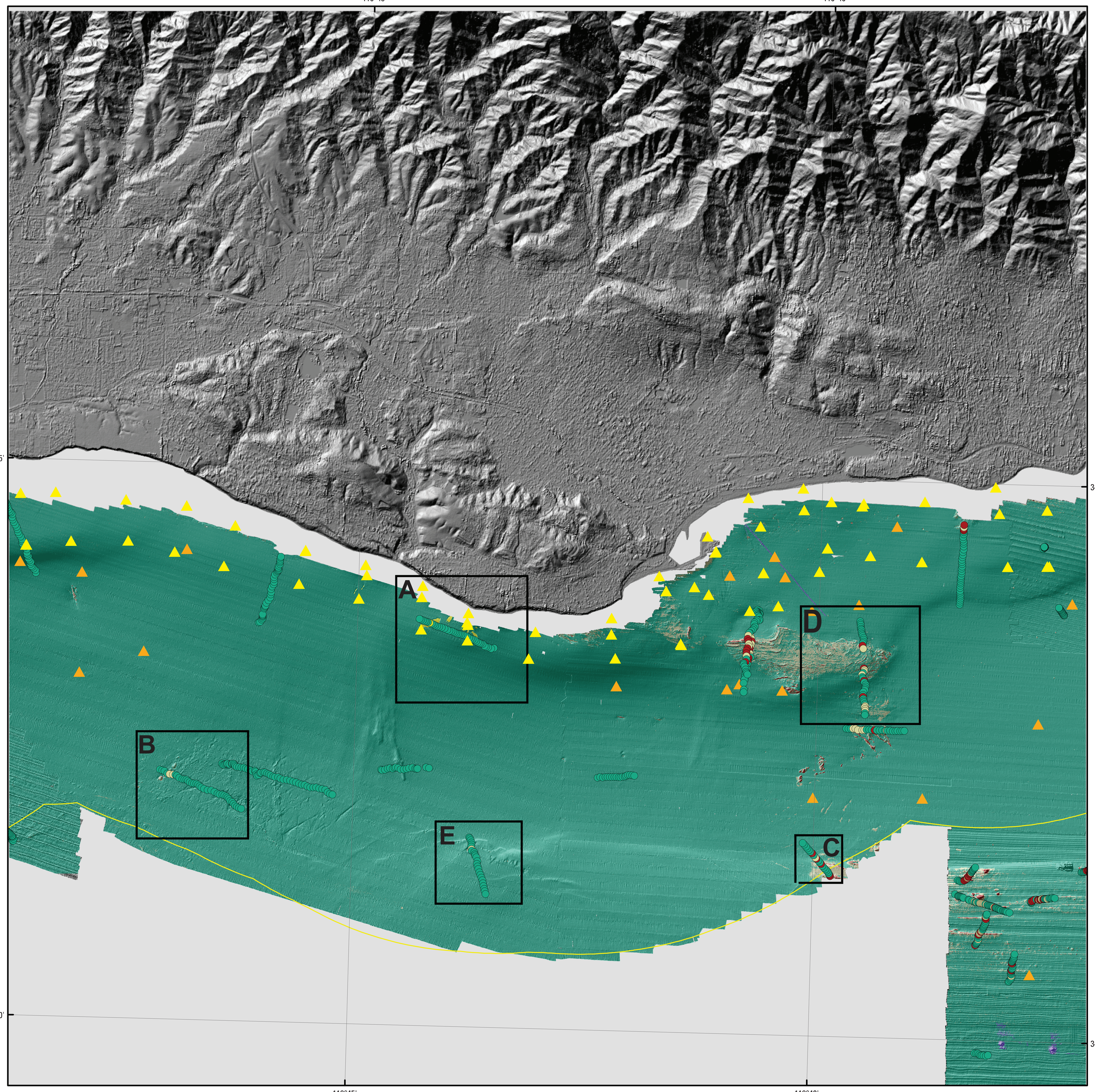


Onshore elevation data from NOAA Coastal Services Center (data collected by EarthData International in 2002-2003) and from U.S. Army Corps of Engineers (data collected by Fugro Pelagos in 2009). Offshore shaded-relief bathymetry from map on sheet 2, this report. California's State Waters limit from NOAA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

Universal Transverse Mercator projection, Zone 11N

NOT INTENDED FOR NAVIGATIONAL USE

12½° TRUE NORTH MAGNETIC NORTH APPROXIMATE MEAN DECLINATION, 2013

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 2008-2009. Sample localities from usSEABED (Reid and others, 2006) and from Barnard and others (2009)

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

Edited by Taryn A. Lindquist

Manuscript approved for publication December 12, 2013

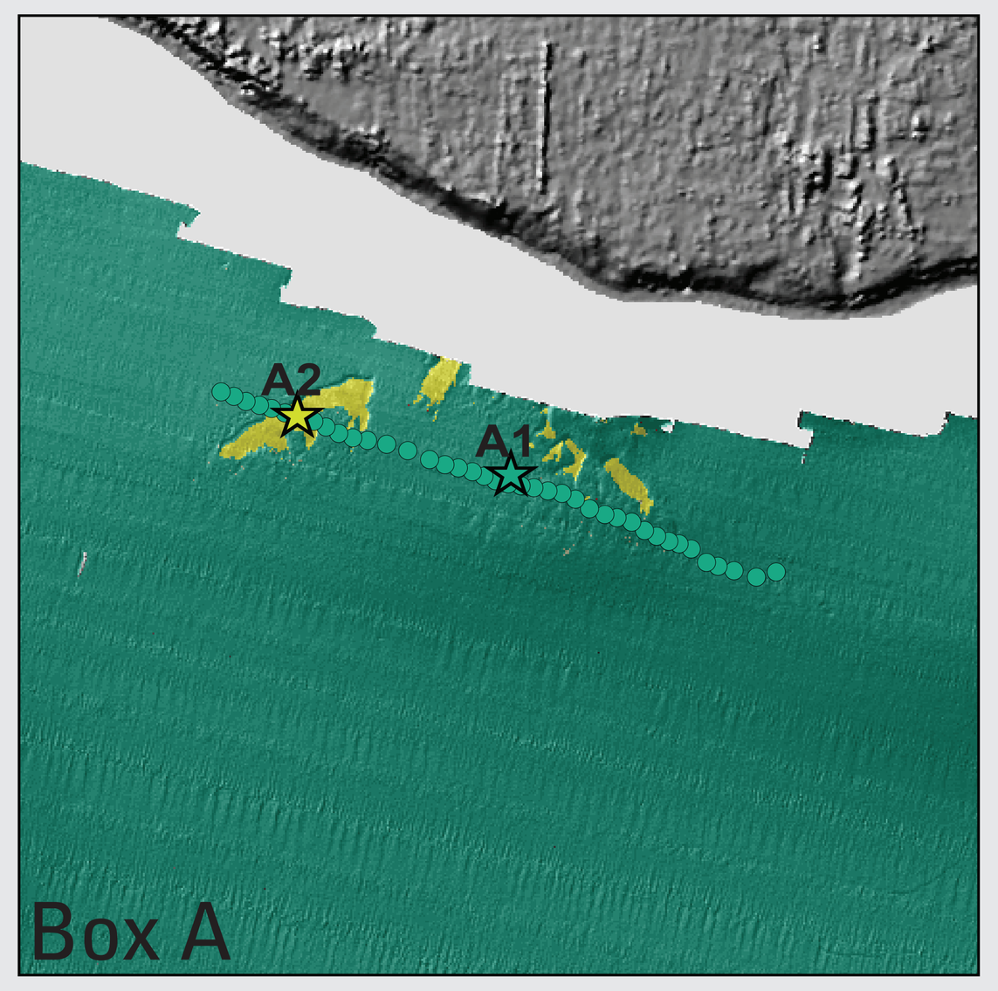


Figure 1A. Detailed view of seafloor character mapped south of Santa Barbara, approximately 0.5 km offshore (see Box A, on map, for location), showing locations of periodic real-time video observations (dots) and digital still photographs (stars; see figs. 1B, 1C) from camera line CAM20, cruise S–1C–08–SC.

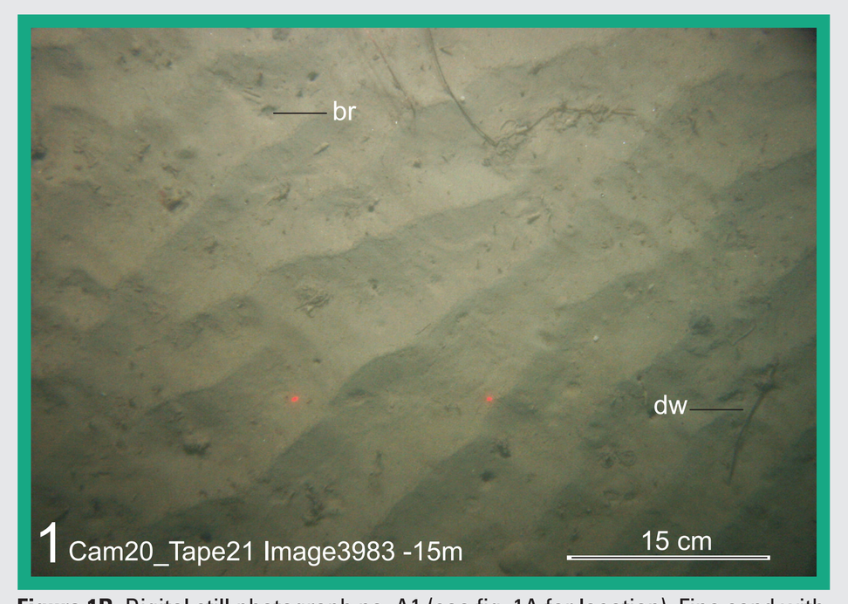


Figure 1B. Digital still photograph no. A1 (see fig. 1A for location). Fine sand with sharp-crested wave ripples (water depth, 15 m). Abiotic complexity is low, biotic complexity is absent, and biocover is low. Biocover includes burrows (br) and drift weed (dw). Distance between lasers (red dots) is 15 cm.

