

A REPORT TO NOAA DEEP-SEA CORAL RESEARCH AND TECHNOLOGY PROGRAM

A CHARACTERIZATION OF THE DEEP-SEA CORAL AND SPONGE COMMUNITY ON PIGGY BANK IN SOUTHERN CALIFORNIA FROM A SURVEY USING AN AUTONOMOUS UNDERWATER VEHICLE

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INTRODUCTION AND SCIENTIFIC OBJECTIVES

In 2010, the NOAA Deep-Sea Coral Research and Technology Program (DSCRTP) initiated a three- year study to advance our understanding of Deep-sea Corals (DSC) off the west coast of the U.S. During the first year of this study, a coast-wide survey of the distribution and abundance of DSC from Washington to southern California was conducted during three legs of a cruise aboard the NOAA ship *McArthur II* using the *Kraken 2* remotely operated vehicle (ROV) operated by the University of Connecticut and the SeaBED autonomous underwater vehicle (AUV) operated by Northwest Fisheries Science Center and collaborators.

The final leg of this cruise focused on documenting the biology and ecology of the deep-sea coral community and habitats on Piggy Bank, a deep offshore bank in the southern California Bight. Individual habitats can be distinct based on the substrate, the influence of local currents and outside influences, such as fishing. It is located within the Channel Islands National Marine Sanctuary and is designated as Essential Fish Habitat (EFH). The Piggy Bank study site is about 30 km². This area contains deep, rocky habitats that support dense stands of deep-sea corals (Tissot et al. 2006) as well as diverse assemblages of fishes (Love et al. 2009).

The goals of this project were:

- (1) to characterize the distribution and abundance of DSC on Piggy Bank.
- (2) to understand factors (e.g. depth, substratum type) that influence their distribution and to assess the condition of DSC assemblages in relation to potential anthropogenic or environmental disturbances.
- (3) to evaluate the function of DSC as fish and invertebrate habitat.

Science operations included quantitative visual surveys of DSC and fishes with their associated habitats. The *Kraken II* ROV was used during the daylight hours and for the collection of coral samples. The SeaBED AUV and associated cameras were used during the night hours to quantitatively survey DSC and habitats particularly at depths beyond the capabilities of the ROV.

This report provides a summary of the methods and results from underwater surveys of corals, sponges and associated habitats, invertebrates, and fishes the using the SeaBED AUV on Piggy Bank.



NOAA Ship *McArthur II*

STUDY SITE

Piggy Bank is located within the Southern California Bight (SCB), more specifically in the Channel Islands National Marine Sanctuary (CINMS) generally in the area of 33°54.84' N and 119°28.35'W. Piggy Bank ranges in depth from 275 to 900 meters and is about 30km² in area. It is designated as essential fish habitat (EFH) by the Pacific Fisheries Management Council (PFMC) and by NOAA Fisheries, and it is located within the Footprint Marine Reserve. The Footprint Reserve is home to some of the largest areas of rocky habitat within the CINMS.

FIELD SURVEY METHODS

Underwater surveys of DSC, sponges, habitats and associates fishes and invertebrates were conducted using the SeaBED class AUV *Lucille* (Figure 1) deployed from the NOAA Ship *McArthur II*. Images of the seafloor were collected using two 5 megapixel, 12-bit dynamic range Prosilica GigE cameras. One camera was mounted to look directly downward and the second camera was angled forward at 30°. Lighting was provided by a strobe synced with the cameras. Dives varied and included straight line transect surveys, zig-zag surveys, and a grid survey designed to collect detailed photographic and multibeam information in a limited area

The AUV was equipped with two navigational sensors: the RDI 1200 kHz Doppler Velocity Log as the primary navigational sensor and the iXSea OCTANS gyrocompass and inertial motion sensor. The AUV was tracked using a Link Quest TrackLink 1500 USBL navigation system. Subsurface communication was provided by the WHOI 256008 acoustic micromodem and surface communication used a FreeWave FGR-115 RCRF radio modem. Depth was determined using a Paroscientific depth sensor. Salinity, temperature, and pressure were collected using a Sea-Bird model 49 FastCat CTD mounted on the AUV.

Eight dives were attempted over 5 days (Figure 2). Camera shutter trigger (interval between photos) and altitude varied by dive and within dives depending on the mission of the dive and the rugosity of the seafloor. Images were down-loaded at the end of each mission and each image was color-corrected. All non-overlapping color-corrected digital stills from the downward looking camera were reviewed following the cruise and invertebrates as well as associated fishes were identified and counted. Photos from the angled camera were used to assist in species identification only.



Figure 1. The NWFSC *Lucille* SeaBED AUV.

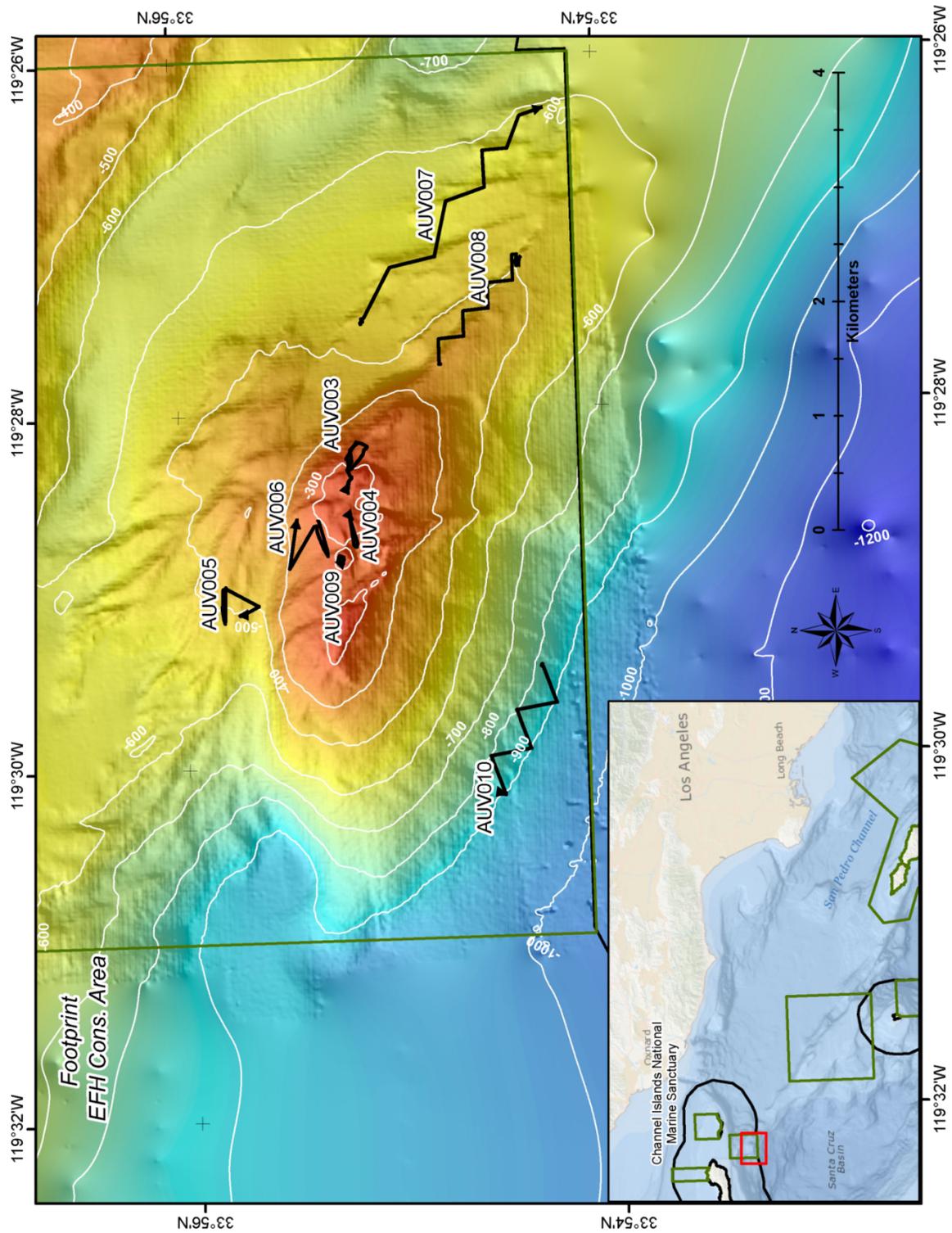


Figure 2. This map shows the bathymetry of Piggy Bank and the projected dive tracks of each of the AUV dives. Dive 4 was not completed due to the AUV encountering extremely rough terrain.

POST-DIVE ANALYSIS

Location of the AUV during each dive was estimated using USBL range and bearing measurements relative to the ship, the X,Y coordinates of the vehicle position relative to its dive origin, and the GPS coordinates of the dive launch point.

All non-overlapping color-corrected digital images from the downward looking camera were reviewed following the cruise. Corals, sponges and other invertebrates as well as associated fishes were identified and counted from all images. The area of each image was estimated using the measured altitude off the bottom and the specified camera field of view. As the altitude maintained by the AUV changed, so did the image area. Dives flown at higher altitudes to avoid bottom obstacles produced pictures with larger fields of view and some additional difficulty in identifying organisms. Marine debris and any evidence of anthropogenic effects were noted.

Seafloor habitats in each photograph were categorized using a two-character code (Table 1) The first character signified the primary habitat type that covered greater than 50% of the field of view, while the second character defined the secondary habitat type covering between 20% and 50%. If the primary habitat coverage exceeded 80%, that letter was denoted twice (e.g., CC).

Temperature and salinity were processed, plotted, and analyzed using Sea-Bird Electronics' data processing software. Large spikes in the data were edited by hand.

Table 1. Habitat types

| Habitat Code | Description | Habitat Name |
|--------------|--|----------------|
| u | small particle size anywhere in grain size from finest mud to coarsest sand | Unconsolidated |
| m | small particle size; darker color than sand & generally deeper water | Mud |
| s | small particle size; white to light gray in color & generally in shallower water; > 0.0625 mm & < 4 mm | Sand/sediment |
| g | >4 mm & <2 cm | Gravel |
| p | >2 cm & <6.4 cm | Pebble |
| c | >6.4 cm & <25.6 cm; often rounded | Cobble |
| b | >25.6 cm; detached from outcrop of origin | Boulder |
| f | <1 m relief; slope angle, <30 deg; flat rock areas away from ridge | Flat Rock |
| r | generally >1 m relief consolidated rock; slope angle >30 deg & <60 deg | Ridge |
| t | >3 m relief; slope angle >60 deg | Pinnacle |

SUMMARY OF DIVES

During this section of the cruise, eight AUV dives were attempted, but only seven were completed. The AUV ran into significant bottom relief during AUV004 and was unable to continue bottom tracking and complete the dive.

| Date | PI | Dive # | Method | Start Time (UTC) | End Time (UTC) | Start Lat (N) | Start Long (W) | End Lat (N) | End Long (W) |
|-----------|-------------|--------|--------|------------------|----------------|---------------|----------------|-------------|--------------|
| 28-Jun-10 | M.E. Clarke | 003 | AUV | 05:33 | 07:09 | 33°55.18' | 119°28.17' | 33°55.21' | 119°28.46' |
| 29-Jun-10 | M.E. Clarke | 005 | AUV | 05:16 | 06:48 | 33°55.79' | 119°28.99' | 33°55.74' | 119°29.13' |
| 29-Jun-10 | M.E. Clarke | 006 | AUV | 09:51 | 12:03 | 33°55.36' | 119°28.61' | 33°55.53' | 119°28.69' |
| 30-Jun-10 | M.E. Clarke | 007 | AUV | 05:05 | 09:11 | 33°55.14' | 119°27.39' | 33°54.16' | 119°26.40' |
| 1-Jul-10 | M.E. Clarke | 008 | AUV | 03:55 | 06:43 | 33°54.77' | 119°27.76' | 33°54.28' | 119°26.99' |
| 1-Jul-10 | M.E. Clarke | 009 | AUV | 10:08 | 12:45 | 33°55.28' | 119°28.86' | 33°55.25' | 119°28.85' |
| 2-Jul-10 | M.E. Clarke | 010 | AUV | 03:22 | 08:06 | 33°54.39' | 119°29.44' | 33°54.53' | 119°30.19' |

A total of 17,173m² of seafloor was classified during the 7 completed dives. The original two-character-code habitat types were aggregated into three general categories for this analysis: the ‘hard’ category included ridge, boulder, cobble and flat rock in various proportions; ‘mixed’ comprised one of the ‘hard’ classifications combined with mud or sand; and ‘sediment’ was represented by mud and sand or a combination of the two. The overall area surveyed by the AUV was approximately 30% hard substrate.

We were able to identify 99 taxa of invertebrates and fishes by analyzing the still images during the 7 successful AUV dives on Piggy Bank. We identified 21 taxa of sponges, 16 taxa of corals, 40 taxa of invertebrates and 22 taxa of fishes. Identifications in question were moved back up to the level of certainty, leading to family and order level groupings.

A total of 5,619 corals, 9,312 sponges and 35,944 invertebrates were enumerated during the 7 dives analyzed (Tables 2 and 3). We also counted 1,518 fishes. Densities of corals, sponges, fishes and invertebrates were estimated by dividing the abundance of each taxon by the area covered during each dive. Area was determined from the altitude of the camera and known field of view for each image. Overall densities varied greatly by dive, the ranges were 28-1595 corals/ 1,000m²; 182-1852 sponges/ 1,000m²; 411-4486 invertebrates/ 1,000m² and 40-193 fishes/ 1,000m². The most abundant corals encountered included cup corals (*Lophelia pertusa* and unidentified cup corals), Christmas tree black coral (*Antipathes dendrochristos*), and the droopy sea pen (*Umbellula lindahli*) in sediment areas. The most abundant sponge morphotypes were mound, foliose (*Thenea muricata*) and vase sponges. The most abundant invertebrates included the fragile sea urchin (*Allocentrotus fragilis*), the sea cucumber

(*Pannychia mosleyi*), and basket stars (*Gorgonocephalus eucnemis*) in the more shallow dives. The most abundant fishes were poachers (family Agonidae) and rockfish (genus *Sebastes*), with thornyheads (genus *Sebastolobus*) becoming the dominant species in the deeper areas.

In the following pages we present summaries, by dive, of the diversity and density of corals, sponges, invertebrates and fishes along with their associated habitats. We also present profiles of sea temperature and salinity with depth during the AUV dives. Some notes on the health and condition of the corals and sponges are included, along with the occurrence of marine debris and evidence of fishing.

