotic complexity is absent, and biocover is low. Biocover includes sea star (sst); cup coral (cc); and spot prawn, *Pandalus platyceros* (pr). Distance between lasers (green dots) is 15 cm.

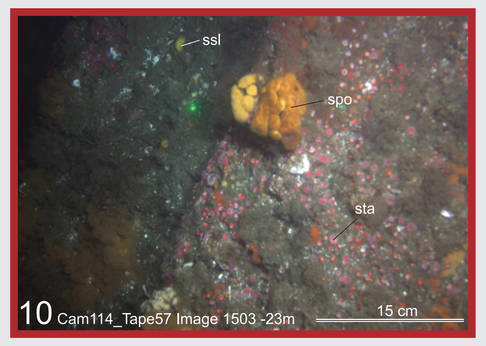


Figure 3K. Digital still photograph no. C10 (see fig. 3A for location). Rock outcrop (water depth, 23 m). Abiotic complexity is moderate, biotic complexity is absent, and biocover is high. Biocover includes sponges (spo); strawberry anemones, *Corynactis californica* (sta); and sea slug (ssl). Distance between lasers (green dots) is 15 cm.

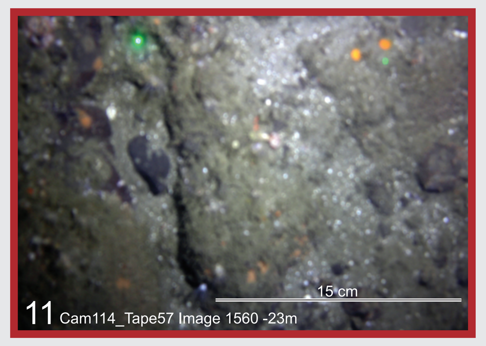


Figure 3L. Digital still photograph no. C11 (see fig. 3A for location). Rock outcrop and scattered shell hash (water depth, 23 m). Abiotic complexity is low, biotic complexity is absent, and biocover is low. Distance between lasers (green dots) is 15 cm.

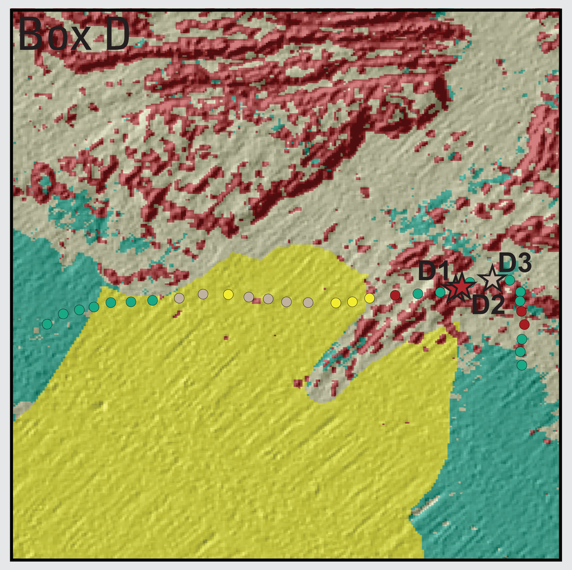


Figure 4A. Detailed view of seafloor character mapped west-southwest of Davenport, approximately 1.5 km offshore (see Box D, on map, for location), showing locations of periodic real-time video observations (dots) and digital still photographs (stars; see figs. 4B through 4D) from camera line CAM115, cruise C–02–12–SC.

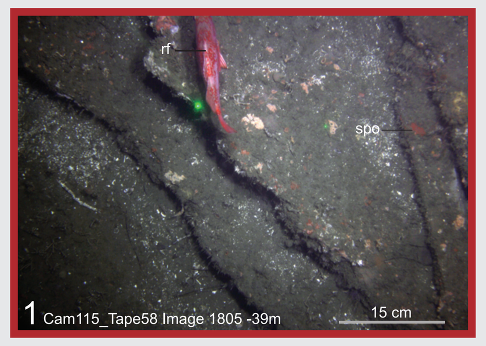


Figure 4B. Digital still photograph no. D1 (see fig. 4A for location). Rock outcrop that has veneer of shell hash (water depth, 39 m). Abiotic complexity is moderate, biotic complexity is absent, and biocover is moderate. Biocover includes vermillion rockfish, *Sebastes miniatus* (rf); and encrusting sponge (spo). Distance between lasers (green dots) is 15 cm.

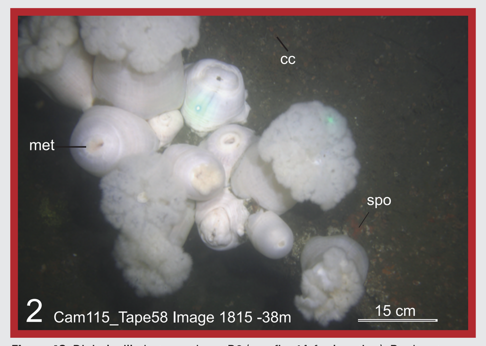


Figure 4C. Digital still photograph no. D2 (see fig. 4A for location). Rock outcrop (water depth, 38 m). Abiotic complexity is low, biotic complexity is present, and biocover is high. Biocover includes white plumed anemones, *Metridium* spp. (met); encrusting sponge (spo); and cup corals (cc). Distance between lasers (green dots) is 15 cm.