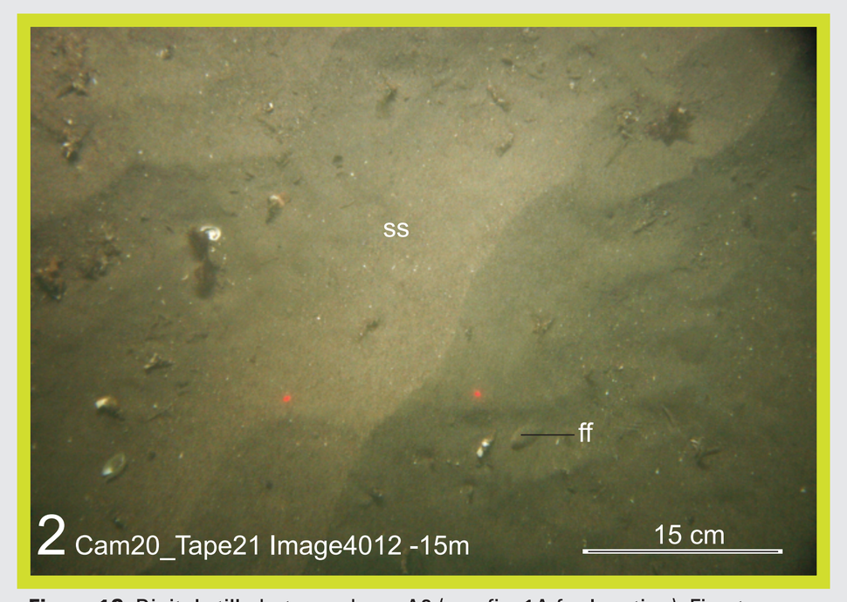


Figure 1C. Digital still photograph no. A2 (see fig. 1A for location). Fine to medium-grained sand, with sharp-crested ripples and scattered shells (water depth, 15 m). Abiotic complexity is low, biotic complexity is absent, and biocover is low. Biocover includes flatfish (ff) and scattered shells (ss). Distance between lasers (red dots) is 15 cm.

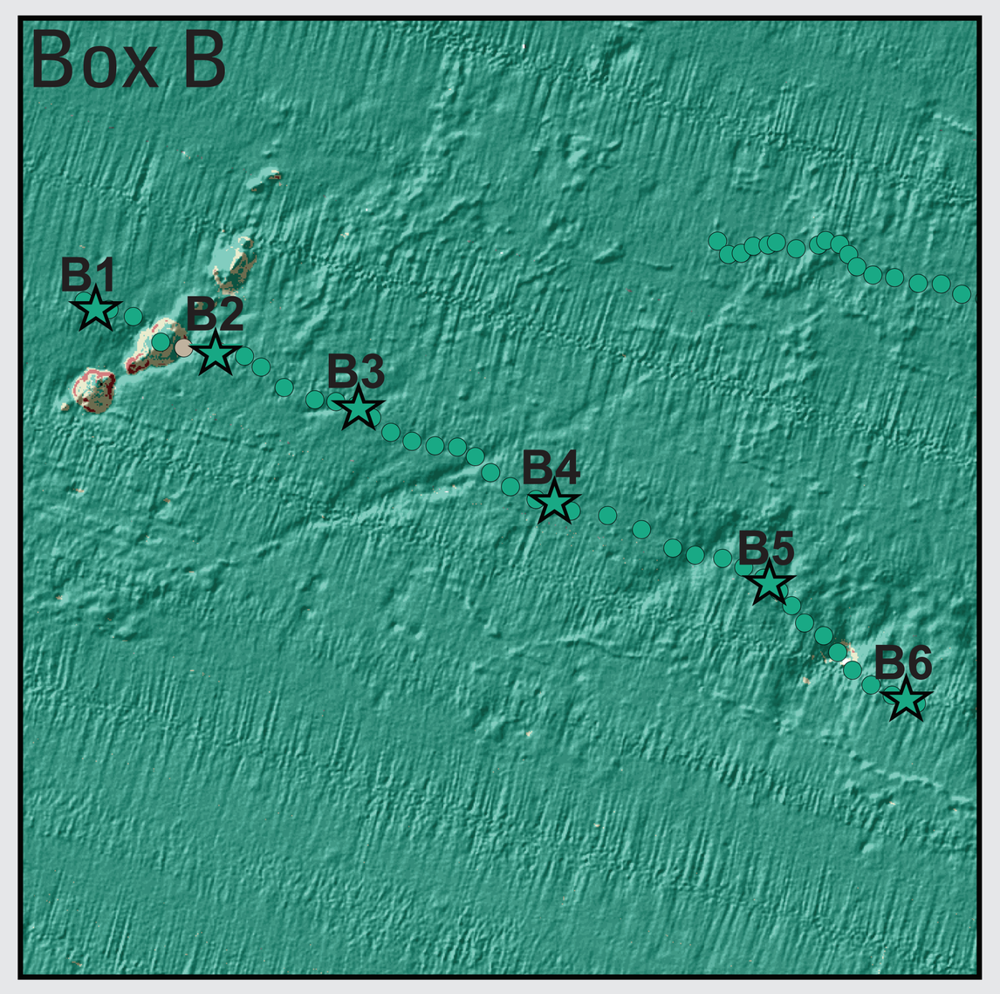


Figure 2A. Detailed view of seafloor character mapped southwest of Santa Barbara, approximately 4.5 km offshore (see Box B, on map, for location), showing locations of periodic real-time video observations (dots) and digital still photographs (stars; see figs. 2B through 2G) from camera line CAM22, cruise S–1C–08–SC.

Figure 2B. Digital still photograph no. B1 (see fig. 2A for location). Mud and sand (water depth, 71 m). Abiotic complexity is low, biotic complexity is absent, and biocover is low. Biocover includes burrows (br) and combfish (f). Distance between lasers (red dots) is 15 cm.

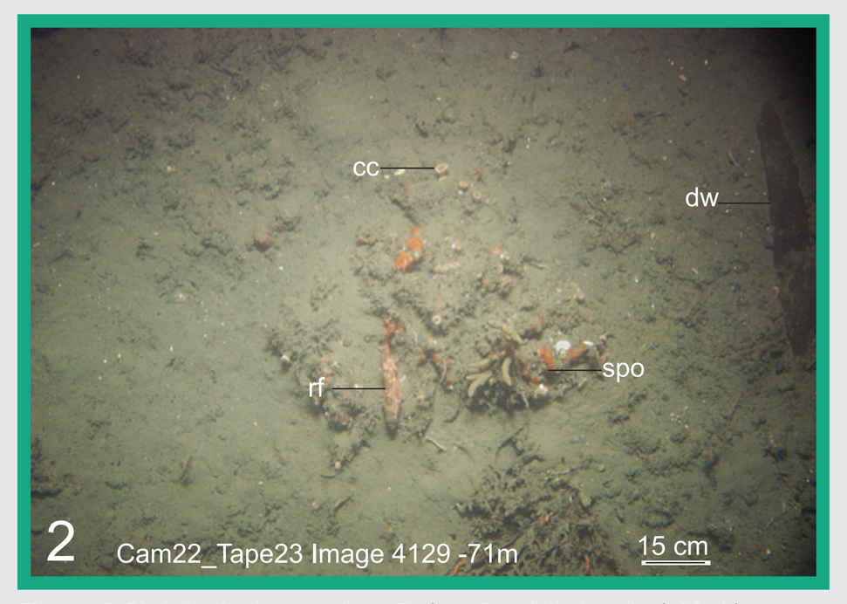


Figure 2C. Digital still photograph no. B2 (see fig. 2A for location). Mud (water depth, 71 m). Abiotic complexity is low, biotic complexity is absent, and biocover is moderate. Biocover includes drift weed (dw), cup coral (cc), sponge (spo), and rockfish (rf). Distance between lasers (red dots are just out of view in this image but are visible in previous video frame) is 15 cm.

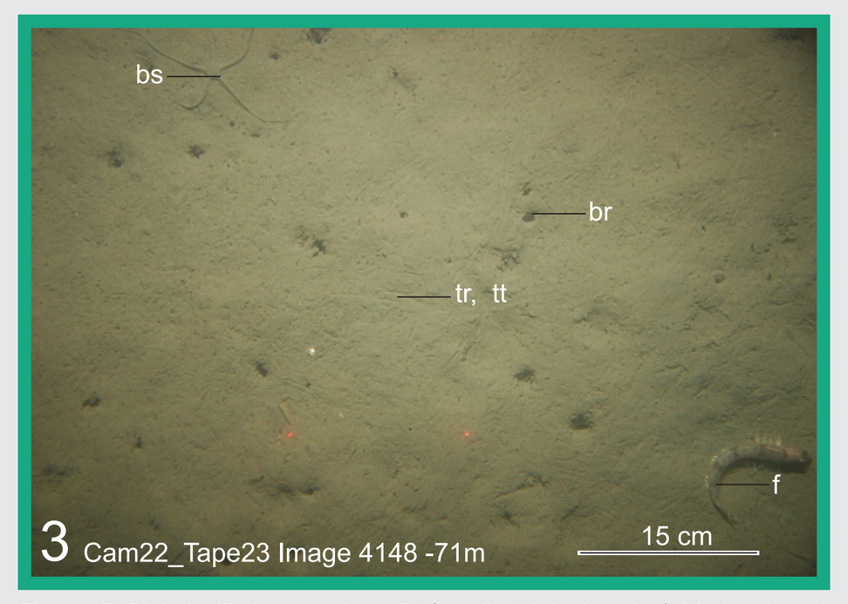


Figure 2D. Digital still photograph no. B3 (see fig. 2A for location). Mud and sand (water depth, 71 m). Abiotic complexity is low, biotic complexity is absent, and biocover is low. Biocover includes burrows (br), combfish (f), brittle star (bs), tracks (tr), and trails (tt). Distance between lasers (red dots) is 15 cm.