Table 2. Invertebrate taxa observed in still photos taken by AUV on the Piggy Bank in the Channel Islands National Marine Sanctuary, 28 June-02 July, 2010.

| Scientific Name | Common Name |
|-----------------------------|--|
| Mud Covered | |
| Porifera | Unidentified vase sponges |
| <i>Staurocalyptus</i> spp. | Unidentified vase sponge (yellow) |
| <i>Heterochone calyx</i> | Fingered goblet vase sponge |
| Porifera | Unidentified barrel sponges |
| Porifera | Unidentified upright flat sponges |
| Porifera | Unidentified shelf sponges |
| <i>Mycale</i> spp. | Upright flat sponge (yellow) |
| Porifera | Unidentified branching sponges |
| Porifera | Unidentified branching sponge |
| Porifera | Unidentified foliose sponges |
| <i>Polymastia</i> spp. | Nipple foliose sponges |
| <i>Thenaea muricata</i> | Foliose Sponge (clear) |
| <i>Farrea occa</i> | Lace (or cloud) foliose sponge |
| Porifera | Unidentified pipe organ sponge (<i>Oceanapia</i> spp.?) |
| Porifera | Unidentified small mound sponges |
| Porifera | Unidentified mound sponges |
| Porifera | Unidentified sponges (blue/white) |
| <i>Asbestopluma</i> spp. #2 | Predatory sponge (clear) |
| <i>Asbestopluma</i> spp. #1 | Pipe cleaner Sponge |
| Porifera | Unidentified sponges |
| Unidentified Gorgonian | Unidentified Gorgonian |
| <i>Paragorgia</i> spp. | Sea fan |
| <i>Parastenella</i> spp. | Primnoid |
| <i>Plumerella</i> spp. | Primnoid |
| Plexauridae | Sea fan |
| <i>Swiftia</i> spp. | Sea fan |

| Scientific Name | Common Name |
|---|---|
| <i>Antipathes dendrochristos</i> | Christmas tree black coral |
| <i>Lopheila</i> spp. | White cup coral |
| Caryophyllidae | Unidentified cup corals |
| <i>Anthomastus ritteri</i> | Mushroom coral |
| Zoantharia | Unidentified zooanthids |
| <i>Clavularia</i> spp. | Soft coral |
| <i>Pennatula</i> spp. | Deep-sea sea pen |
| <i>Anthoptilum grandiflorum</i> | Feather boa sea pen |
| <i>Umbellula lindahli</i> | Droopy sea pen |
| Anthozoa | Unidentified coral/ sea pen |
| Actinidae | Unidentified anemone |
| <i>Liponema brevicornis</i> | Tentacle shedding anemone |
| Asteroidea | Unidentified Sea star |
| <i>Gorgonocephalus eucnemis</i> | Basket Star |
| Ophiocanthidae | Unidentified brittlestar |
| <i>Rathbunaster californicus</i> | Deep-sea sunflower star |
| <i>Ceramaster</i> spp. | Cookie star |
| <i>Pteraster</i> spp. | Slime star |
| <i>Henricia</i> spp. | Henricia star |
| <i>Thrissacanthius penicillatus</i> | Carpet star |
| Asteroidea | <i>Nearchaster/Cheiraster</i> spp. |
| Asteroidea | <i>Myxoderma platycanthum</i> -like |
| <i>Solaster</i> spp. | Deep-sea sunstar |
| <i>Crossaster/ Heterozonias</i> spp. | Unidentified deep-sea sunstar |
| <i>Crossaster papposus</i> | Rose star |
| <i>Hippasteria</i> spp. | Unidentified spiny star |
| <i>Zoroaster evermanni</i> | Slender star |
| <i>Stylasterias forreri</i> | Fish-eating star |
| <i>Poraniopsis</i> spp. | Thorny star |
| <i>Brisingella</i> spp. | Lacy-armed star |
| <i>Dipsacaster eximius</i> | Broad sand star |
| Asteroidea | Unidentified mud star (<i>Ctenodiscus</i> spp.?) |
| Galatheoidea | Unidentified Galtheid crab |
| <i>Chorilia longipes</i> | Long-horned decorator crab |
| Decapoda | Unidentified shrimp |
| Decapoda | Unidentified crab |
| <i>Psolus squamatus</i> | White-scaled cucumber |
| <i>Parastichopus</i> spp. | Giant Orange/Giant California cucumber |
| <i>Pannychia moseleyi</i> | Sloppy cucumber |
| Holothuroidea | Unidentified sea cucumber |
| <i>Brisaster</i> spp./ <i>Brissopsis</i> spp. | Unidentified mud urchin |
| <i>Allocentrotus fragilis</i> | Fragile red sea urchin |
| <i>Florometra serratissima</i> | Feather star crinoid |

| Scientific Name | Common Name |
|------------------------------------|---------------------------|
| Tunicata | Unidentified tunicates |
| Unidentified invertebrate | Unidentified invertebrate |
| Cephalopoda | Unidentified octopus |
| Opisthobranchia | Unidentified nudibranch |
| <i>Pleurobranchaea californica</i> | California sea slug |
| <i>Acesta sphoni</i> | Sphon's giant file clam |
| <i>Dromalia alexandri</i> | Benthic siphonophore |

Table 3. Fish taxa observed in still photos taken by AUV on the Piggy Bank in the Channel Islands National Marine Sanctuary, 28 June-02 July, 2010.

| Scientific Name | Common Name |
|--------------------------------|-------------------------------|
| Myxinidae | Unidentified hagfish |
| <i>Hydrolagus colliei</i> | Spotted ratfish |
| <i>Raja rhina</i> | Longnose skate |
| Scyliorhinidae | Unidentified catshark |
| Agonidae | Unidentified poachers |
| Zoarcidae | Unidentified eelpouts |
| Alepocephalidae | Unidentified slickheads |
| Macrouridae | Unidentified grenadiers |
| Liparidae | Unidentified snailfish |
| Cottidae | Unidentified sculpins |
| <i>Glyptocephalus zachirus</i> | Rex sole |
| <i>Microstomus pacificus</i> | Dover sole |
| <i>Embassichthys bathybius</i> | Deepsea sole |
| Pleuronectiformes | Unidentified flatfish |
| Osteichthyes | Unidentified fishes |
| <i>Sebastes diploproa</i> | Splitnose rockfish |
| <i>Sebastes rufus</i> | Bank rockfish |
| <i>Sebastes melanostomus</i> | Blackgill rockfish |
| <i>Sebastes</i> spp. | Rockfish Unid. |
| Sebastomus | Unidentified White-spotted RF |
| <i>Sebastolobus alascanus</i> | Shortspine thornyhead |
| <i>Sebastolobus</i> spp. | Unidentified thornyhead |

DIVE NUMBER: AUV003

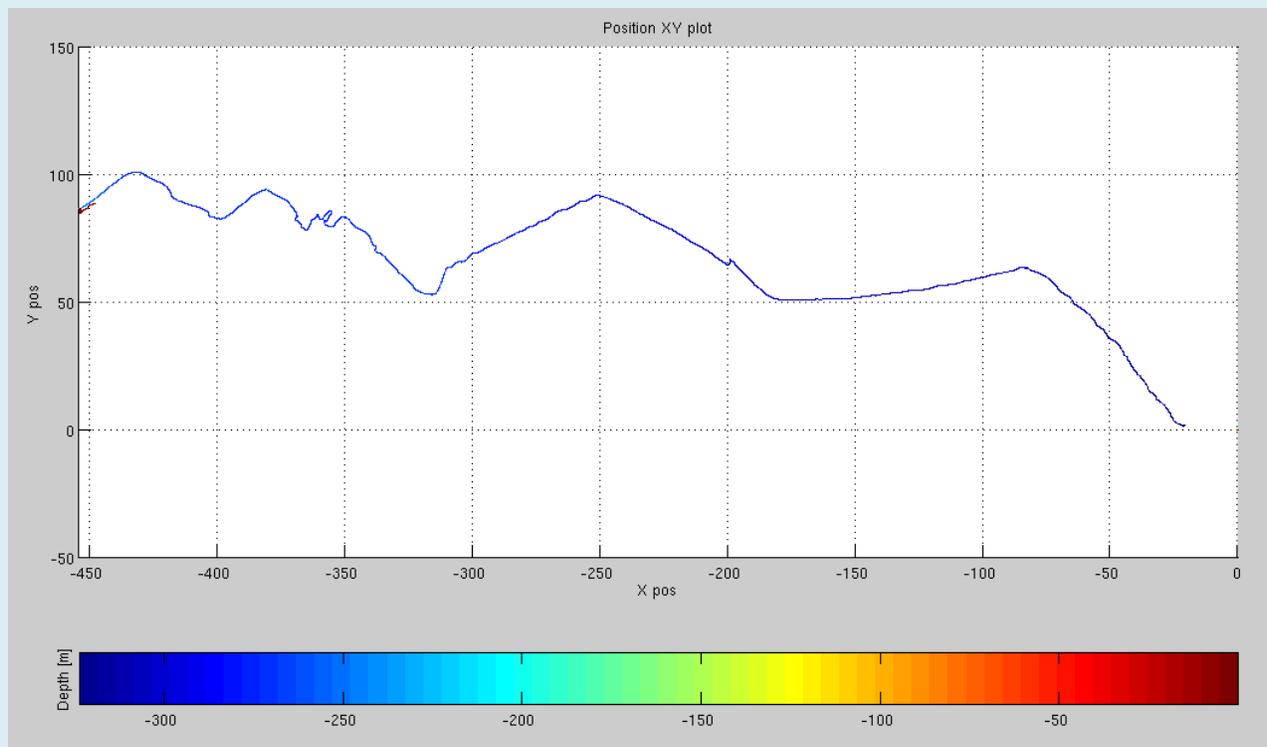
STATION OVERVIEW

| | |
|-----------------------------|--|
| Project | U.S. West Coast Deep Coral Cruise |
| Chief Scientist | M. Elizabeth Clarke |
| Contact Information | NMFS, NWFSC, elizabeth.clarke@noaa.gov |
| Purpose | Survey deep coral communities as Piggy Bank in the CINMS |
| Vessel | NOAA Ship <i>McArthur II</i> , Leg 3; <i>Lucille</i> AUV |
| Team | C. Whitmire, E. Fruh, J. Anderson, J. Taylor |
| Digital Still Photos | 3019 |
| Positioning System | Ship: GPS; AUV: DVL, gyrocompass, USBL |
| CTD Sensor | Yes |

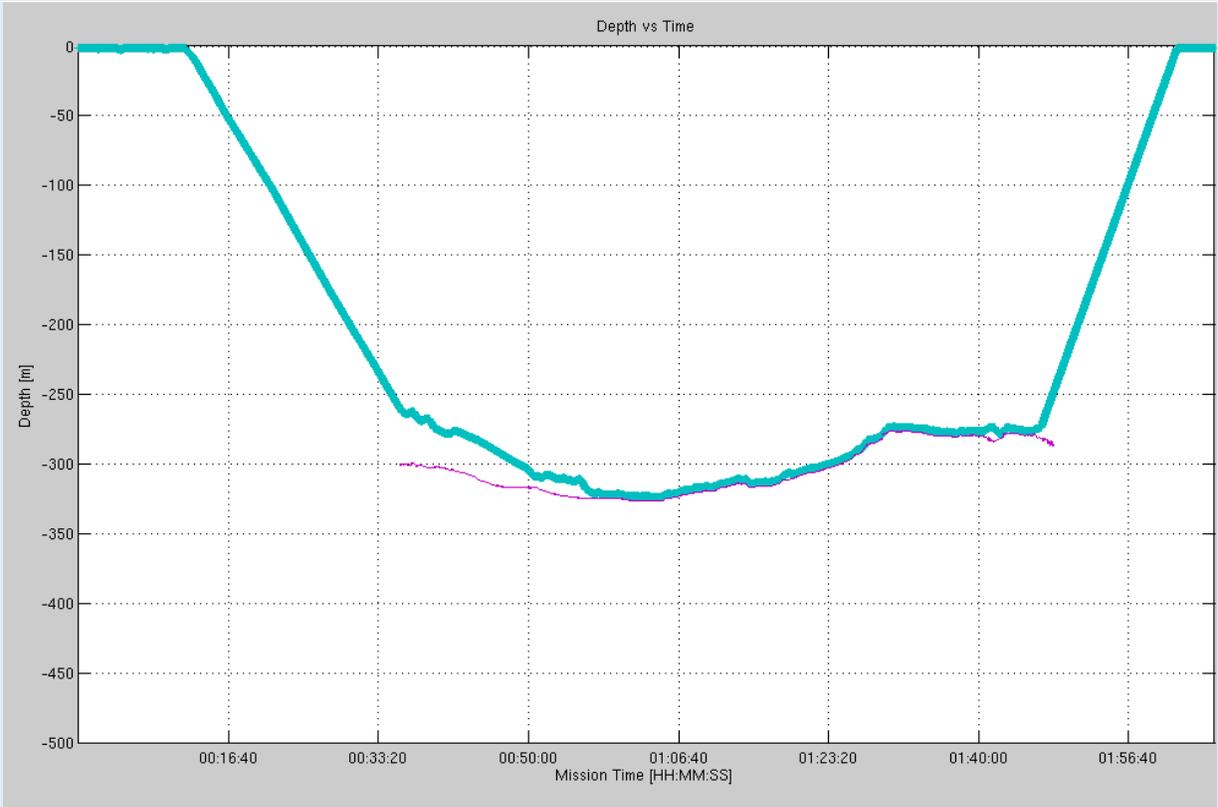
DIVE DATA

| | | | |
|--------------------------|--------------|------------------------|------------|
| Date | 28 June 2010 | Starting Latitude (N) | 33°55.21' |
| Maximum Bottom Depth (m) | 325 | Starting Longitude (W) | 119°28.17' |
| Start Time (UTC) | 05:33 | Ending Latitude (N) | 33°55.21' |
| End Time (UTC) | 07:09 | Ending Longitude (W) | 119°28.46' |

GENERAL LOCATION AND DIVE TRACK



Survey pattern of dive AUV003.

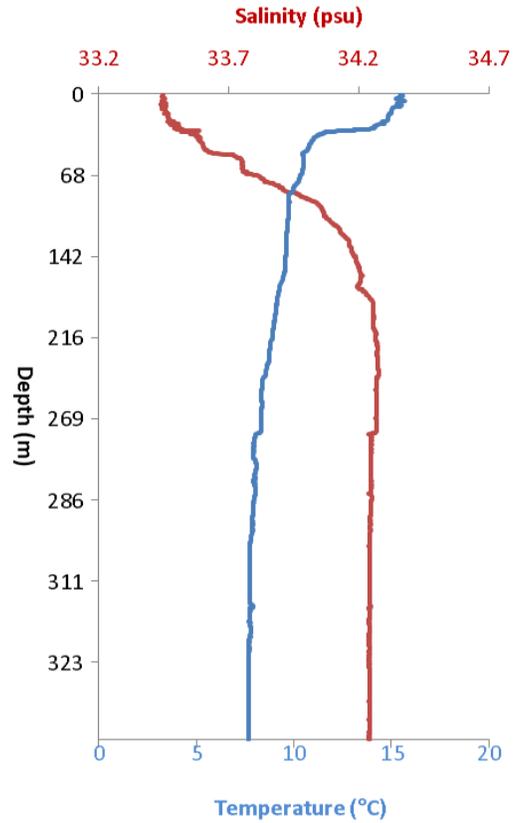


Depth track of dive AUV003 showing bottom in pink (—) and vehicle tracking bottom in teal (—).