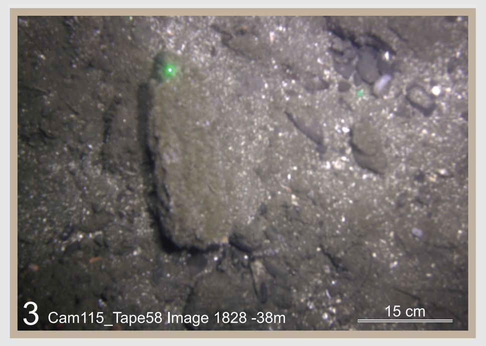


Figure 4D. Digital still photograph no. D3 (see fig. 4A for location). Mixed cobbles, gravel, sand, and shell hash (water depth, 38 m). Abiotic complexity is low, biotic complexity is absent, and biocover is low. Distance between lasers (green dots) is 15 cm.

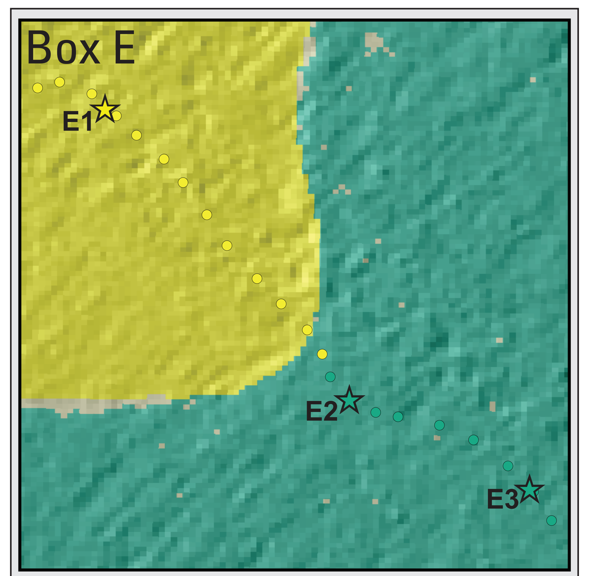


Figure 5A. Detailed view of seafloor character mapped southwest of Davenport, approximately 2.3 km offshore (see Box E, on map, for location), showing locations of periodic real-time video observations (dots) and digital still photographs (stars; see figs. 5B through 5D) from camera line CAM116, cruise C–02–12–SC.

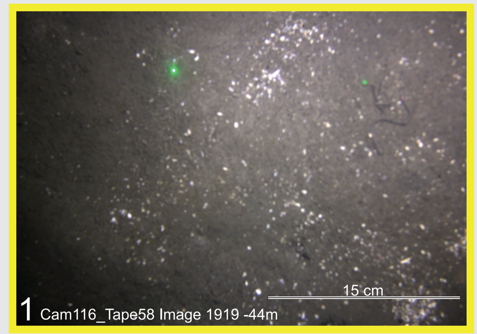


Figure 5B. Digital still photograph no. E1 (see fig. 5A for location). Hardpan seabed that has unconsolidated, fine sand and shell hash (water depth, 44 m). Abiotic complexity is low, biotic complexity is absent, and biocover is absent. Distance between lasers (green dots) is 15 cm.

Figure 5C. Digital still photograph no. E2 (see fig. 5A for location). Unconsolidated, fine sand and shell hash (water depth, 44 m). Abiotic complexity is low, biotic complexity is present, and biocover is high. Biocover includes brittle stars (bs). Distance between lasers (green dots) is 15 cm.

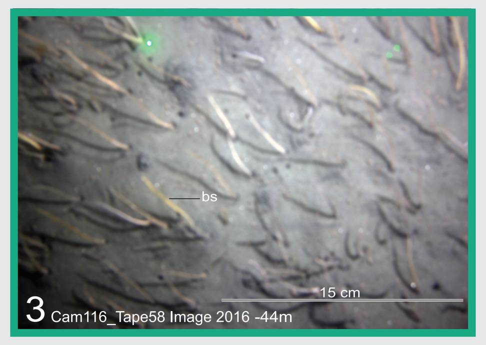
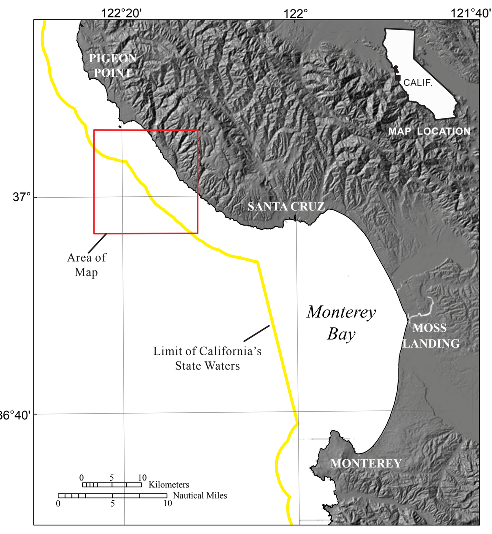


Figure 5D. Digital still photograph no. E3 (see fig. 5A for location). Unconsolidated fine sand (water depth, 44 m). Abiotic complexity is low, biotic complexity is present, and biocover is high. Biocover includes brittle stars (bs). Distance between lasers (green dots) is 15 cm.