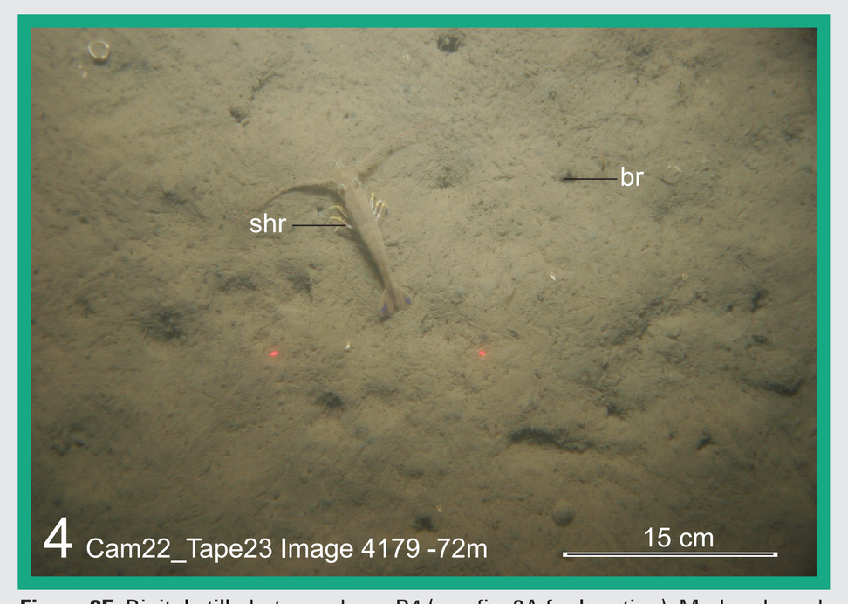


Figure 2E. Digital still photograph no. B4 (see fig. 2A for location). Mud and sand (water depth, 72 m). Abiotic complexity is low, biotic complexity is absent, and biocover is low. Biocover includes burrows (br) and shrimp (shr). Distance between lasers (red dots) is 15 cm.

Figure 2F. Digital still photograph no. B5 (see fig. 2A for location). Mud and sand (water depth, 72 m). Abiotic complexity is low, biotic complexity is absent, and biocover is low. Biocover includes combfish (f). Distance between lasers (red dots) is 15 cm.

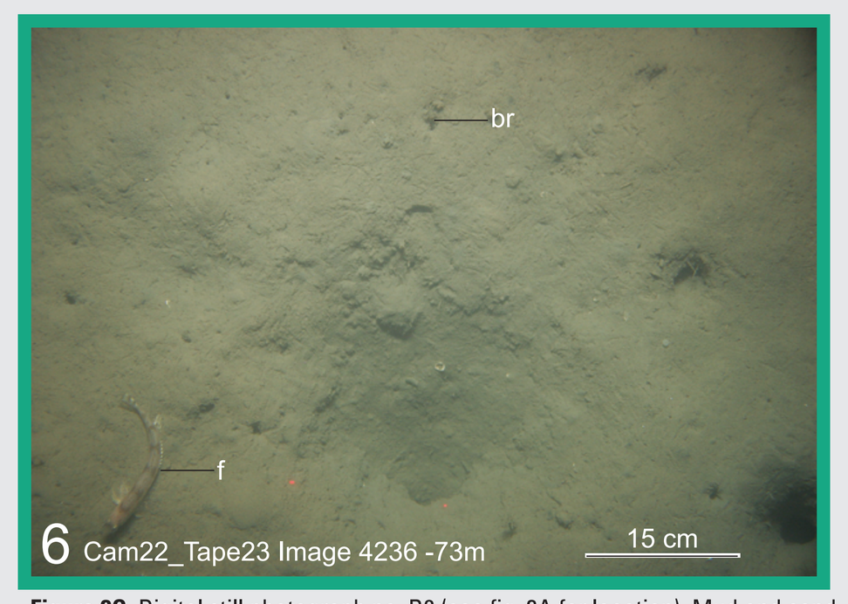


Figure 2G. Digital still photograph no. B6 (see fig. 2A for location). Mud and sand (water depth, 73 m). Abiotic complexity is low, biotic complexity is absent, and biocover is low. Biocover includes burrows (br) and combfish (f). Distance between lasers (red dots) is 15 cm.

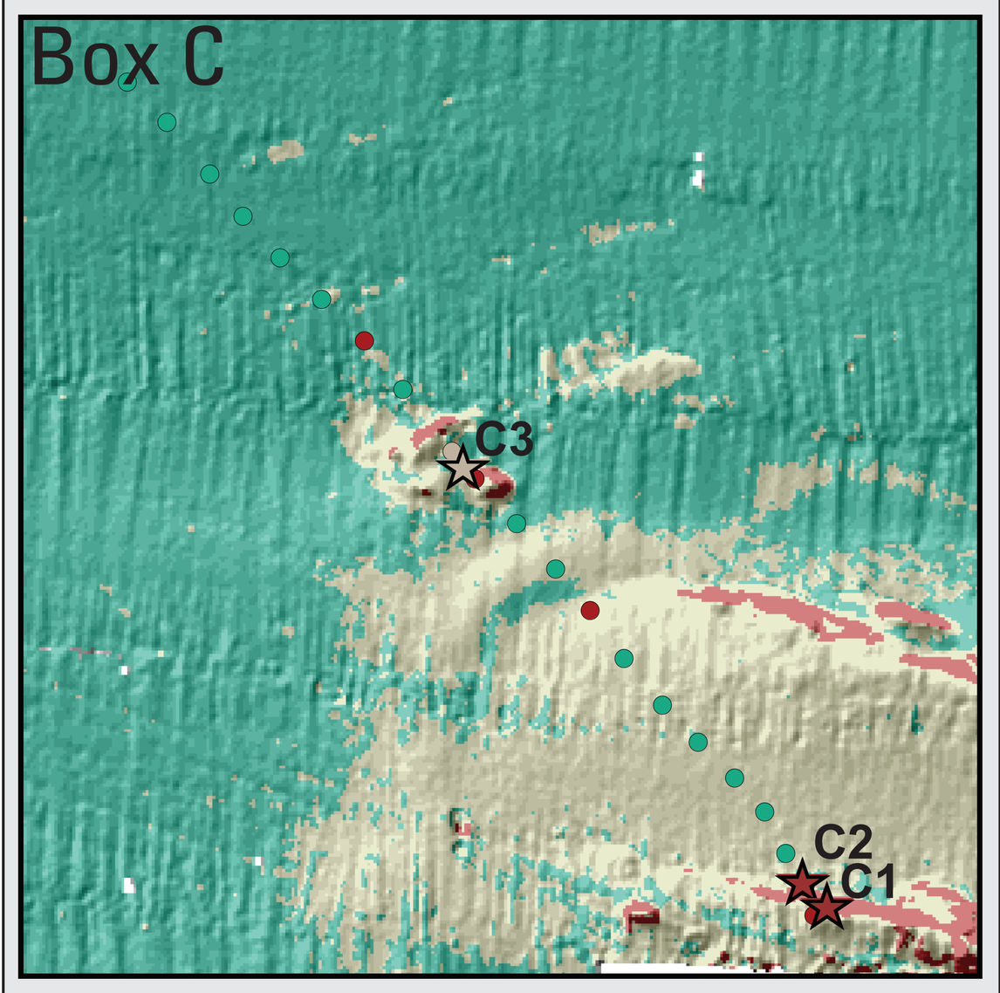


Figure 3A. Detailed view of seafloor character mapped southeast of Santa Barbara, approximately 5.5 km offshore (see Box C, on map, for location), showing locations of periodic real-time video observations (dots) and digital still photographs (stars; see figs. 3B through 3D) from camera line CAM23, cruise S–1C–08–SC.