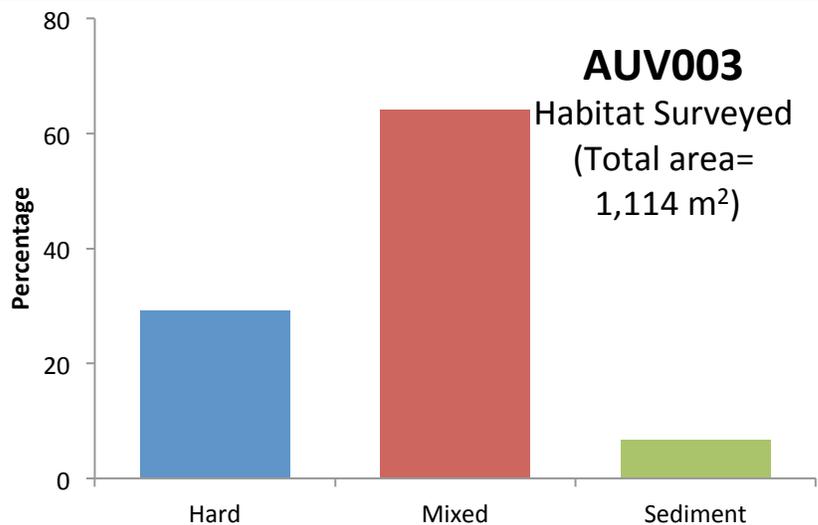
PHYSICAL ENVIRONMENT

The AUV was equipped with an onboard Sea-Bird model 49 FastCat CTD that collected temperature and salinity information throughout the AUV’s descent as well as along the dive track. During the dive AUV003 descent, the temperature varied from 15.5 to 7.68°C and salinity varied from 33.45 to 34.24 (psu).

Dive AUV003 descent temperature and salinity profiles.



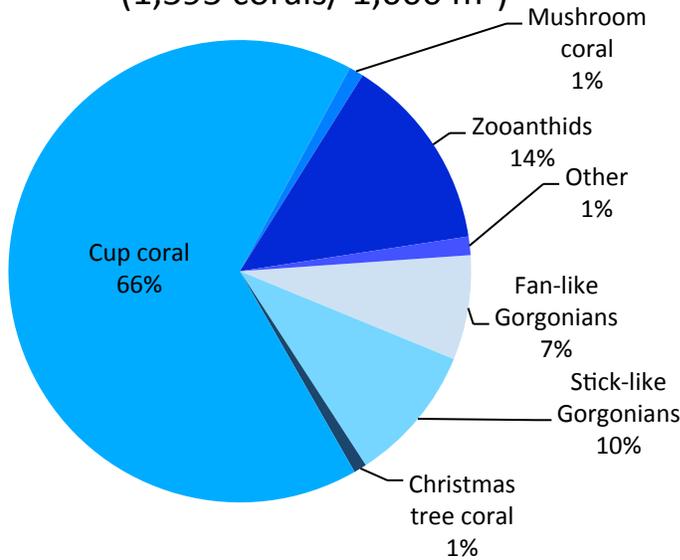
In total, 1,114 m² of seafloor were surveyed during dive AUV003 using the *Lucille* AUV deployed from the NOAA ship *McArthur II* on the Piggy Bank off southern California. Habitat types were classified as (1) Hard (29% of the total area surveyed), which included boulders, rock ridges and cobble; (2) Mixed (64% of the total area surveyed), which included mud appearing with rock, boulder or cobble; and (3) Sediment (7% of the total area surveyed), which consisted of mud and/or sand.



BIOLOGICAL ENVIRONMENT: CORALS

AUV003- Density of Corals

(1,595 corals/ 1,000 m²)

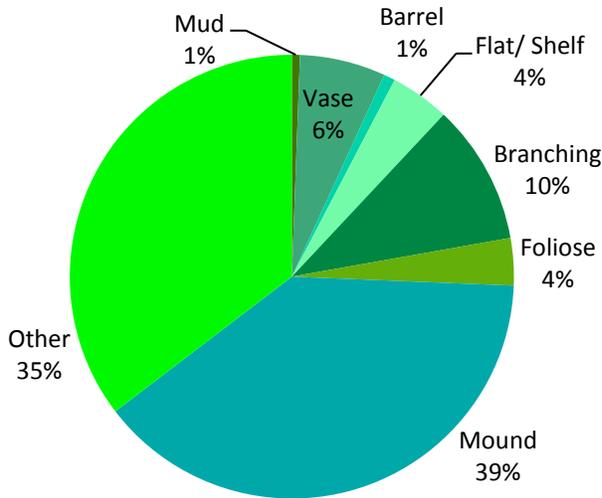


A total of 1,776 individual corals were enumerated from the 240 frames sampled from dive AUV003 conducted on the Piggy Bank from the NOAA vessel *McArthur II*. They represented 11 taxonomic groups. An overall density of 1,595 corals per 1,000 m² of seafloor was estimated. Unidentified cup corals and *Lophelia pertusa* combined to make up the highest density of corals (66%). Zooanthids accounted for the second highest density at 14%. Stick- and fan-like gorgonians accounted for a combined density of 17%, these included the genera *Paragorgia* spp., *Plumerella*

spp., *Swiftia* spp. and the family Plexauridae. *Anthomastus ritteri*, *Antipathes dendrochristos* and other unidentified corals were each represented at 1% of the total density of corals. All of these corals occurred on the hard or mixed substrates. The colors in the pie diagram match the colors in the list of coral taxa.

| Scientific Name | Common Name | Count |
|----------------------------------|-----------------------------|-------|
| Unidentified Gorgonian | Unidentified Gorgonian | 16 |
| <i>Paragorgia</i> spp. | Sea fan | 8 |
| <i>Plumerella</i> sp. | Primnoid | 106 |
| Plexauridae | Sea fan | 118 |
| <i>Swiftia</i> spp. | Sea fan | 53 |
| <i>Antipathes dendrochristos</i> | Antipathes sp. | 16 |
| <i>Lopheila</i> spp. | White cup coral | 68 |
| Caryophyllidae | Unidentified cup corals | 1107 |
| <i>Anthomastus ritteri</i> | Anthomastus sp. | 18 |
| Zoantharia | Unidentified zooanthids | 243 |
| Anthozoa | Unidentified coral/ sea pen | 23 |

AUV003- Density of Sponges
(1,852 sponges/ 1,000 m²)



**BIOLOGICAL ENVIRONMENT:
SPONGES**

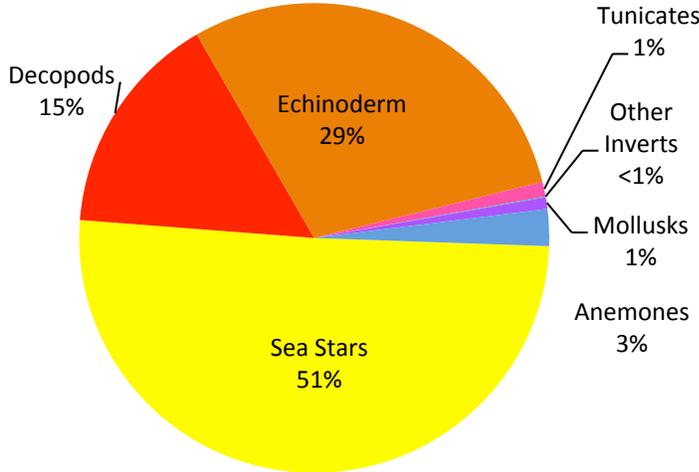
A total of 2,063 individual sponges from 16 different taxonomic classifications were observed during the 240 frames sampled from dive AUV003 on Piggy Bank from the NOAA vessel *McArthur II*. An overall density of 1,852 sponges per 1,000 m² of seafloor was estimated. Mound sponges were found to be the most abundant accounting for 39% of the total density. Other and unidentified sponges, including *Asbestopluma* spp. and an unidentified spotted sponge accounted for 35% of the overall density. Branching sponges (10%), vase (6%), foliose (4%, including *Farrea occa* and *Polymastia* spp.), flat/ shelf sponges (4%), barrel (1%) and mud covered (1%) comprised the remaining sponge density. The majority of the sponges occurred on hard and mixed habitats. Colors in the pie chart above match the list of sponge taxa following.

vase (6%), foliose (4%, including *Farrea occa* and *Polymastia* spp.), flat/ shelf sponges (4%), barrel (1%) and mud covered (1%) comprised the remaining sponge density. The majority of the sponges occurred on hard and mixed habitats. Colors in the pie chart above match the list of sponge taxa following.

| Scientific Name | Common Name | Count |
|-----------------------------|-----------------------------------|-------|
| Mud Covered | | 12 |
| Porifera | Unidentified vase sponges | 126 |
| <i>Staurocalyptus</i> spp. | Unidentified vase sponge (yellow) | 3 |
| Porifera | Unidentified barrel sponges | 17 |
| Porifera | Unidentified shelf sponges | 16 |
| Porifera | Unidentified upright flat sponges | 73 |
| Porifera | Unidentified branching sponges | 2 |
| Porifera | Unidentified branching sponge | 209 |
| <i>Farrea occa</i> | Lace (or cloud) foliose sponge | 35 |
| <i>Polymastia</i> sp. | Nipple foliose sponges | 36 |
| Porifera | Unidentified small mound sponges | 87 |
| Porifera | Unidentified mound sponges | 717 |
| Porifera | Unidentified sponges (blue/white) | 146 |
| <i>Asbestopluma</i> spp. #2 | Predatory sponge (clear) | 4 |
| <i>Asbestopluma</i> spp. #1 | Pipe Cleaner Sponge | 70 |
| Porifera | Unidentified sponges | 510 |

AUV003- Density of Other Invertebrates

(1,349 inverts/ 1,000 m²)



**BIOLOGICAL ENVIRONMENT:
OTHER INVERTEBRATES**

A total of 1,502 invertebrates representing 26 taxa were counted for dive AUV003 from the NOAA vessel *McArthur II* on the Piggy Bank. An overall density of 1,349 invertebrates per 1,000m² of seafloor was estimated. Sea stars were the most abundant invertebrate representing 51% of the overall density. This number did not include individuals from the family Ophiocanthidae, which were too numerous to accurately count. The sea star grouping was made up of 14 genera or species pairings, including *Rathbunaster*

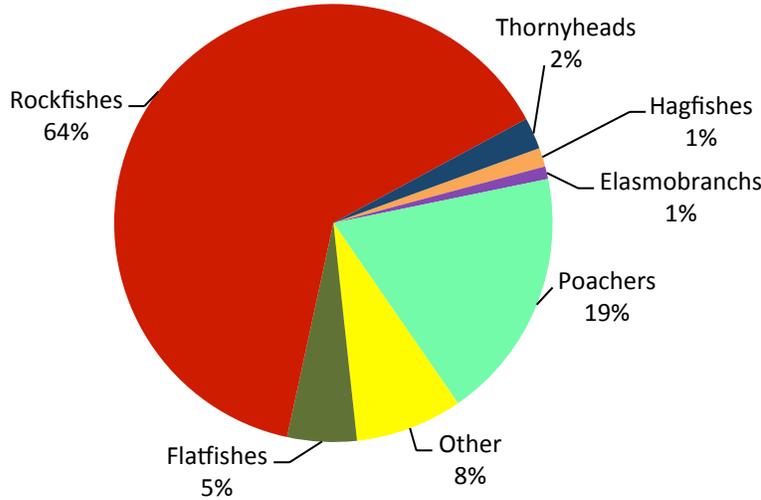
californicus, *Gorgonocephalus eucnemis* and an unidentified mud star, possibly *Ctenodiscus* spp. Echinoderms represented 29% of the invertebrate density including *Psolus squamatus*, and *Parastichopus* spp. Decapods, comprised of galatheid crabs (squat lobsters) accounted for 15% of the invertebrate density. Other groups represented included anemones (3%), mollusks (1%, unidentified octopus and nudibranchs), tunicates (1%) and other unidentified invertebrates (<1%). Invertebrates were distributed throughout all habitat types. The pie diagram colors match with the list of invertebrate taxa below.

| Scientific Name | Common Name | Count |
|-------------------------------------|---|-------|
| Asteroidea | Unidentified Sea star | 249 |
| <i>Gorgonocephalus eucnemis</i> | Basket Star | 161 |
| Ophiocanthidae | Unidentified brittlestar | |
| <i>Rathbunaster californicus</i> | Deep-sea sunflower star | 72 |
| <i>Ceramaster</i> spp. | Cookie star | 8 |
| <i>Pteraster</i> spp. | Slime star | 3 |
| <i>Henricia</i> spp. | Henricia star | 8 |
| <i>Thrissacanthius penicillatus</i> | <i>Carpel star</i> | 1 |
| Asteroidea | <i>Nearchaster/Cheiraster</i> spp. | 115 |
| Asteroidea | <i>Myxoderma platycanthum</i> -like | 3 |
| <i>Solaster</i> spp. | Deep-sea sunstar | 4 |
| <i>Crossaster papposus</i> | Rose star | 1 |
| <i>Stylasterias forreri</i> | Fish-eating star | 3 |
| <i>Poraniopsis</i> spp. | Thorny star | 5 |
| Asteroidea | Unidentified mud star (<i>Ctenodiscus</i> spp.?) | 128 |
| Galatheoidea | Unidentified Galtheid crab | 232 |
| <i>Psolus squamatus</i> | White-scaled cucumber | 279 |
| <i>Parastichopus</i> spp. | Giant Orange/Giant California cucumber | 142 |
| <i>Allocentrotus fragilis</i> | Fragile red sea urchin | 22 |
| <i>Liponema brevicornis</i> | Tentacle shedding anemone | 9 |
| Actinidae | Unidentified anemone | 29 |
| Tunicata | Unidentified tunicates | 15 |
| Unidentified invertebrate | Unidentified invertebrate | 1 |
| Cephalopoda | Unidentified octopus | 7 |
| Opisthobranchia | Unidentified nudibranch | 2 |
| <i>Pleurobranchaea californica</i> | California sea slug | 3 |

BIOLOGICAL ENVIRONMENT: FISHES

A total of 215 fishes were counted representing 11 different taxonomic groupings during dive

AUV003- Density of Fishes
(193 fishes/ 1,000 m²)

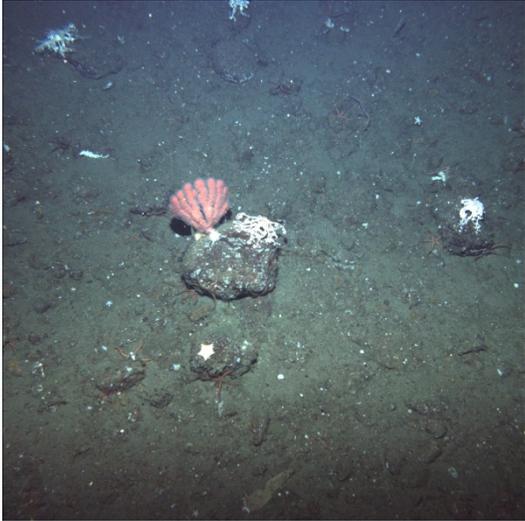


AUV003 on Piggy Bank from the NOAA ship McArthur II. An overall density of 193 fishes per 1,000 m² was estimated. Rockfishes (bank, splitnose, Sebastomus and unidentified rockfish) represented 64% of the overall fish density. Poachers were the next most abundant category at 19% of the overall density. The remainder of the fish assemblage included flatfishes (5%, Dover sole

(*Microstomus pacificus*)), hagfishes (Myxinidae) (1%), thornyheads (*Sebastolobus* spp.) (2%), elasmobranchs (*Hydrolagus colliei*) (1%) and other (8%, including Cottids, and unidentified fishes). The colors in the pie chart match the colors in the list of fish taxa.