DISCUSSION

Between 2006 and 2007, the seafloor in the Offshore of Scott Creek map area in central California was mapped by California State University, Monterey Bay (CSUMB), by Fugro Pelagos, and by the U.S. Geological Survey (USGS), using both multibeam echosounders and bathymetric sidescan-sonar systems (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, the USGS ground-truth surveyed the area by towing a camera sled (fig. 6) over specific locations throughout the map area in 2007 and 2012.

During the ground-truth-survey cruises, the camera sled was towed 1 to 2 m above the seafloor, at speeds of between 1 and 2 nautical miles/hour. The sled housed two standard-definition (640×480 pixel resolution) video cameras (one forward looking, the other downward looking), 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 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. The locations 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 bottoms 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, 2A, 3A, 4A, 5A). 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 high-relief, rocky and boulder habitat in the nearshore, out to depths of as much as 45 m, and low-relief sand and mud habitat in deeper waters.

Each detailed view (figs. 1A, 2A, 3A, 4A, 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 through 2G; 3B through 3L; 4B through 4D; 5B through 5D). 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 Scott Creek map area include approximately 8 trackline kilometers of video and 3,700 still photographs, in addition to 548 seafloor observations of abiotic and biotic attributes. A visual estimate of slope was also 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 (Tissot and others, 2006).

Biocover—The visual estimate of the proportion of biologic cover by encrusting organisms: high, greater than 50 percent; moderate, between 10 percent and 50 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
- **Medium- to coarse-grained sediment**—Very high backscatter, low rugosity; typically medium- to coarse-grained sediment, with varying amounts of shell hash; in scour depressions
- **Rock and boulder, rugose**—High backscatter, high rugosity; typically boulders and rugose bedrock

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
- **Medium- to coarse-grained sediment**—Very high backscatter, low rugosity; typically medium- to coarse-grained sediment, with varying amounts of shell hash; in scour depressions
- **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
- **Medium- to coarse-grained sediment**—Very high backscatter, low rugosity; typically medium- to coarse-grained sediment, with varying amounts of shell hash; in scour depressions
- **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
- **Medium- to coarse-grained sediment**—Very high backscatter, low rugosity; typically medium- to coarse-grained sediment, with varying amounts of shell hash; in scour depressions
- **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

Coastal Conservancy · California Ocean Protection Council · NOAA · Seafloor Mapping Lab CSU Monterey Bay · BOEM Bureau of Ocean Energy Management

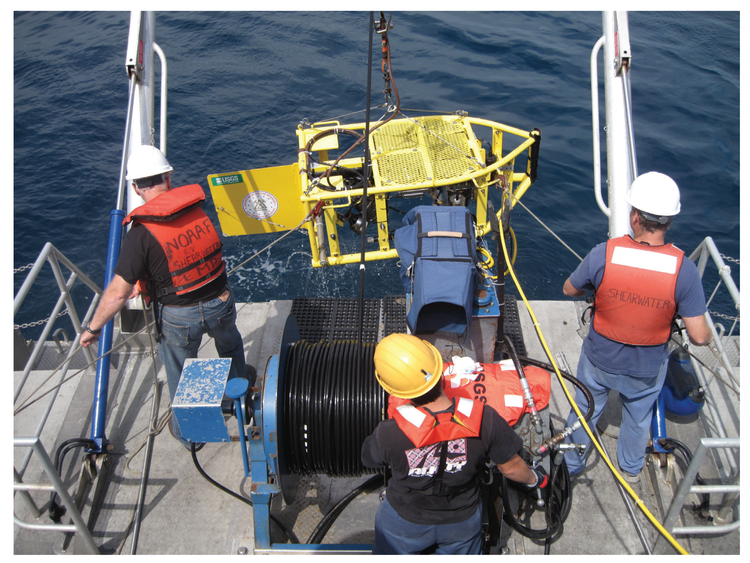


Figure 6. USGS-designed camera sled being launched off research vessel in preparation for ground-truth studies. Components include four digital video camcorders, one 8-megapixel digital SLR camera, lasers for scale, and various strobe and video lights, as well as telemetry instrumentation that records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

Ground-Truth Studies, Offshore of Scott Creek Map Area, California

By

Nadine E. Golden,[1] Guy R. Cochrane,[1] and Lisa M. Krigsman[2]

2015

[1]U.S. Geological Survey;
[2]National Oceanic and Atmospheric Administration, National Marine Fisheries Service

Any use of trade, product, or firm names in this publication is for descriptive purposes only and does not imply endorsement by the U.S. Government

ISSN 2331-1258 (online)
http://dx.doi.org/10.3133/ofr20151191