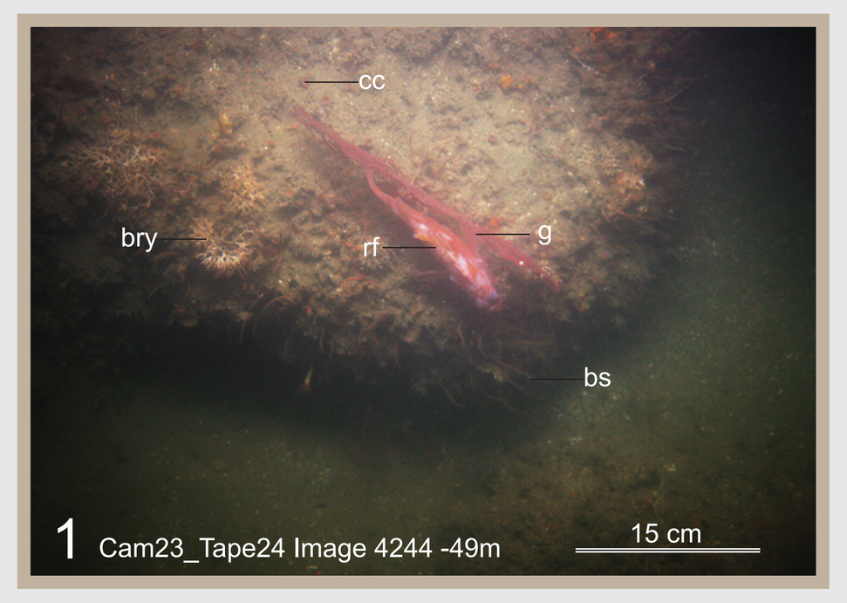


Figure 3B. Digital still photograph no. C1 (see fig. 3A for location). Boulder in area of rock outcrop (water depth, 49 m). Abiotic complexity is moderate, biotic complexity is present, and biocover is high. Biocover includes gorgonian (g); cup coral (cc); rosy rockfish, *Sebastes rosaceus* (rf); brittle star (bs); and bryozoan (bry). Distance between lasers (red dots are just out of view in this image but are visible in previous video frame) is 15 cm.

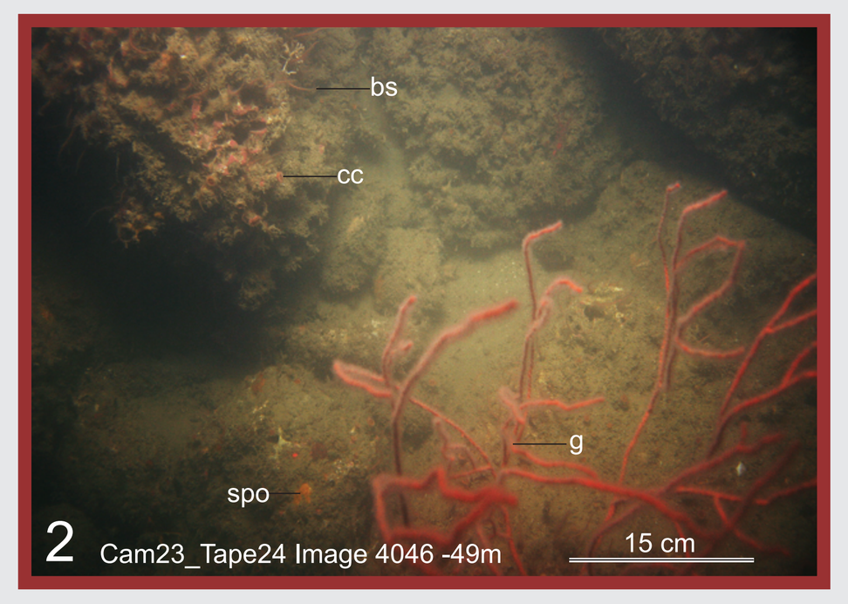


Figure 3C. Digital still photograph no. C2 (see fig. 3A for location). Boulder in area of rock outcrop (water depth, 49 m). Abiotic complexity is moderate, biotic complexity is present, and biocover is high. Biocover includes gorgonian (g), sponge (spo), brittle star (bs), and cup coral (cc). Distance between lasers (only one red dot is visible in this image, but both are visible in previous video frame) is 15 cm.

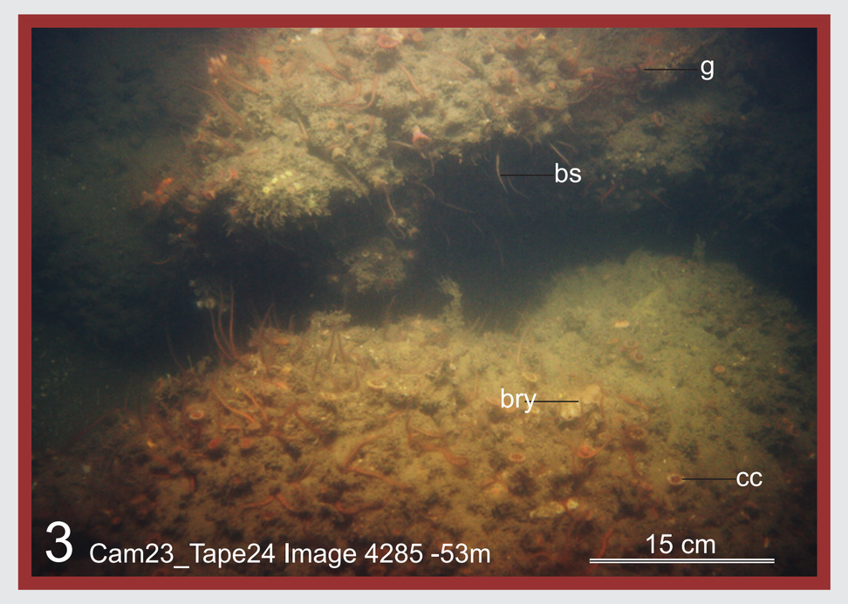


Figure 3D. Digital still photograph no. C3 (see fig. 3A for location). Boulder in area of rock outcrop, with mud-filled interstices (water depth, 53 m). Abiotic complexity is low, biotic complexity is absent, and biocover is high. Biocover includes cup coral (cc), brittle star (bs), gorgonian (g), and bryozoan (bry). Distance between lasers (red dots are just out of view in this image but are visible in previous video frame) is 15 cm.

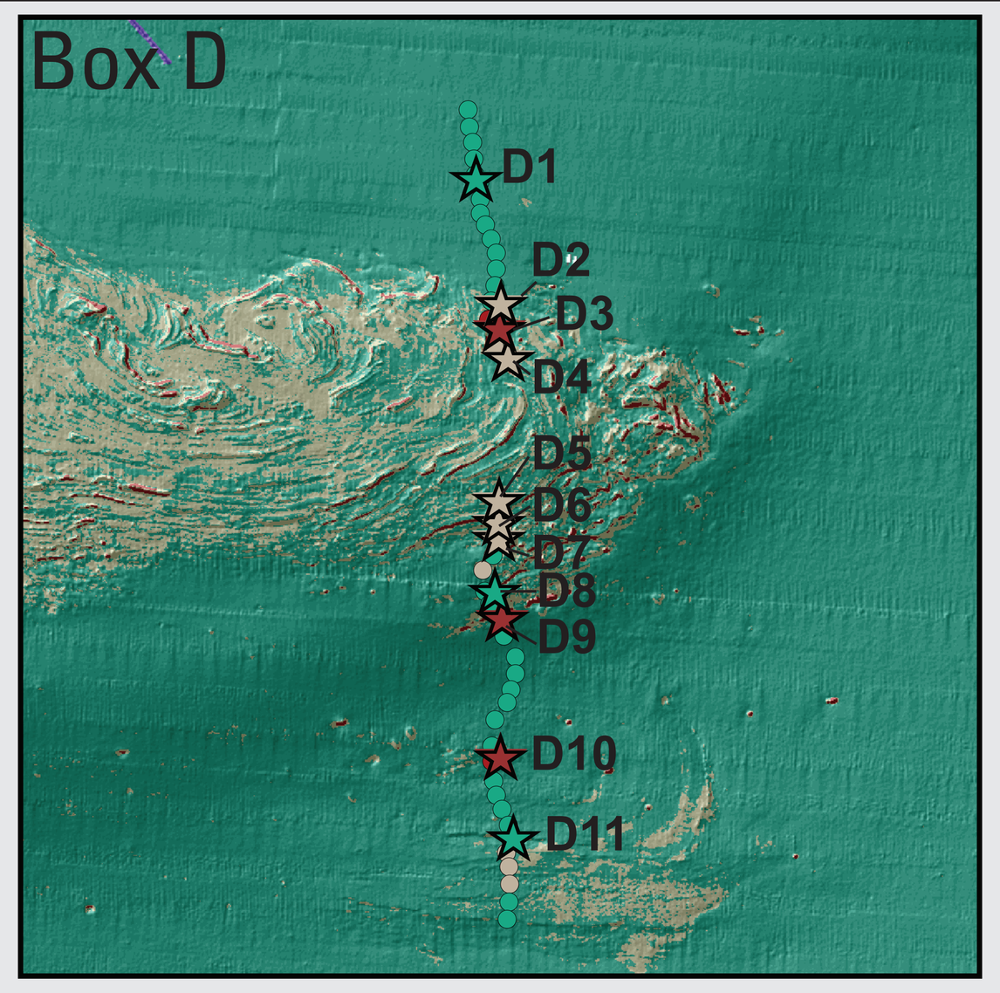


Figure 4A. Detailed view of seafloor character mapped east of Santa Barbara, approximately 2.5 km offshore (see Box D, on map, for location), showing locations of periodic real-time video observations (dots) and digital still photographs (stars; see figs. 4B through 4L) from camera line CAM24, cruise S–1C–08–SC.

Figure 4B. Digital still photograph no. D1 (see fig. 4A for location). Mud and sand with subtle ripples (water depth, 26 m). Abiotic complexity is low, biotic complexity is absent, and biocover is low. Biocover includes short-spined sea star, *Pisaster brevispinis* (sst). Distance between lasers (red dots) is 15 cm.