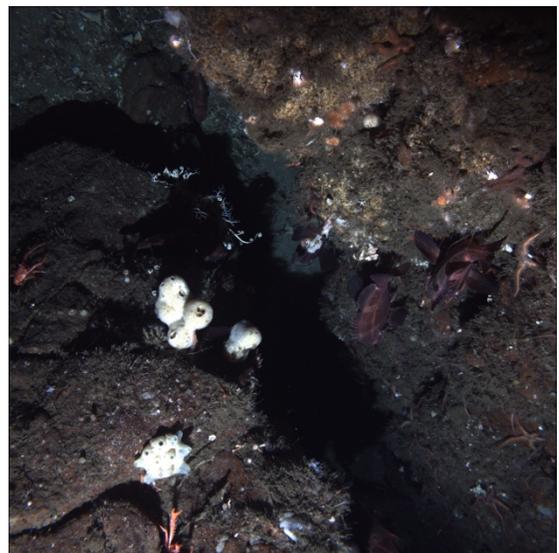
| Scientific Name | Common Name | Count |
|------------------------------|-------------------------------|-------|
| Myxinidae | Unidentified hagfish | 3 |
| <i>Hydrolagus colliei</i> | Spotted ratfish | 2 |
| Agonidae | Unidentified poachers | 40 |
| <i>Microstomus pacificus</i> | Dover sole | 11 |
| Cottidae | Unidentified sculpins | 10 |
| Osteichthyes | Unidentified fishes | 7 |
| <i>Sebastes diploproa</i> | Splitnose rockfish | 5 |
| <i>Sebastes rufus</i> | Bank rockfish | 47 |
| <i>Sebastes</i> spp. | Rockfish Unid. | 49 |
| Sebastomus | Unidentified White-spotted RF | 36 |
| <i>Sebastolobus</i> spp. | Unidentified thornyhead | 5 |

IMAGE GALLERY- AUV003



Paragorgia spp., *Gorgonocephalus eucnemis* and a *Ceramaster* spp. on mixed habitat (cobble and mud).

Polymastia spp., and unidentified mound sponges on rock ridge habitat (hard). Cup corals (*Caryophyllidae*), basket stars (*Gorgonocephalus eucnemis*), galatheid crabs and bank rockfish (*Sebastes rufus*) are also in the frame.



Parastenella spp., *Plumerella* spp. and *Parastichopus* spp. in mixed habitat (cobble and mud). To the bottom right there is an unidentified mound sponge.

DIVE NUMBER: AUV005

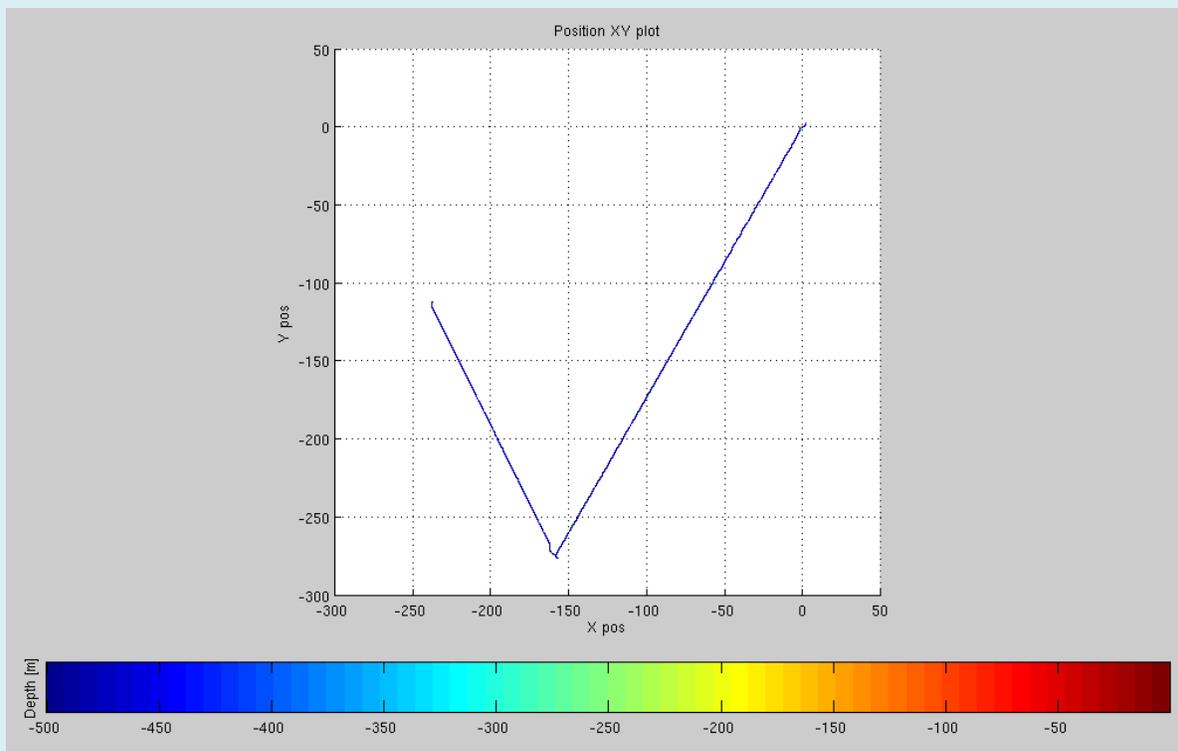
STATION OVERVIEW

| | |
|-----------------------------|--|
| Project | U.S. West Coast Deep Coral Cruise |
| Chief Scientist | M. Elizabeth Clarke |
| Contact Information | NMFS, NWFSC, elizabeth.clarke@noaa.gov |
| Purpose | Survey deep coral communities as Piggy Bank in the CINMS |
| Vessel | NOAA Ship <i>McArthur II</i> , Leg 3; <i>Lucille</i> AUV |
| Team | C. Whitmire, E. Fruh, J. Anderson, J. Taylor |
| Digital Still Photos | 1219 |
| Positioning System | Ship: GPS; AUV: DVL, gyrocompass, USBL |
| CTD Sensor | Yes |

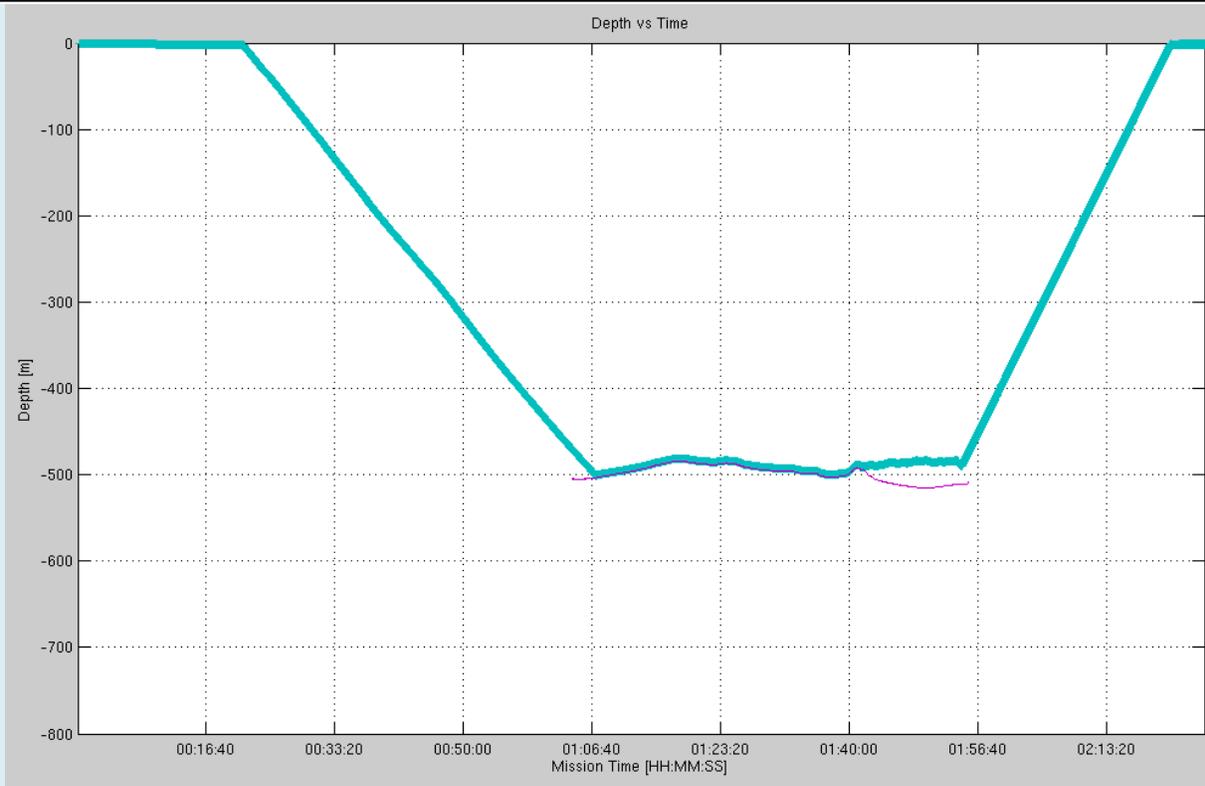
DIVE DATA

| | | | |
|--------------------------|--------------|------------------------|------------|
| Date | 29 June 2010 | Starting Latitude (N) | 33°55.79' |
| Maximum Bottom Depth (m) | 504 | Starting Longitude (W) | 119°28.99' |
| Start Time (UTC) | 05:16 | Ending Latitude (N) | 33°55.74' |
| End Time (UTC) | 06:48 | Ending Longitude (W) | 119°29.13' |

GENERAL LOCATION AND DIVE TRACK

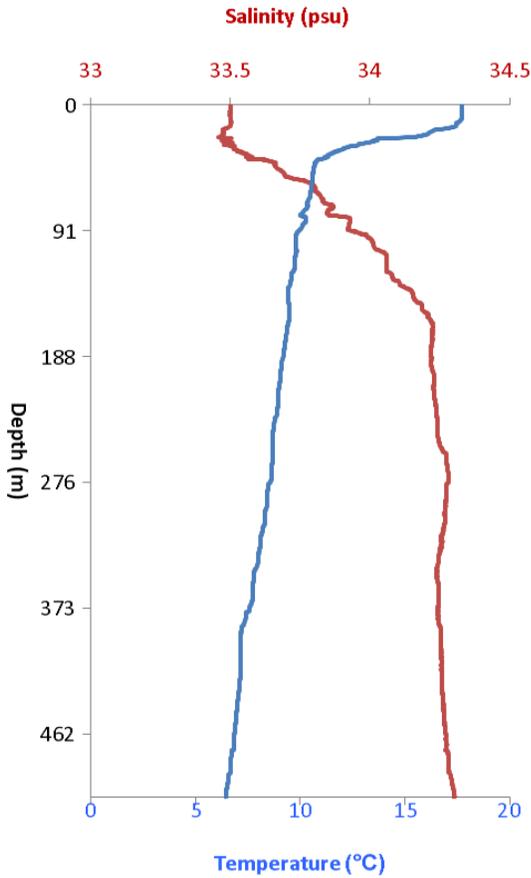


Survey track of dive AUV005.



Depth track of dive AUV005 showing bottom in pink (—) and vehicle tracking bottom in teal (—).

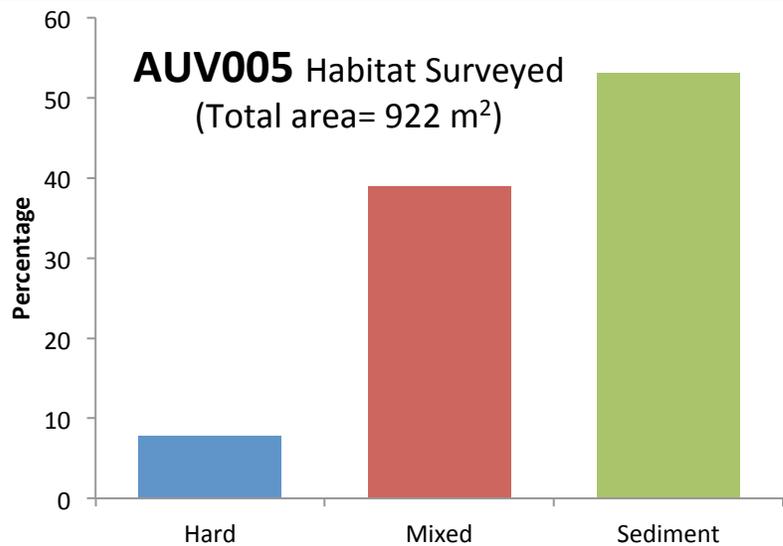
PHYSICAL ENVIRONMENT



The AUV was equipped with an onboard Sea-Bird model 49 FastCat CTD that collected temperature and salinity information throughout the AUV’s descent as well as along the dive track. During the dive AUV005 descent, the temperature varied from 17.71 to 7.45°C and salinity varied from 33.5 to 34.3 (psu).

Dive AUV005 descent temperature and salinity profiles.

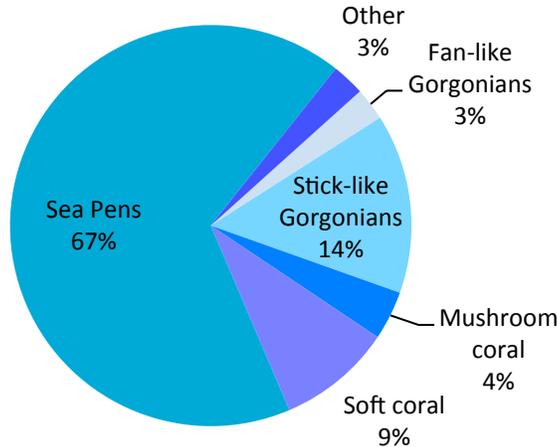
In total, 922 m² of sea floor were surveyed during dive AUV005 using the *Lucille* AUV deployed from the NOAA ship *McArthur II* on the Piggy Bank off southern California. Habitat types were classified as (1) Hard (8% of the total area surveyed), which included boulders and cobble; (2) Mixed (39% of the total area surveyed), which included mud appearing with rock, boulder or cobble; and (3) Sediment (53% of the total area surveyed), which consisted of mud.



BIOLOGICAL ENVIRONMENT: CORALS

AUV005- Density of Corals

(82 corals/ 1,000 m²)

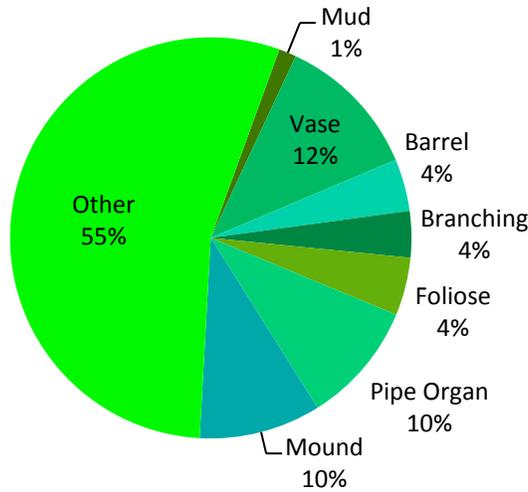


A total of 76 individual corals were enumerated from the 205 frames sampled from dive AUV005 conducted on the Piggy Bank from the NOAA vessel *McArthur II*. They represented 8 taxonomic groups. An overall density of 82 corals per 1,000 m² of seafloor was estimated. Unidentified sea pens, *Umbellula lindahli*, and *Anthoptilum grandiflorum* combined to make up the highest density of corals (67%). Stick-like gorgonians (*Swiftia* spp. and the family Plexauridae) accounted for the second highest density at 14%. Soft corals (*Clavularia* spp.) made up 9% of the overall coral

density. Fan-like gorgonians and *Anthomastus ritteri* accounted for 3% and 4% respectively. Other unidentified corals were represented at 3% of the total density of corals. The sea pens were all found on sediment, while the rest of the corals occurred on the hard or mixed substrates. The colors in the pie diagram match the colors in the list of coral taxa.

| Scientific Name | Common Name | Count |
|---------------------------------|-----------------------------|-------|
| Unidentified Gorgonian | Unidentified Gorgonian | 2 |
| <i>Swiftia</i> spp. | Sea fan | 3 |
| Plexauridae | Sea fan | 8 |
| <i>Anthomastus ritteri</i> | Mushroom coral | 3 |
| <i>Clavularia</i> spp. | Soft coral | 7 |
| <i>Anthoptilum grandiflorum</i> | Feather boa sea pen | 42 |
| <i>Umbellula lindahli</i> | Droopy sea pen | 9 |
| Anthozoa | Unidentified coral/ sea pen | 2 |

AUV005- Density of Sponges
(232 sponges/ 1,000 m²)



**BIOLOGICAL ENVIRONMENT:
SPONGES**

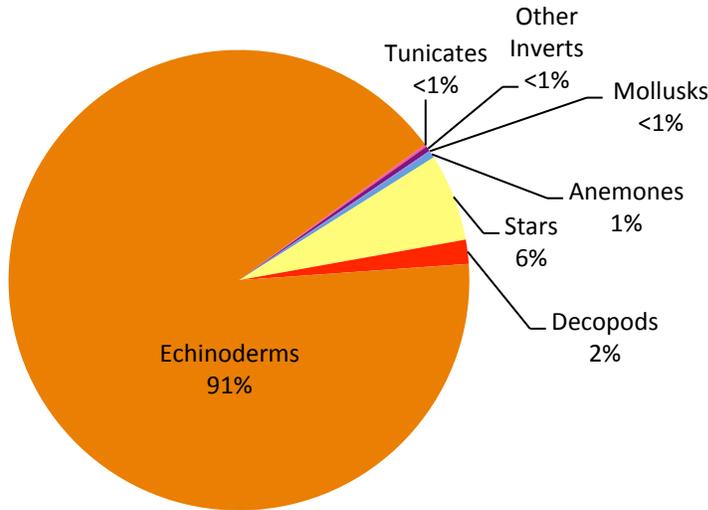
A total of 214 individual sponges from 12 different taxonomic classifications were observed during the 205 frames sampled from dive AUV005 on Piggy Bank from the NOAA vessel *McArthur II*. An overall density of 232 sponges per 1,000 m² of seafloor was estimated. Unidentified and other sponges were found to be the most abundant, accounting for 55% of the total density. Vase, mound and pipe organ (possibly *Oceanapia* spp.) sponges accounted for 12%, 10% and 10% respectively, of the total sponge density. Branching sponges, foliose

and barrel sponges each accounted for 4% of the overall density. Mud covered sponges made up 1% of the overall sponge density. The majority of the sponges occurred on hard and mixed habitats. Colors in the pie chart above match the list of sponge taxa following.

| Scientific Name | Common Name | Count |
|-----------------------------|-----------------------------------|-------|
| Mud Covered | | 3 |
| Porifera | Unidentified vase sponges | 24 |
| <i>Heterochone calyx</i> | Fingered goblet vase sponge | 1 |
| Porifera | Unidentified barrel sponges | 9 |
| Porifera | Unidentified branching sponge | 8 |
| <i>Thenia muricata</i> | Foliose Sponge (clear) | 10 |
| Porifera | Unidentified pipe organ sponge | 21 |
| Porifera | Unidentified mound sponges | 20 |
| Porifera | Unidentified small mound sponges | 1 |
| <i>Asbestopluma</i> spp. #1 | Pipe Cleaner Sponge | 14 |
| Porifera | Unidentified sponges (blue/white) | 1 |
| Porifera | Unidentified sponges | 102 |

AUV005- Density of Other Invertebrates

(4,486 invertebrates/ 1,000 m²)



BIOLOGICAL ENVIRONMENT: OTHER INVERTEBRATES

A total of 4,137 invertebrates representing 21 taxa were enumerated for dive AUV005 from the NOAA vessel *McArthur II* on the Piggy Bank. An overall density of 4,486 invertebrates per 1,000 m² of seafloor was estimated.

Echinoderms (mostly the urchins, *Allocentrotus fragilis* and *Brisaster* spp./ *Brissopsis* spp.) were the most abundant invertebrate representing 91% of the overall density. The sea star grouping was made up of 7 genera or species pairings, including *Rathbunaster californicus*, *Nearchaster* spp./ *Cheiraster* spp. and other unidentified stars, and

represented 6% of the overall invertebrate density. This percentage did not include individuals from the family Ophiocanthidae, which we were unable to accurately count. Decapods, comprised of galatheid crabs (squat lobsters) and unidentified shrimp accounted for 2% of the invertebrate density. Other groups represented included anemones (1%), mollusks (<1%, unidentified octopus and nudibranchs), tunicates (<1%) and other unidentified invertebrates (<1%, the benthic siphonophore, *Dromalia alexandri*). Invertebrates were distributed throughout all habitat types. The pie diagram colors match with the list of invertebrate taxa below.

Characterization of Deep-sea Coral Communities

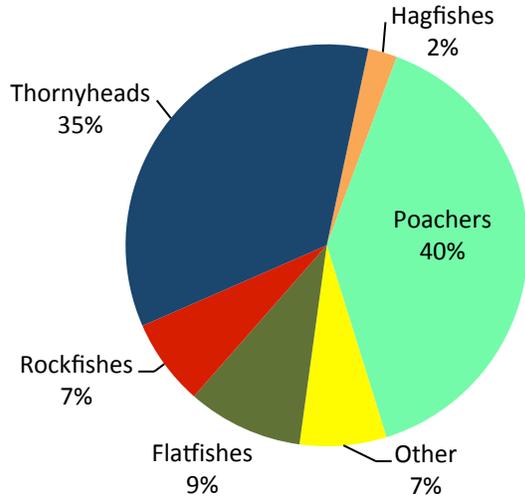
Area: Piggy Bank

| Scientific Name | Common Name | Count |
|--|-------------------------------------|-------|
| Asteroidea | Unidentified Sea star | 130 |
| <i>Ophiocanthidae</i> | Unidentified brittlestar | |
| <i>Rathbunaster californicus</i> | Deep-sea sunflower star | 43 |
| <i>Pteraster</i> spp. | Slime star | 7 |
| <i>Thrissacanthius penicillatus</i> | Carpet star | 2 |
| Asteroidea | <i>Nearchaster/Cheiraster</i> spp. | 55 |
| Asteroidea | <i>Myxoderma platycanthum</i> -like | 7 |
| <i>Crossaster</i> spp./ <i>Heterozonius</i> spp. | Unidentified deep-sea sunstar | 10 |
| Galatheoidea | Unidentified Galtheid crab | 31 |
| Decapoda | Unidentified shrimp | 39 |
| <i>Psolus squamatus</i> | White-scaled cucumber | 31 |
| <i>Pannychia moseleyi</i> | Sloppy cucumber | 161 |
| Holothuroidea | Unidentified sea cucumber | 2 |
| <i>Brisaster</i> spp./ <i>Brissopsis</i> spp. | Unidentified mud urchin | 302 |
| <i>Allocentrotus fragilis</i> | Fragile red sea urchin | 3270 |
| <i>Florometra serratissima</i> | Feather star crinoid | 3 |
| <i>Liponema brevicornis</i> | Tentacle shedding anemone | 3 |
| Actinidae | Unidentified anemone | 17 |
| Tunicata | Unidentified tunicates | 7 |
| Unidentified invertebrate | Unidentified invertebrate | 3 |
| Cephalopoda | Unidentified octopus | 2 |
| <i>Dromalia alexandri</i> | Benthic siphonophore | 12 |

BIOLOGICAL ENVIRONMENT: FISHES

AUV005- Density of Fishes

(93 fishes/ 1,000 m²)

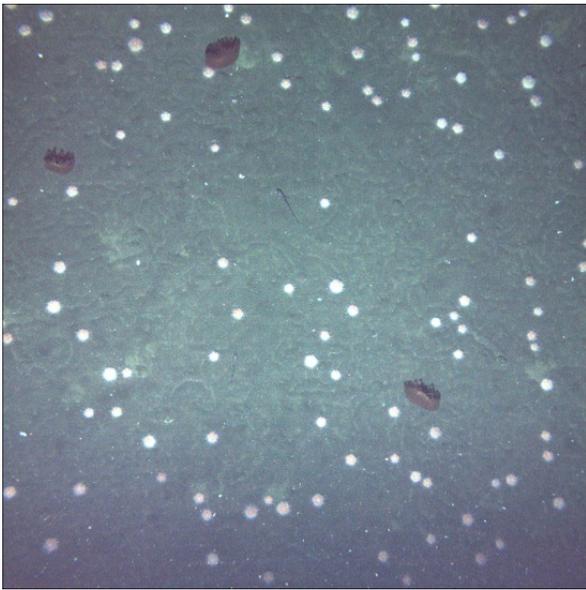


A total of 86 fishes were enumerated, representing 8 different taxonomic groupings during dive AUV005 on Piggy Bank from the NOAA ship *McArthur II*. An overall density of 93 fishes per 1,000 m² was estimated. Unidentified poachers from the family Agonidae were the most abundant fish encountered at 40% of the overall density. Unidentified thornyheads, grouped as *Sebastolobus* spp., represented 35% of the total fish density. Flatfishes (9%, represented by Dover sole, *Microstomus pacificus*), rockfishes (7%, *Sebastes* spp. and *Sebastes melanostomus*),

and Other (7%, included Liparidae and unidentified fishes) were the next largest densities. Hagfishes (Myxinidae) made up the last 2% in overall density of fishes. The colors in the pie chart match the colors in the list of fish taxa below.

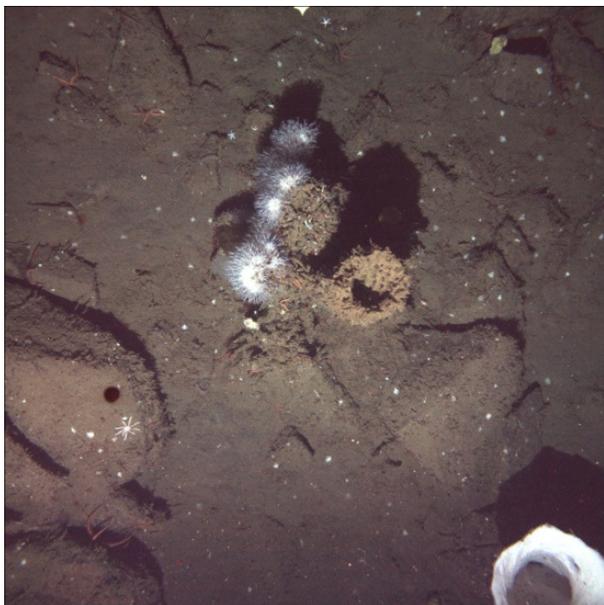
| Scientific Name | Common Name | Count |
|------------------------------|-------------------------|-------|
| Myxinidae | Unidentified hagfish | 2 |
| Agonidae | Unidentified poachers | 34 |
| Liparidae | Unidentified snailfish | 3 |
| <i>Microstomus pacificus</i> | Dover sole | 8 |
| Osteichthyes | Unidentified fishes | 3 |
| <i>Sebastes</i> spp. | Rockfish Unid. | 1 |
| <i>Sebastes melanostomus</i> | Blackgill rockfish | 5 |
| <i>Sebastolobus</i> spp. | Unidentified thornyhead | 30 |

IMAGE GALLERY- AUV005



To the left, we see sediment habitat with *Allocentrotus fragilis* sea urchins and *Anthoptilum grandiflorum* sea pens. There are also unidentified poachers in this image.

To the right, we see mixed habitat with a blackgill rockfish (*Sebastes melanostomus*), unidentified sea stars and *Anthomastus ritteri*, (mushroom coral).



This image shows mixed habitat with an unidentified vase sponge and mud covered *Heterochone calyx*. Also present is the soft coral, *Clavularia* spp.

DIVE NUMBER: AUV006

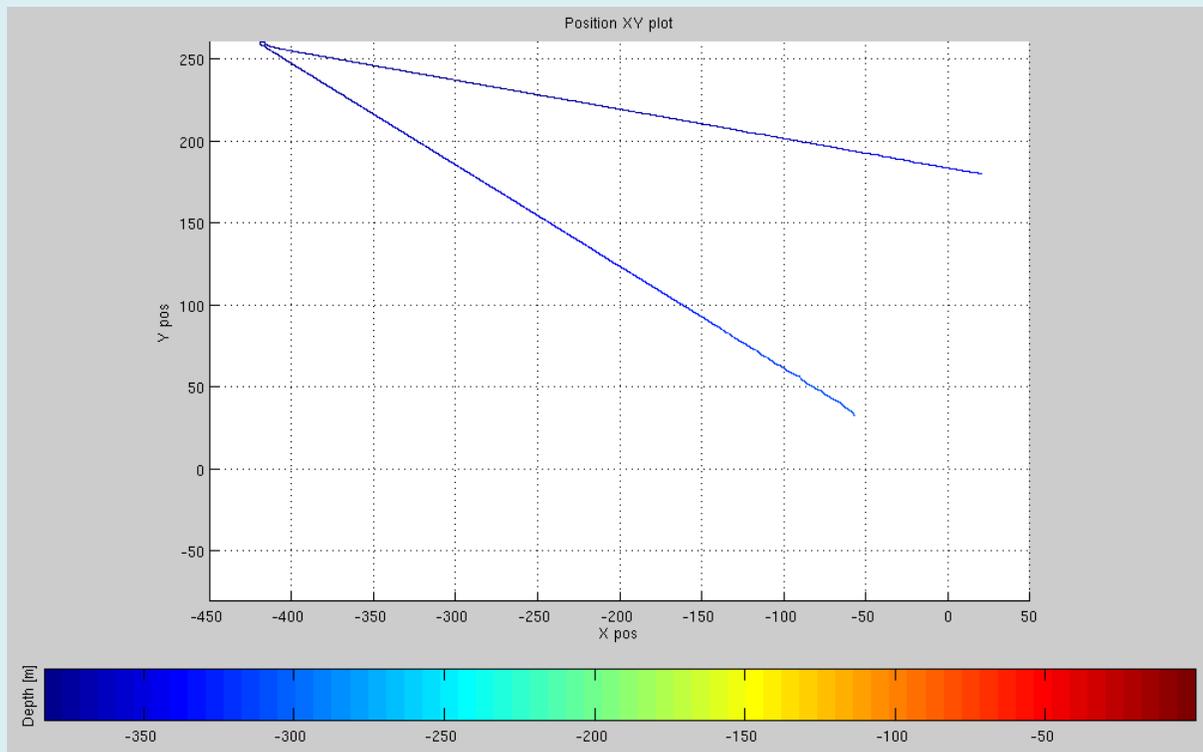
STATION OVERVIEW

| | |
|-----------------------------|--|
| Project | U.S. West Coast Deep Coral Cruise |
| Chief Scientist | M. Elizabeth Clarke |
| Contact Information | NMFS, NWFSC, elizabeth.clarke@noaa.gov |
| Purpose | Survey deep coral communities as Piggy Bank in the CINMS |
| Vessel | NOAA Ship <i>McArthur II</i> , Leg 3; <i>Lucille</i> AUV |
| Team | C. Whitmire, E. Fruh, J. Anderson, J. Taylor |
| Digital Still Photos | 1003 |
| Positioning System | Ship: GPS; AUV: DVL, gyrocompass, USBL |
| CTD Sensor | Yes |