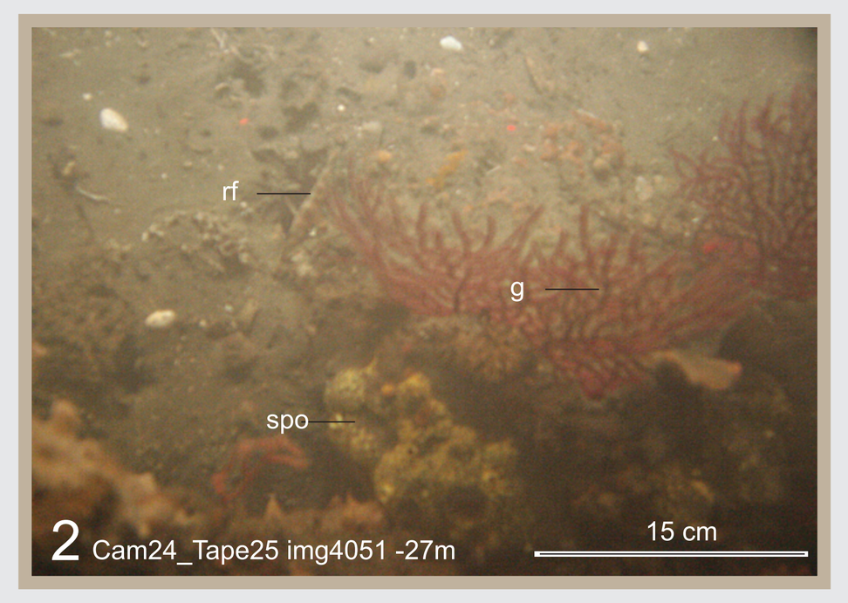


Figure 4C. Digital still photograph no. D2 (see fig. 4A for location). Sand on rock outcrop (water depth, 27 m). Abiotic complexity is low, biotic complexity is present, and biocover is high. Biocover includes gorgonian (g), rockfish (rf), and sponge (spo). Distance between lasers (red dots) is 15 cm.

Figure 4D. Digital still photograph no. D3 (see fig. 4A for location). Gravel and sand patch in rocky area, with scattered shells and shell fragments (water depth, 27 m). Abiotic complexity is moderate, biotic complexity is absent, and biocover is low. Biocover includes shell debris (sd). Distance between lasers (red dots) is 15 cm.

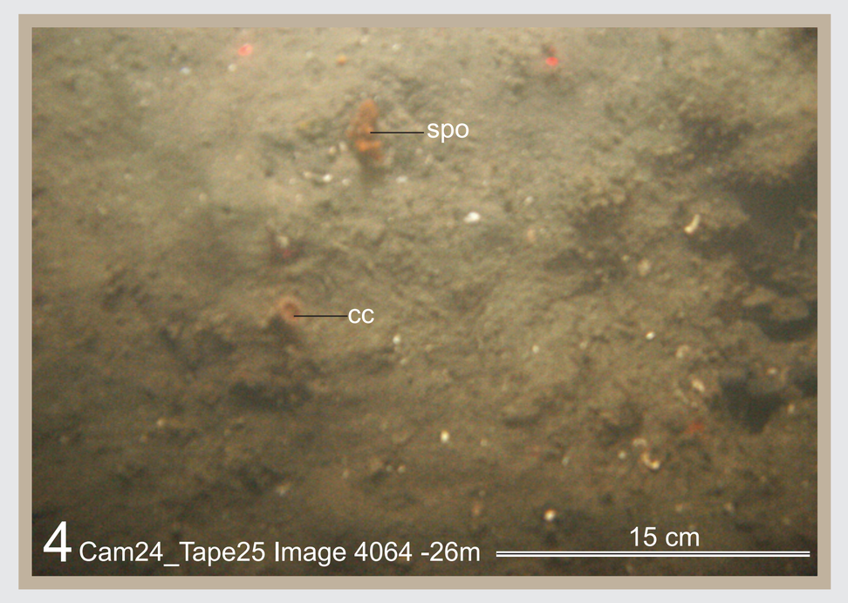


Figure 4E. Digital still photograph no. D4 (see fig. 4A for location). Sand on rock outcrop (water depth, 26 m). Abiotic complexity is low, biotic complexity is absent, and biocover is low. Biocover includes cup coral (cc) and sponge (spo). Distance between lasers (red dots) is 15 cm.

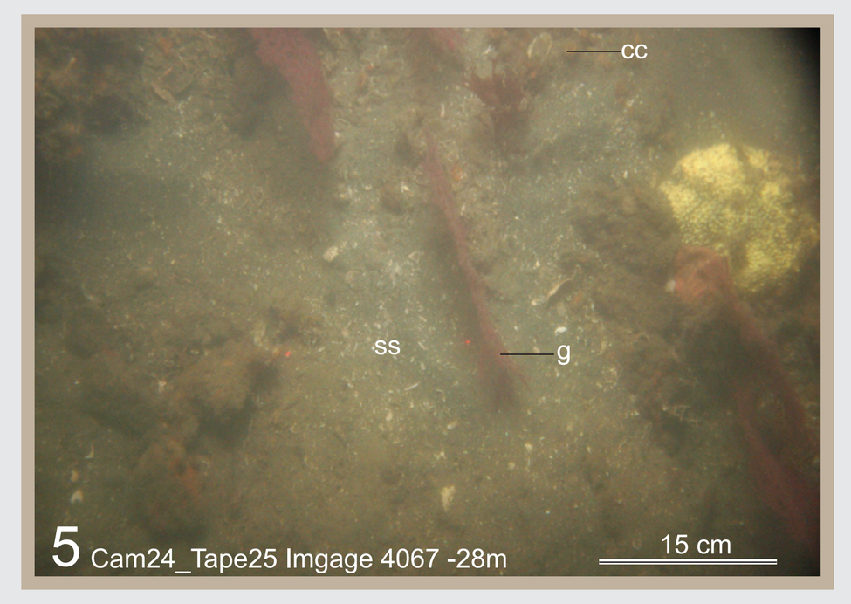


Figure 4F. Digital still photograph no. D5 (see fig. 4A for location). Sand in area of rock outcrop, with scattered shells (water depth, 28 m). Abiotic complexity is moderate, biotic complexity is present, and biocover is moderate. Biocover includes cup coral (cc), gorgonian (g), and scattered shells (ss). Distance between lasers (red dots) is 15 cm.

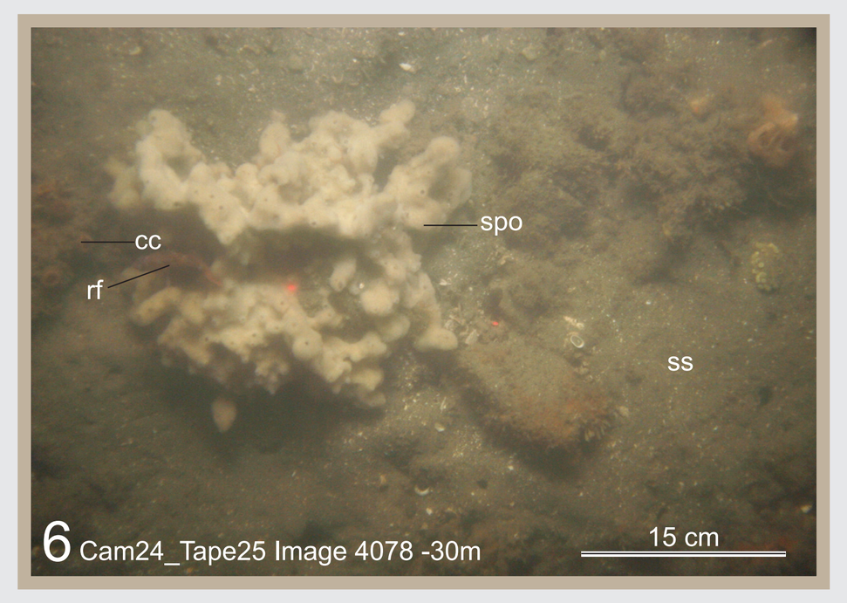


Figure 4G. Digital still photograph no. D6 (see fig. 4A for location). Sand and gravel in area of rock outcrop, with scattered shells (water depth, 30 m). Abiotic complexity is moderate, biotic complexity is present, and biocover is high. Biocover includes sponge (spo), rockfish (rf), cup coral (cc), and scattered shells (ss). Distance between lasers (red dots) is 15 cm.

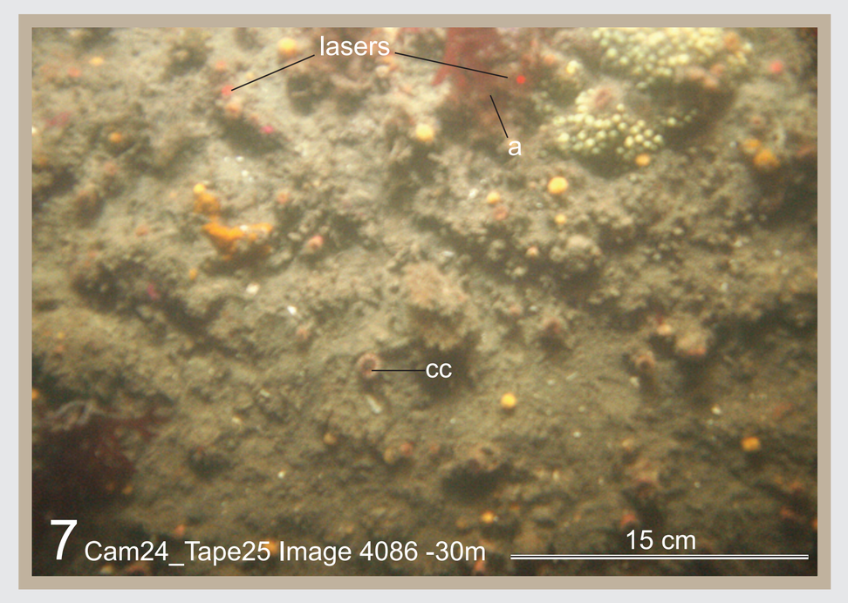


Figure 4H. Digital still photograph no. D7 (see fig. 4A for location). Mud, sand, and gravel in area of rock outcrop (water depth, 30 m). Abiotic complexity is low, biotic complexity is absent, and biocover is moderate. Biocover includes cup coral (cc) and red algae (a). Distance between lasers (red dots) is 15 cm.