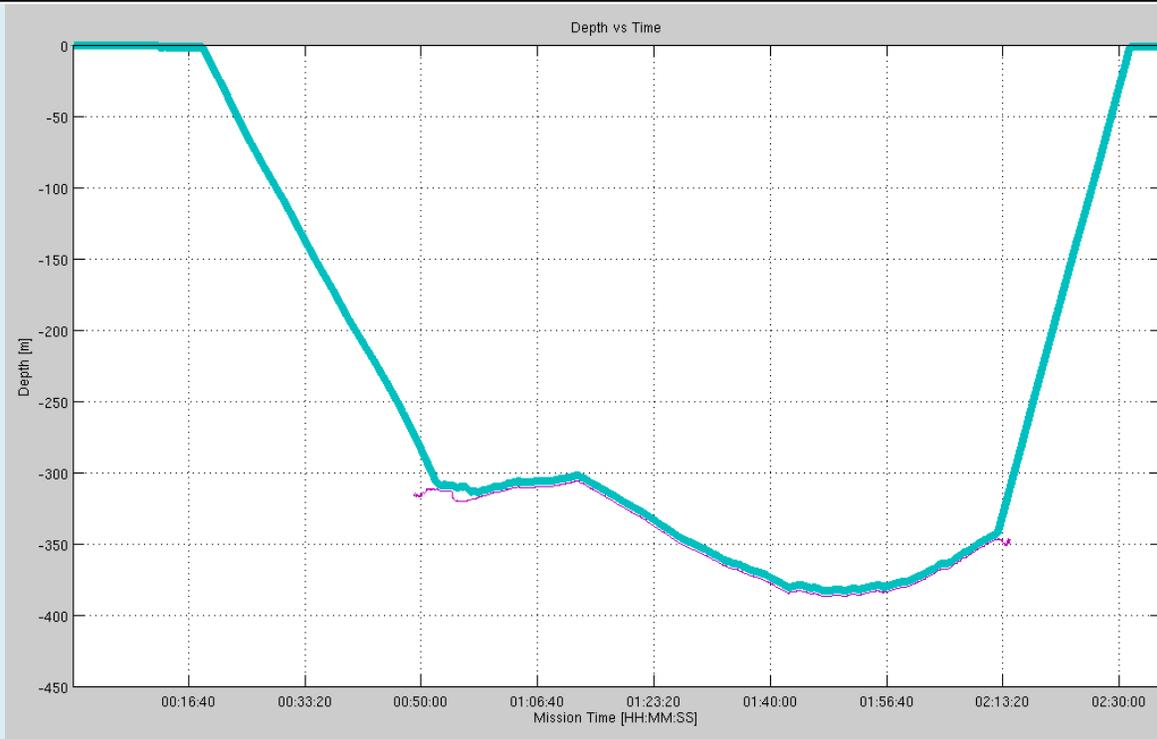
DIVE DATA

| | | | |
|--------------------------|--------------|------------------------|------------|
| Date | 29 June 2010 | Starting Latitude (N) | 33°55.36' |
| Maximum Bottom Depth (m) | 315 | Starting Longitude (W) | 119°28.61' |
| Start Time (UTC) | 09:51 | Ending Latitude (N) | 33°55.53' |
| End Time (UTC) | 012:03 | Ending Longitude (W) | 119°28.69' |

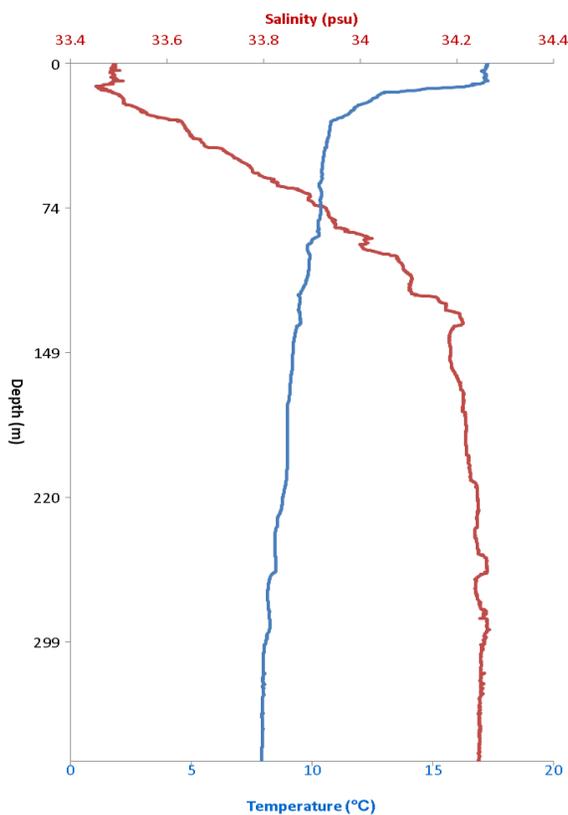
GENERAL LOCATION AND DIVE TRACK



Survey track of dive AUV006.



Depth track of dive AUV006 showing bottom in pink (—) and vehicle tracking bottom in teal (—).

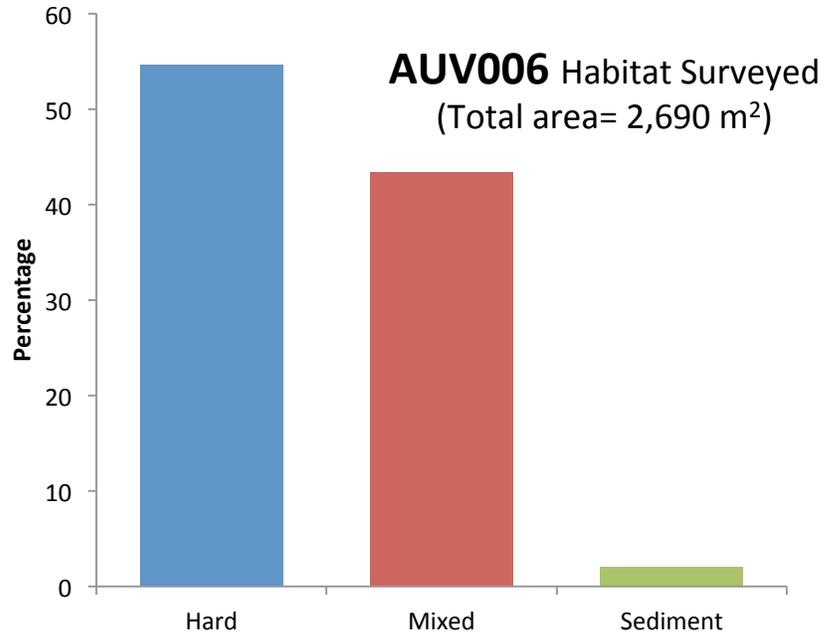


PHYSICAL ENVIRONMENT

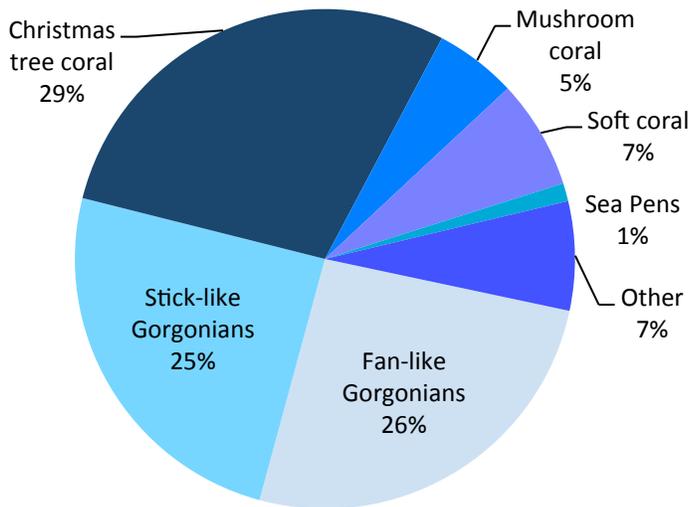
The AUV was equipped with an onboard Sea-Bird model 49 FastCat CTD that collected temperature and salinity information throughout the AUV’s descent as well as along the dive track. During the dive AUV006 descent, the temperature varied from 17.3 to 7.91°C and salinity varied from 33.5 to 34.25 (psu).

Dive AUV006 descent temperature and salinity profiles.

In total, 2,690 m² of sea floor were surveyed during dive AUV006 using the *Lucille* AUV deployed from the NOAA ship *McArthur II* on the Piggy Bank off southern California. Habitat types were classified as (1) Hard (55% of the total area surveyed), which included boulders, flat rock and cobble; (2) Mixed (43% of the total area surveyed), which included mud appearing with rock, boulder or cobble; and (3) Sediment (2% of the total area surveyed), which consisted of mud. This mission was flown at a higher altitude (4m), which increased the area of each image.



AUV006- Density of Corals
(63 corals/ 1,000 m²)



BIOLOGICAL ENVIRONMENT: CORALS

A total of 170 individual corals were enumerated from the 337 frames sampled from dive AUV006 conducted on the Piggy Bank from the NOAA vessel *McArthur II*. They represented 10 taxonomic groups. An overall density of 63 corals per 1,000 m² of seafloor was estimated. Christmas tree black corals (*Antipathes dendrochristos*) were the most abundant species during this dive at 29% of the overall density. Fan-like (26%, *Paragorgia* spp., *Parastenella* spp. and *Plumerella* spp.) and stick-like (25%, *Plexuridae* and *Swiftia* spp.)

gorgonians combined to account for 51% of the overall coral density. Unidentified corals (Anthozoa) and soft corals (*Clavularia* spp.) each made up 7% of the overall coral density. *Anthomastus ritteri* accounted for 5% and sea pens (*Anthoptilum grandiflorum*) represented 1% of the total density of corals. The majority of the corals occurred on the hard or mixed substrates. The colors in the pie chart match the colors in the list of coral taxa below.

| Scientific Name | Common Name | Count |
|----------------------------------|-----------------------------|-------|
| <i>Paragorgia</i> spp. | Sea fan | 4 |
| <i>Parastenella</i> spp. | Primnoid | 3 |
| <i>Plumerella</i> spp. | Primnoid | 37 |
| Plexauridae | Sea fan | 41 |
| <i>Swiftia</i> spp. | Sea fan | 1 |
| <i>Antipathes dendrochristos</i> | Christmas tree black coral | 49 |
| <i>Anthomastus ritteri</i> | Mushroom coral | 9 |
| <i>Clavularia</i> spp. | Soft coral | 12 |
| <i>Anthoptilum grandiflorum</i> | Feather boa sea pen | 2 |
| Anthozoa | Unidentified coral/ sea pen | 12 |

BIOLOGICAL ENVIRONMENT: SPONGES

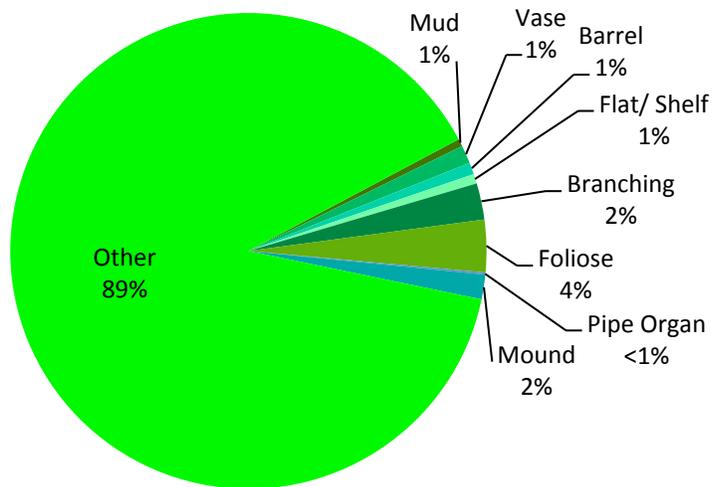
A total of 1,377 individual sponges from 16 different taxonomic classifications were observed during the 337 frames sampled from dive AUV006 on Piggy Bank from the NOAA vessel *McArthur II*. An overall density of 512 sponges per 1,000 m² of seafloor was estimated.

Unidentified and other (including *Asbestopluma* spp.) sponges were found to be the most abundant, accounting for 89% of the total density.

Foliose sponges (*Thenea muricata*, *Polymastia* spp. and *Farrea occa*) made up 4% of the overall sponge density. Branching and mound sponges each accounted for 2% of the sponge density.

Vase, mud covered, barrel, flat/shelf and pipe organ (possibly *Oceanapia* spp.) sponges accounted for ≤1% each of the total sponge density in dive AUV006. All of the sponges occurred on hard and mixed habitats. Colors in the pie chart above match the list of sponge taxa following.