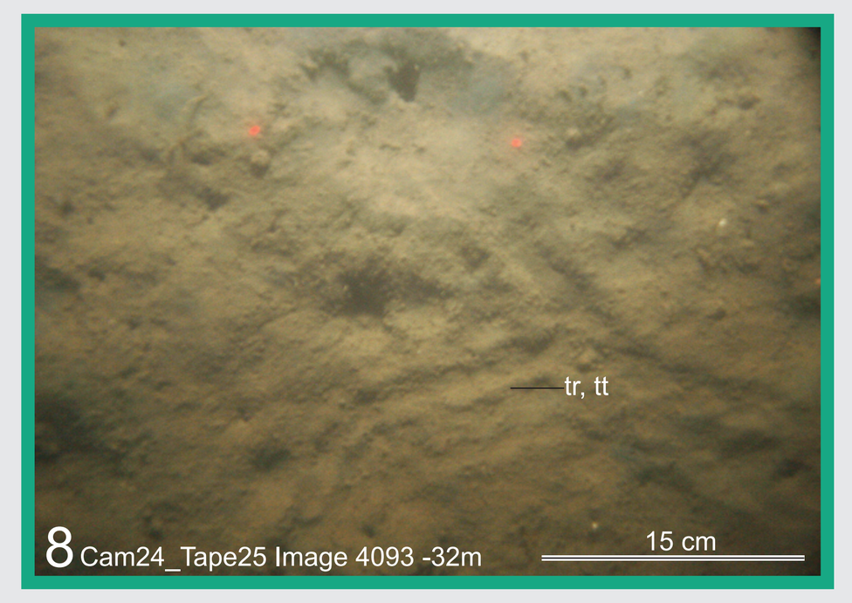


Figure 4I. Digital still photograph no. D8 (see fig. 4A for location). Patch of mud and sand in area of rock outcrop (water depth, 32 m). Abiotic complexity is low, biotic complexity is absent, and biocover is low. Biocover includes tracks (tr) and trails (tt). Distance between lasers (red dots) is 15 cm.

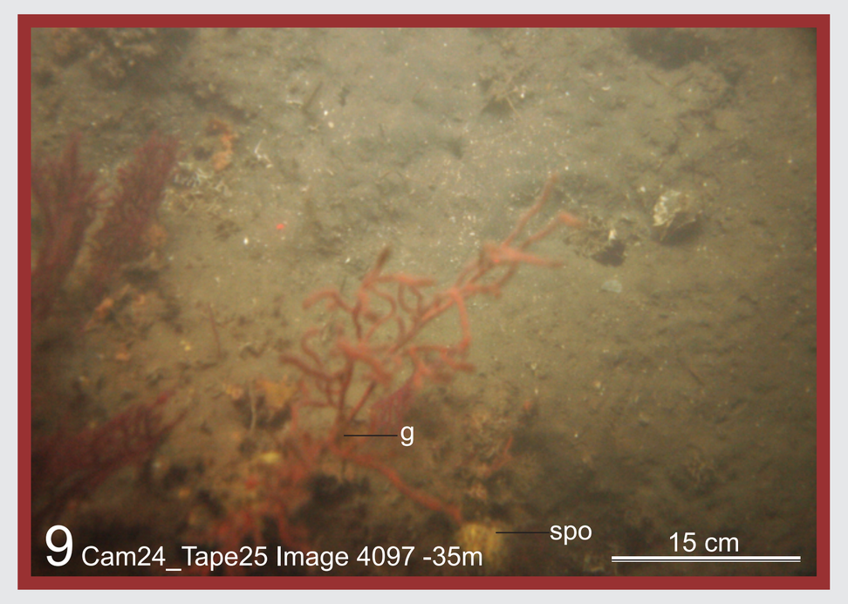


Figure 4J. Digital still photograph no. D9 (see fig. 4A for location). Sand and gravel in area of rock outcrop (water depth, 35 m). Abiotic complexity is moderate, biotic complexity is present, and biocover is moderate. Biocover includes gorgonian (g) and sponge (spo). Distance between lasers (red dots) is 15 cm.

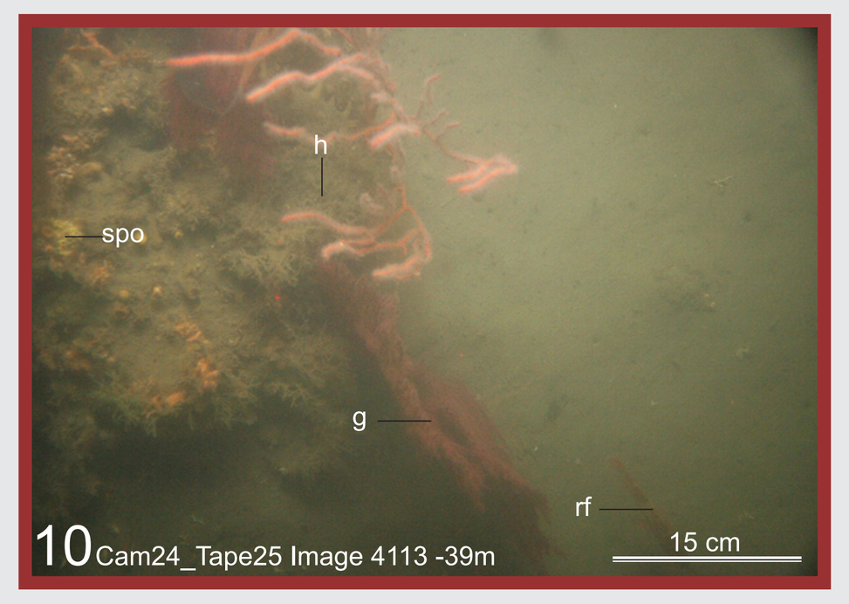


Figure 4K. Digital still photograph no. D10 (see fig. 4A for location). Sand and mud at edge of rock outcrop area (water depth, 39 m). Abiotic complexity is moderate, biotic complexity is present, and biocover is moderate. Biocover includes gorgonian (g), hydroid (h), sponge (spo), and rockfish (rf). Distance between lasers (red dots) is 15 cm.

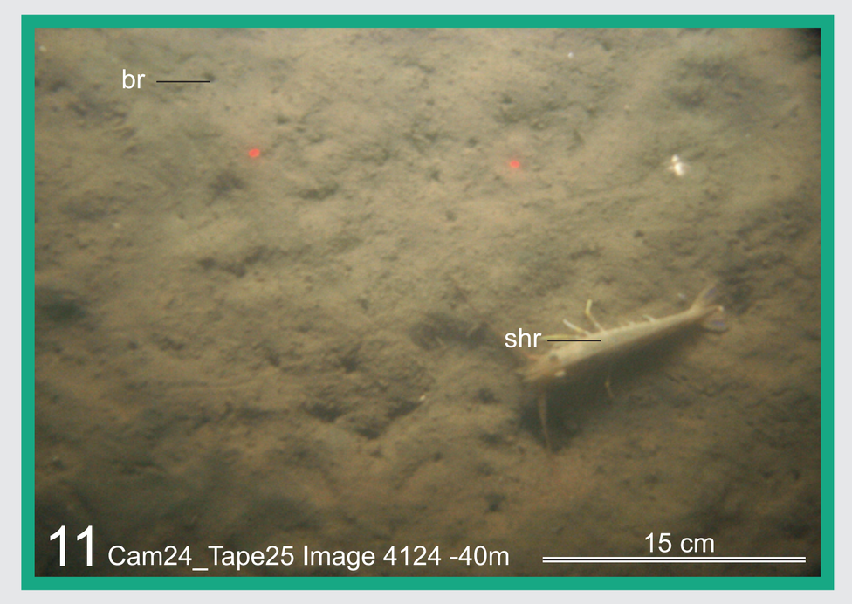


Figure 4L. Digital still photograph no. D11 (see fig. 4A for location). Patch of mud and sand in area of rock outcrop (water depth, 40 m). Abiotic complexity is low, biotic complexity is absent, and biocover is low. Biocover includes burrows (br) and shrimp (shr). Distance between lasers (red dots) is 15 cm.

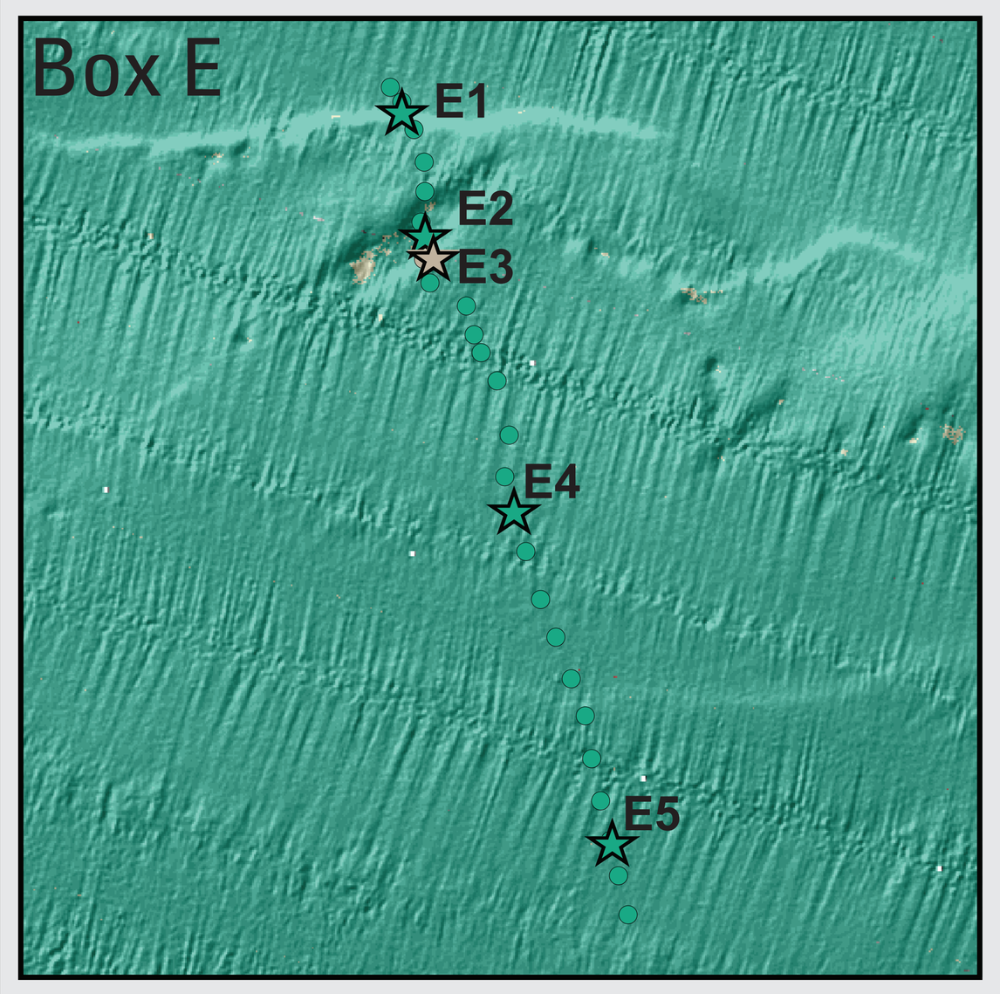


Figure 5A. Detailed view of seafloor character mapped south of Santa Barbara, approximately 4 km offshore (see Box E, on map, for location), showing locations of periodic real-time video observations (dots) and digital still photographs (stars; see figs. 5B through 5F) from camera line CAM21, cruise S–1C–08–SC.

Figure 5B. Digital still photograph no. E1 (see fig. 5A for location). Mud and sand (water depth, 68 m). Abiotic complexity is low, biotic complexity is absent, and biocover is low. Biocover includes burrows (br), sea anemone (sa), and sea pen (sp). Distance between lasers (red dots) is 15 cm.

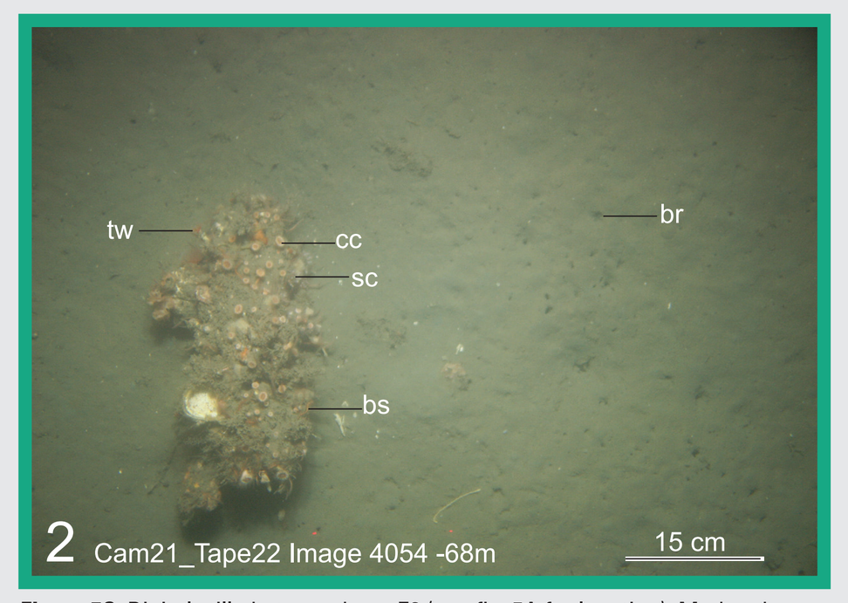


Figure 5C. Digital still photograph no. E2 (see fig. 5A for location). Mud and isolated boulder (water depth, 68 m). Abiotic complexity is low, biotic complexity is absent, and biocover is moderate. Biocover includes burrows (br), cup coral (cc), tubeworm (tw), sea cucumber (sc), and brittle star (bs). Distance between lasers (red dots) is 15 cm.

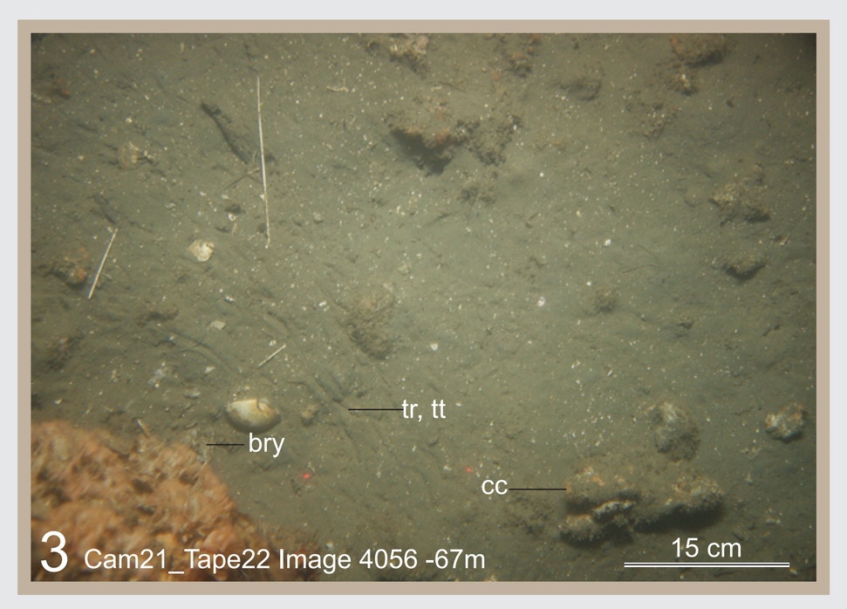


Figure 5D. Digital still photograph no. E3 (see fig. 5A for location). Mud and sand over rock outcrop, with scattered shells and shell fragments (water depth, 67 m). Abiotic complexity is low, biotic complexity is absent, and biocover is low. Biocover includes cup coral (cc), bryozoan (bry), tracks (tr), and trails (tt). Distance between lasers (red dots) is 15 cm.

Figure 5E. Digital still photograph no. E4 (see fig. 5A for location). Mud and sand (water depth, 66 m). Abiotic complexity is low, biotic complexity is absent, and biocover is low. Biocover includes burrows (br); pink surfperch, *Zalembius rosaceus* (f); rockfish (rf); tracks (tr); and trails (t). Distance between lasers (red dots) is 15 cm.