AUV006- Density of Sponges
(512 sponges/ 1,000 m²)



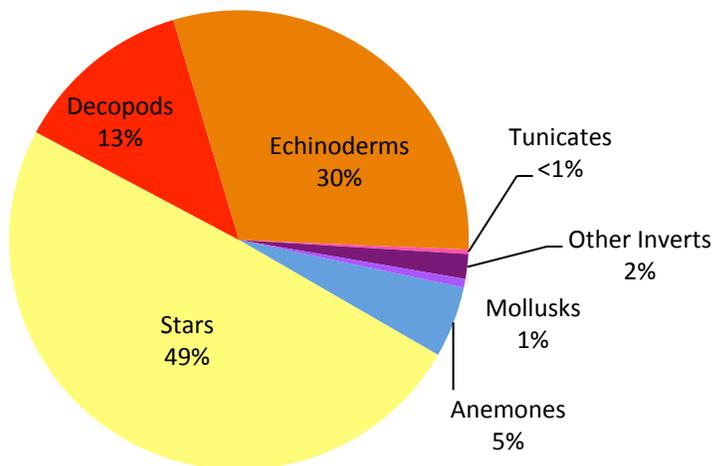
| Scientific Name | Common Name | Count |
|-----------------------------|-----------------------------------|-------|
| Mud Covered | | 7 |
| Porifera | Unidentified vase sponges | 16 |
| <i>Staurocalyptus</i> spp. | Unidentified vase sponge (yellow) | 1 |
| Porifera | Unidentified barrel sponges | 11 |
| Porifera | Unidentified upright flat sponges | 9 |
| Porifera | Unidentified branching sponge | 34 |
| <i>Polymastia</i> sp. | Nipple foliose sponges | 23 |
| <i>Thenea muricata</i> | Foliose Sponge (clear) | 22 |
| <i>Farrea occa</i> | Lace (or cloud) foliose sponge | 4 |
| Porifera | Unidentified pipe organ sponge | 2 |
| Porifera | Unidentified small mound sponges | 6 |
| Porifera | Unidentified mound sponges | 17 |
| Porifera | Unidentified sponges (blue/white) | 17 |
| <i>Asbestopluma</i> spp. #2 | Predatory sponge (clear) | 4 |
| <i>Asbestopluma</i> spp. #1 | Pipe Cleaner Sponge | 53 |
| Porifera | Unidentified sponges | 1151 |

BIOLOGICAL ENVIRONMENT: OTHER INVERTEBRATES

A total of 1,317 invertebrates representing 25 taxa were enumerated for dive AUV006 from the NOAA vessel *McArthur II* on the Piggy Bank. An overall density of 490 invertebrates per 1,000

AUV006- Density of Other Invertebrates

(490 invertebrates/ 1,000 m²)



m² of seafloor was estimated. The sea star grouping was made up of 11 genera or species pairings, including *Rathbunaster californicus*, *Nearchaster* spp./ *Cheiraster* spp. and other unidentified stars, and represented 49% of the overall invertebrate density. Echinoderms (mostly sea cucumbers, *Psolus squamatus* and *Parastichopus* spp.) were the next most abundant invertebrate representing 30% of the overall density. Decapods, comprised of galatheid crabs (squat lobsters) and unidentified crab species accounted for 13% of the

invertebrate density. Other groups represented included anemones (5%, *Liponema brevicornis* and unidentified anemones), mollusks (1%, unidentified octopus and nudibranchs), tunicates (<1%) and other unidentified invertebrates (2%, including the benthic siphonophore, *Dromalia alexandri*). Invertebrates were distributed throughout all habitat types. The pie diagram colors match with the list of invertebrate taxa below

Characterization of Deep-sea Coral Communities

Area: Piggy Bank

| Scientific Name | Common Name | Count |
|--|--|-------|
| Asteroidea | Unidentified Sea star | 280 |
| <i>Gorgonocephalus eucnemis</i> | Basket Star | 8 |
| <i>Rathbunaster californicus</i> | Deep-sea sunflower star | 49 |
| <i>Ceramaster</i> spp. | Cookie star | 4 |
| <i>Pteraster</i> spp. | Slime star | 1 |
| <i>Thrissacanthius penicillatus</i> | Carpet star | 67 |
| Asteroidea | <i>Nearchaster/Cheiraster</i> spp. | 220 |
| <i>Solaster</i> spp. | Deep-sea sunstar | 17 |
| <i>Crossaster</i> spp./ <i>Heterozonius</i> spp. | Unidentified deep-sea sunstar | 3 |
| <i>Hippasteria</i> spp. | Unidentified spiny star | 1 |
| <i>Stylasterias forreri</i> | Fish-eating star | 1 |
| Galatheoidea | Unidentified Galtheid crab | 165 |
| Decapoda | Unidentified crab | 1 |
| <i>Psolus squamatus</i> | White-scaled cucumber | 111 |
| <i>Parastichopus</i> spp. | Giant Orange/Giant California cucumber | 175 |
| <i>Pannychia moseleyi</i> | Sloppy cucumber | 2 |
| Holothuroidea | Unidentified sea cucumber | 1 |
| <i>Allocentrotus fragilis</i> | Fragile red sea urchin | 109 |
| <i>Florometra serratissima</i> | Feather star crinoid | 1 |
| <i>Liponema brevicornis</i> | Tentacle shedding anemone | 20 |
| Actinidae | Unidentified anemone | 46 |
| Tunicata | Unidentified tunicates | 4 |
| Cephalopoda | Unidentified octopus | 6 |
| Opisthobranchia | Unidentified nudibranch | 2 |
| <i>Dromalia alexandri</i> | Benthic siphonophore | 23 |

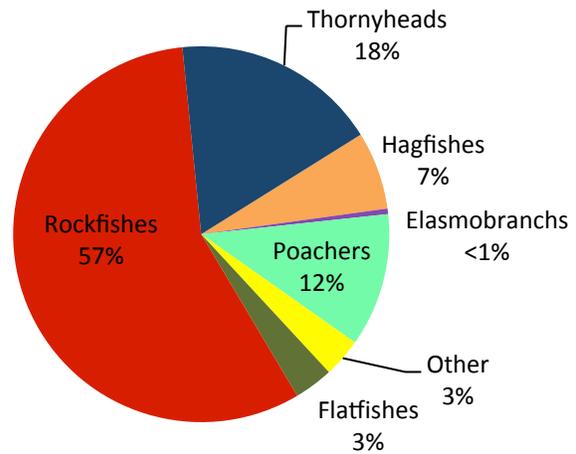
BIOLOGICAL ENVIRONMENT: FISHES

A total of 209 fishes were enumerated, representing 12 different taxonomic groupings during dive AUV006 on Piggy Bank from the NOAA ship *McArthur II*. An overall density of 78 fishes per 1,000 m² was estimated.

Unidentified rockfishes, *Sebastes melanostomus*, *Sebastes diploproa* and the Sebastomus grouping made up 57% of the total fish density. The *Sebastolobus* spp. grouping made up 18% of the total density for dive AUV006. Poachers (family Agonidae) from accounted for 12% of the overall density.

Hagfishes (family Myxinidae) represented 7% of the observed fish density. Flatfishes (3%, represented by Dover sole (*Microstomus pacificus*) and rex sole (*Glyptocephalus zachirus*), and Other (3%, including Cottidae and unidentified fishes) were the next largest densities. Elasmobranchs (represented by *Hydrolagus colliei*, spotted ratfish) made up <1% in the overall density of fishes. The colors in the pie chart match the colors in the list of fish taxa below.

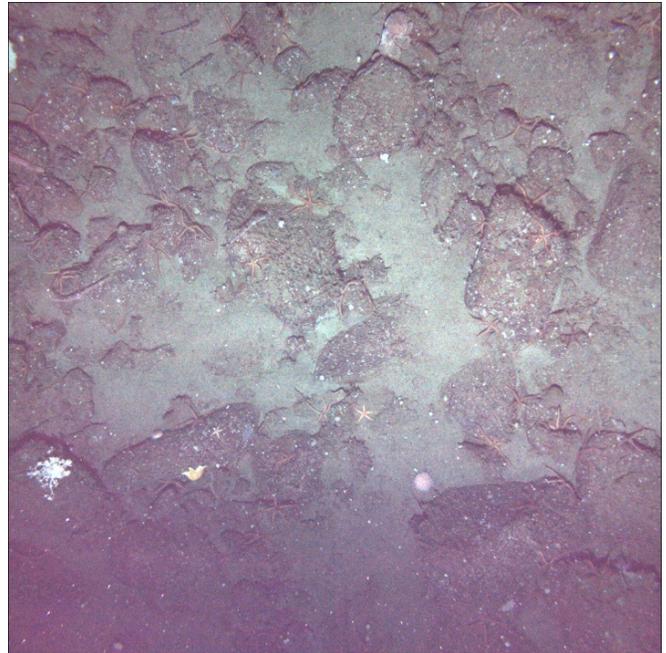
AUV006- Density of Fishes
(78 fishes/ 1,000 m²)



| Scientific Name | Common Name | Count |
|--------------------------------|-------------------------------|-------|
| Myxinidae | Unidentified hagfish | 14 |
| <i>Hydrolagus colliei</i> | Spotted ratfish | 1 |
| Agonidae | Unidentified poachers | 24 |
| Cottidae | Unidentified sculpins | 4 |
| <i>Glyptocephalus zachirus</i> | Rex sole | 1 |
| <i>Microstomus pacificus</i> | Dover sole | 6 |
| Osteichthyes | Unidentified fishes | 3 |
| <i>Sebastes diploproa</i> | Splitnose rockfish | 6 |
| <i>Sebastes melanostomus</i> | Blackgill rockfish | 5 |
| <i>Sebastes spp.</i> | Rockfish Unid. | 97 |
| Sebastomus | Unidentified White-spotted RF | 11 |
| <i>Sebastolobus spp.</i> | Unidentified thornyhead | 37 |

IMAGE GALLERY- AUV006

To the right, we see boulder / cobble (hard) habitat with two poachers (Agonidae), a basket star (*Gorgonocephalus eucnemis*) and two Plexuridae coral. We also see an unidentified octopus, sea stars and fragile urchins (*Allocentrotus fragilis*).



This photo shows Christmas tree black coral (*Antipathes dendrochristos*), a Sebastomus rockfish, and a basket star (*Gorgonocephalus eucnemis*) on boulder/ cobble (hard) habitat. Note the presence of Ophiocanthidae in large numbers.

This image shows mixed habitat (cobble and mud) with unidentified rockfish, an unidentified vase sponge, an *Asbestopluma* spp. (sponge), galatheid crab and a Christmas tree black coral (*Antipathes dendrochristos*).



These images below show anthropogenic marine debris in the form of aluminum cans and pot fishing gear.



DIVE NUMBER: AUV007

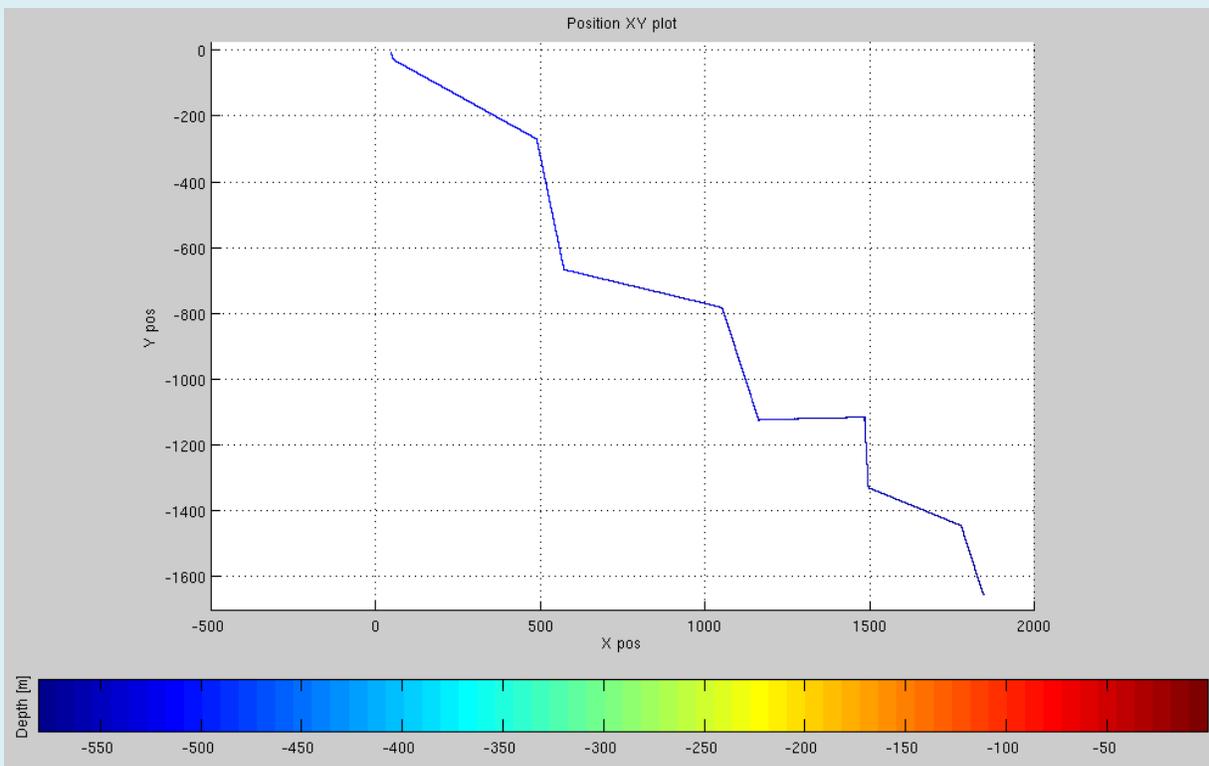
STATION OVERVIEW

| | |
|-----------------------------|--|
| Project | U.S. West Coast Deep Coral Cruise |
| Chief Scientist | M. Elizabeth Clarke |
| Contact Information | NMFS, NWFSC, elizabeth.clarke@noaa.gov |
| Purpose | Survey deep coral communities as Piggy Bank in the CINMS |
| Vessel | NOAA Ship <i>McArthur II</i> , Leg 3; <i>Lucille</i> AUV |
| Team | C. Whitmire, E. Fruh, J. Anderson, J. Taylor |
| Digital Still Photos | 2360 |
| Positioning System | Ship: GPS; AUV: DVL, gyrocompass, USBL |
| CTD Sensor | Yes |

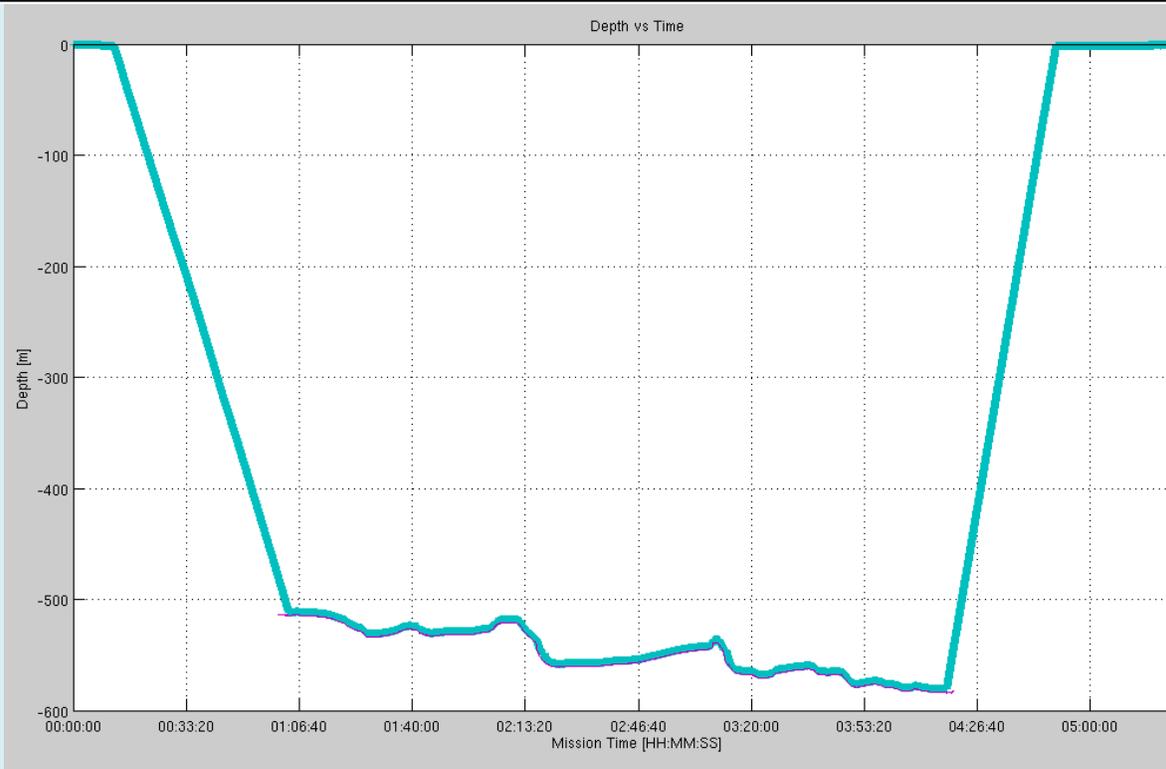
DIVE DATA

| | | | |
|--------------------------|--------------|------------------------|------------|
| Date | 30 June 2010 | Starting Latitude (N) | 33°55.14' |
| Maximum Bottom Depth (m) | 585 | Starting Longitude (W) | 119°27.39' |
| Start Time (UTC) | 05:05 | Ending Latitude (N) | 33°54.16' |
| End Time (UTC) | 09:11 | Ending Longitude (W) | 119°26.40' |

GENERAL LOCATION AND DIVE TRACK



Survey track of dive AUV007.