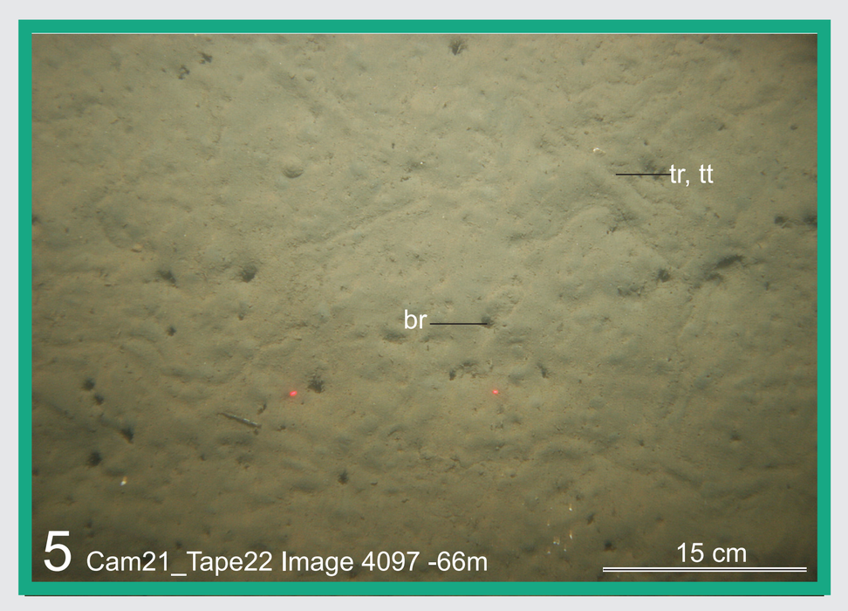
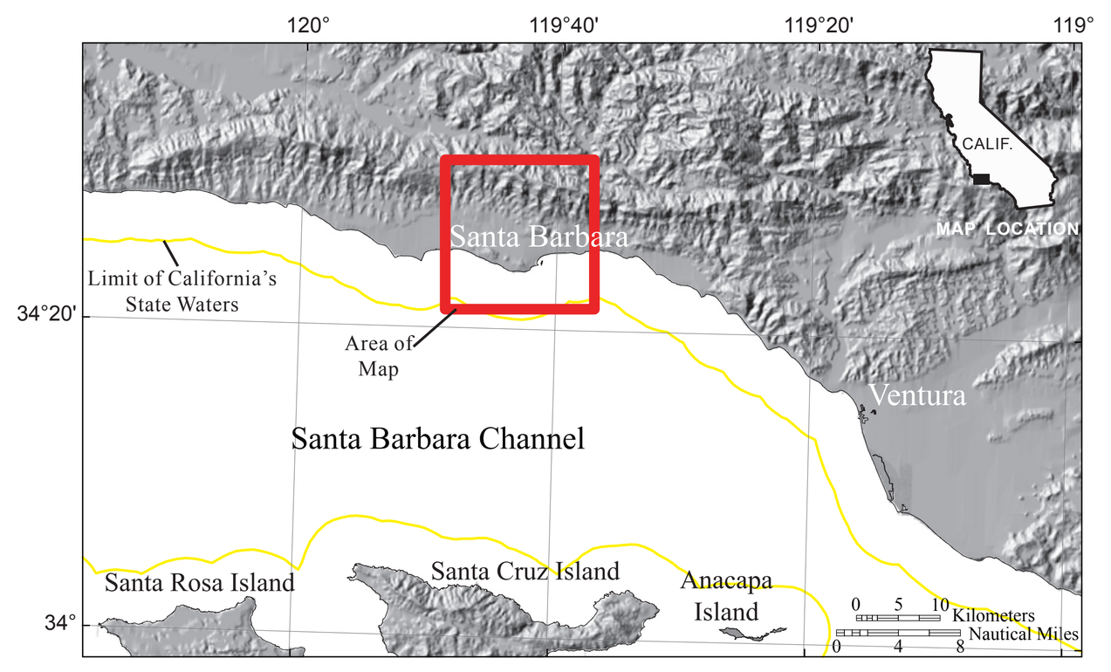


Figure 5F. Digital still photograph no. E5 (see fig. 5A for location). Mud and sand (water depth, 66 m). Abiotic complexity is low, biotic complexity is absent, and biocover is low. Biocover includes burrows (br), tracks (tr), and trails (tt). Distance between lasers (red dots) is 15 cm.



DISCUSSION

Between 2005 and 2008, the seafloor in the Offshore of Santa Barbara 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 cruises in 2005, 2006, and 2008. The camera sleds were towed 1 to 2 m over the seafloor, at speeds of between 1 and 2 nautical miles/hour. During the 2005 and 2006 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 ground-truth cruise, 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 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 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) and by Barnard and others (2009) 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 some differentially eroded bedrock outcrops offshore of Santa Barbara. The more rugose rock outcrops are surrounded by areas of either mixed rock and sediment or flat rock 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, 1C; 2B through 2G; 3B through 3D; 4B through 4L; 5B through 5F). Only primary and secondary substrate are reported, although individual photographs may show more substrate types. Organisms, when present, are labeled on the photographs.

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

Barnard, P.L., Revell, D.L., Hoover, D., Warrick, J., Brocatus, J., Draut, A.E., Dartnell, P., Elias, E., Mustain, N., Hart, P.E., and Ryan, H.F., 2009, Coastal processes study of Santa Barbara and Ventura Counties, California: U.S. Geological Survey Open-File Report 2009–1029, 926 p., available at http://pubs.usgs.gov/of/2009/1029/.

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

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

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)

From Barnard and others (2009)

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

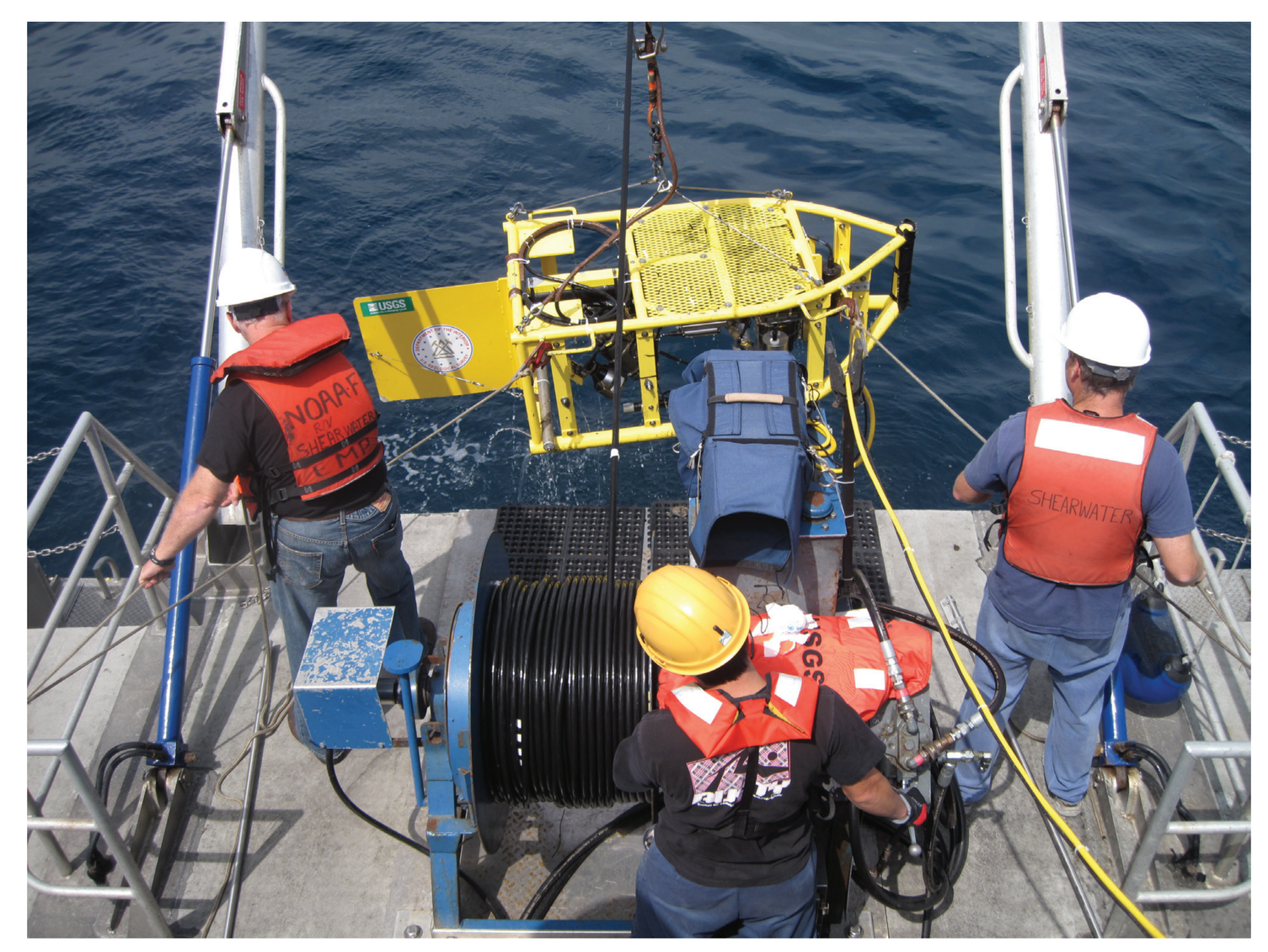


Figure 6. USGS-designed camera sled being launched off research vessel for ground-truth studies. Components onboard sled include four digital video camcorders, one 8-megapixel digital SLR camera, lasers for scale, and various strobe and video lights, as well as telemetry instrumentation that records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

Ground-Truth Studies, Offshore of Santa Barbara Map Area, California

By

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

2013

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

ISSN 2329-132X (online)
http://dx.doi.org/10.3133/sim3281

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

This map was printed on an electronic plotter directly from digital files. Dimensional calibration may vary between electronic plotters and between X and Y directions on the same plotter, and paper may change size due to atmospheric conditions; therefore, scale and proportions may not be true on plots of this map.

For sale by U.S. Geological Survey, Information Services, Box 25286, Federal Center, Denver, CO 80225, 1–888–ASK–USGS

Digital files available at http://pubs.usgs.gov/sim/3281/

Suggested Citation: Golden, N.E., Cochrane, G.R., and Krigsman, L.M., 2013, Ground-truth studies, Offshore of Santa Barbara map area, California, *sheet 6 in* Johnson, S.Y., Dartnell, P., Cochrane, G.R., Golden, N.E., Phillips, E.L., Ritchie, A.C., Greene, H.G., Krigsman, L.M., Kvitek, R.G., Dieter, B.E., Endris, C.A., Seitz, G.G., Sliter, R.W., Erdey, M.D., Gutierrez, C.I., Wong, F.L., Yoklavich, M.M., Draut, A.E., Hart, P.E., and Conrad, J.E. (S.Y. Johnson and S.A. Cochran, eds.), California State Waters Map Series—Offshore of Santa Barbara, California: U.S. Geological Survey Scientific Investigations Map 3281, pamphlet 45 p., 11 sheets, scale 1:24,000, *http://dx.doi.org/10.3133/sim3281.*