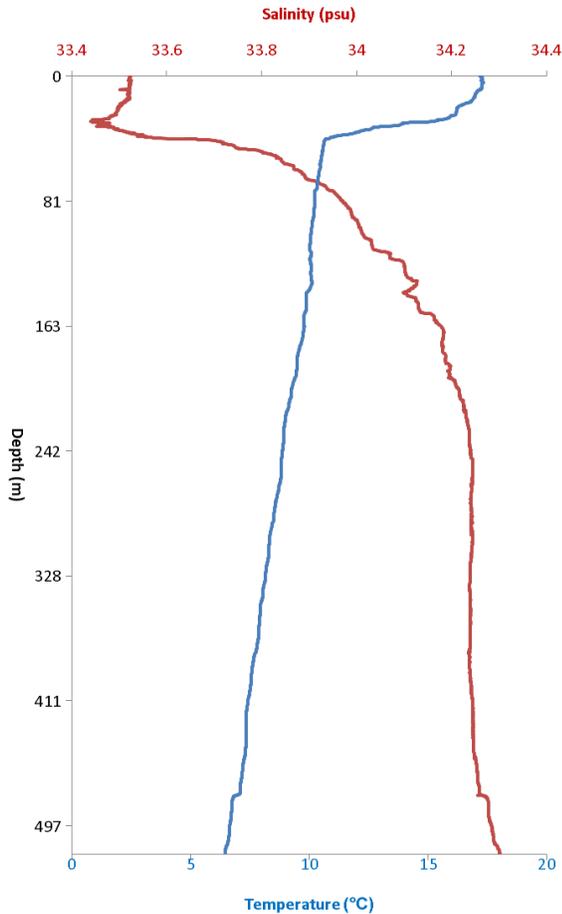


Depth track of dive AUV007 showing bottom in pink (—) and vehicle tracking bottom in teal (—).

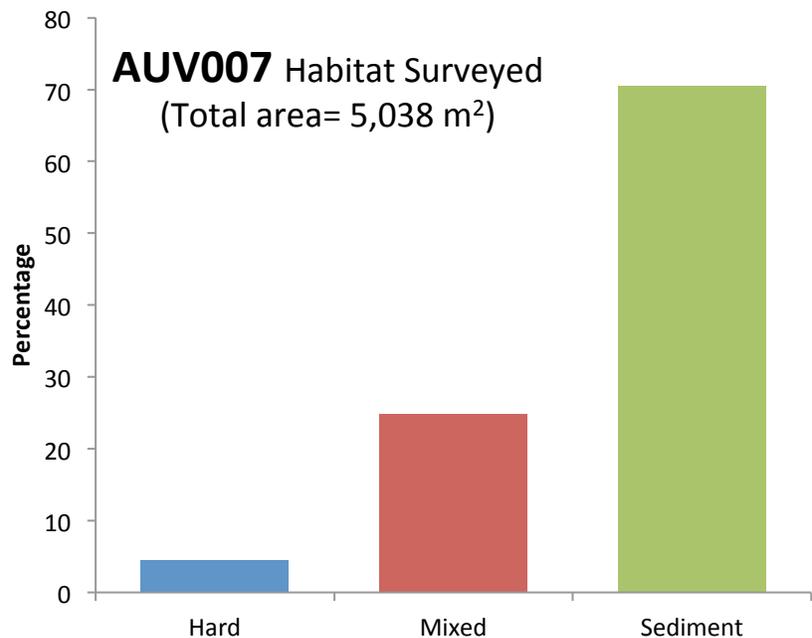
PHYSICAL ENVIRONMENT

The AUV was equipped with an onboard Sea-Bird model 49 FastCat CTD that collected temperature and salinity information throughout the AUV's descent as well as along the dive track. During the dive AUV007 descent, the temperature varied from 17.21 to 6.47°C and salinity varied from 33.5 to 34.3 (psu).

Dive AUV007 descent temperature and salinity profiles.



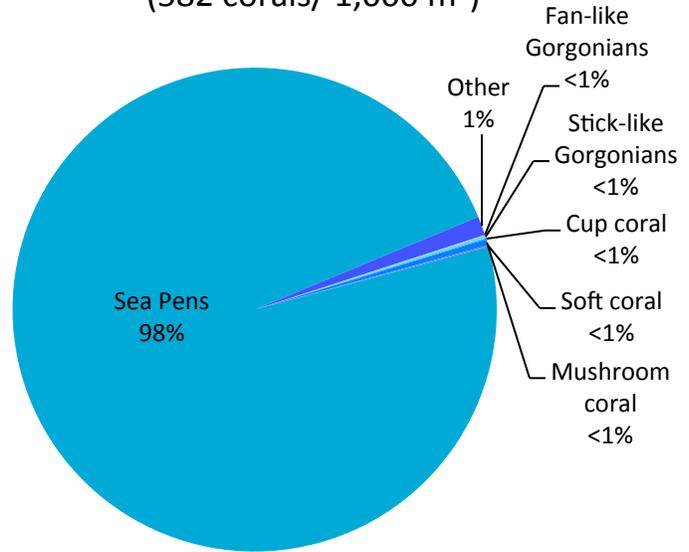
In total, 5,038 m² of sea floor were surveyed during dive AUV007 using the *Lucille* AUV deployed from the NOAA ship *McArthur II* on the Piggy Bank off southern California. Habitat types were classified as (1) Hard (5% of the total area surveyed), which included boulders, ridge and cobble; (2) Mixed (25% of the total area surveyed), which included mud appearing with rock, boulder or cobble; and (3) Sediment (70% of the total area surveyed), which consisted of mud. This mission was flown at an altitude of 3 meters.



BIOLOGICAL ENVIRONMENT: CORALS

A total of 2,933 individual corals were enumerated from the 1,124 frames sampled from dive AUV007 conducted on the Piggy Bank from the NOAA vessel *McArthur II*. They represented 10 taxonomic groups. An overall density of 582 corals per 1,000 m² of seafloor was estimated. Sea pens accounted for 98% of the overall coral density during this dive, and was predominantly an unidentified stick-like sea pen found on mud substrate. The sea pen category also contained *Umbellula lindahli*, *Anthoptilum grandiflorum*, and *Pennatula* spp. The other category, comprised of unidentified corals, accounted for 1% of the overall coral density. Fan-like gorgonians, stick-like gorgonians, cup corals, soft corals and *Anthomastus ritteri* each accounted for <1% of the overall coral density. These groups occurred on mixed or hard substrates.

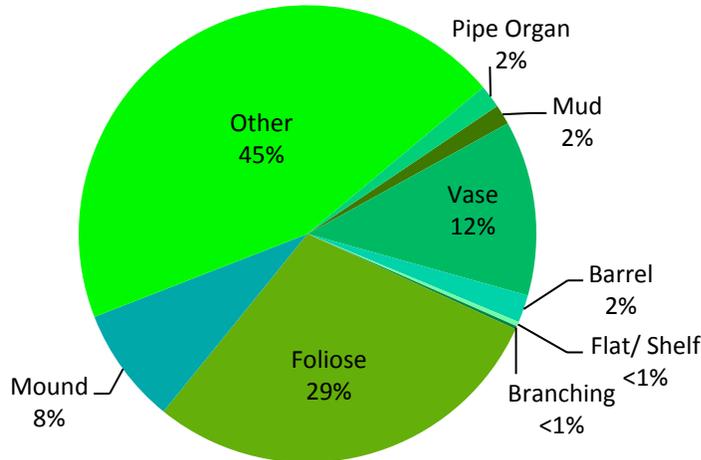
AUV007- Density of Corals
(582 corals/ 1,000 m²)



| Scientific Name | Common Name | Count |
|---------------------------------|-------------------------|-------|
| <i>Paragorgia</i> spp. | Sea fan | 1 |
| Plexauridae | Sea fan | 6 |
| <i>Anthomastus ritteri</i> | Mushroom coral | 12 |
| Caryophyllidae | Unidentified cup corals | 2 |
| <i>Clavularia</i> spp. | Soft coral | 3 |
| <i>Pennatula</i> spp. | Deep-sea sea pen | 80 |
| Pennatulacea | Unidentified sea pen | 2352 |
| <i>Anthoptilum grandiflorum</i> | Feather boa sea pen | 68 |
| <i>Umbellula lindahli</i> | Droopy sea pen | 372 |
| Anthozoa | Unidentified coral | 37 |

BIOLOGICAL ENVIRONMENT: SPONGES

AUV007- Density of Sponges
(182 sponges/ 1,000 m²)



A total of 921 individual sponges from 15 different taxonomic classifications were observed during the 1,124 frames sampled from dive AUV007 on Piggy Bank from the NOAA vessel *McArthur II*. An overall density of 182 sponges per 1,000 m² of seafloor was estimated. Unidentified and other (including *Asbestopluma* spp.) sponges were found to be the most abundant, accounting for 45% of the total density. Foliose sponges (including *Thenea muricata* and *Farrea occa*) made up 29% of the overall sponge density. Vase sponges, including *Heterochone calyx* and *Staurocalyptus* spp., accounted for

12% of the total density. Unidentified mound sponges (8%), unidentified pipe organ sponges (2%), mud covered sponges (2%) and barrel sponges (2%) were the next most abundant taxa. Unidentified flat/ shelf sponges and branching sponges each accounted for <1% of the overall density. Colors in the pie chart above match the list of sponge taxa following.

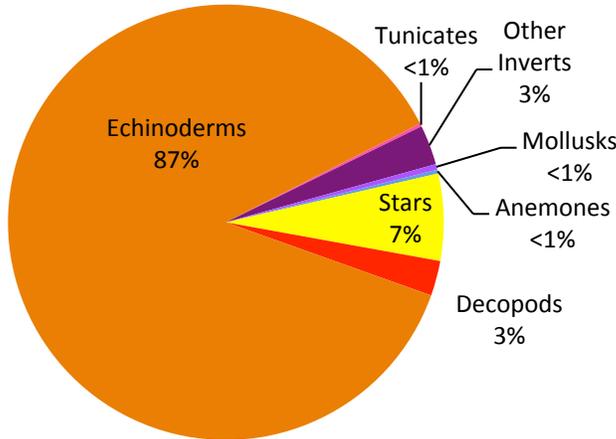
| Scientific Name | Common Name | Count |
|-----------------------------|-----------------------------------|-------|
| | Mud Covered | 13 |
| Porifera | Unidentified vase sponges | 96 |
| <i>Staurocalyptus</i> spp. | Unidentified vase sponge (yellow) | 2 |
| <i>Heterochone calyx</i> | Fingered goblet vase sponge | 16 |
| Porifera | Unidentified barrel sponges | 18 |
| Porifera | Unidentified upright flat sponges | 3 |
| Porifera | Unidentified branching sponge | 2 |
| Porifera | Unidentified foliose sponges | 6 |
| <i>Thenea muricata</i> | Foliose Sponge (clear) | 257 |
| <i>Farrea occa</i> | Lace (or cloud) foliose sponge | 4 |
| Porifera | Unidentified pipe organ sponge | 15 |
| Porifera | Unidentified small mound sponges | 27 |
| Porifera | Unidentified mound sponges | 49 |
| <i>Asbestopluma</i> spp. #1 | Pipe Cleaner Sponge | 93 |
| Porifera | Unidentified sponges | 320 |

BIOLOGICAL ENVIRONMENT: OTHER INVERTEBRATES

A total of 18,901 invertebrates representing 32 taxa were enumerated for dive AUV007 from the NOAA vessel *McArthur II* on the Piggy Bank. An overall density of 3,741 invertebrates per 1,000m² of seafloor was estimated. Echinoderms (the urchins, *Allocentrotus fragilis* and

AUV007- Density of Other Invertebrates

(3,741 invertebrates/ 1,000 m²)



Brisaster spp./ *Brissopsis* spp. and the cucumber *Pannychia moseleyi*) were the most abundant invertebrates representing 87% of the overall density. The sea star grouping was made up of 14 genera or species pairings, including *Ceramaster* spp., a *Myxoderma platycanthum*-like star and *Brisengella* spp., and represented 7% of the overall invertebrate density. This percentage did not include individuals from the family Ophiocanthidae, which we were unable to accurately count. Decapods, comprised of galatheid crabs (squat lobsters), unidentified

crabs and unidentified shrimp accounted for 3% of the invertebrate density. The other group, which included the abundant benthic siphonophore, *Dromalia alexandri*, accounted for 3% of the overall density. Anemones (<1%, including *Liponema brevicornis*), mollusks (<1%, *Acesta sphoni* (a deepwater clam), unidentified octopus and nudibranchs), and tunicates (<1%) were the remaining groupings encountered in this dive. Invertebrates were distributed throughout all habitat types. The pie diagram colors match with the list of invertebrate taxa below.

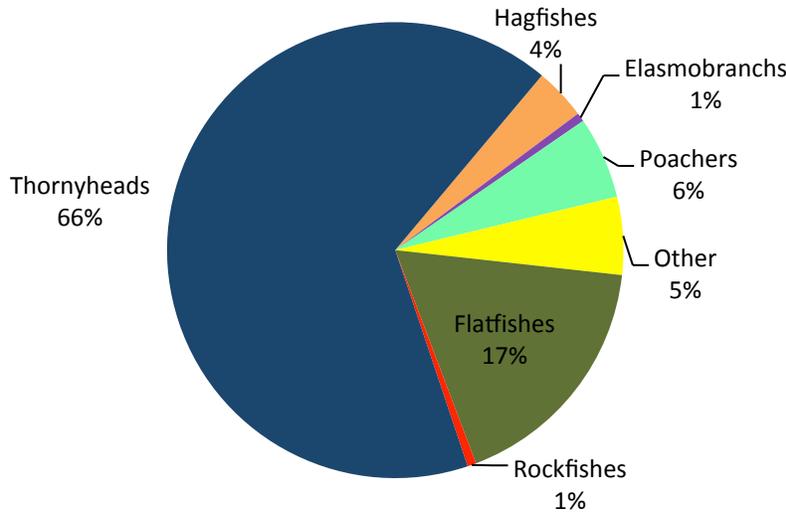
Characterization of Deep-sea Coral Communities

Area: Piggy Bank

| Scientific Name | Common Name | Count |
|--|---|-------|
| Asteroidea | Unidentified Sea star | 596 |
| <i>Gorgonocephalus eucnemis</i> | Basket Star | 1 |
| <i>Rathbunaster californicus</i> | Deep-sea sunflower star | 15 |
| <i>Ceramaster</i> spp. | Cookie star | 79 |
| <i>Pteraster</i> spp. | Slime star | 19 |
| <i>Thrissacanthius penicillatus</i> | Carpet star | 24 |
| Asteroidea | Nearchaster/Cheiraster spp. | 1 |
| Asteroidea | <i>Myxoderma platycanthum</i> -like | 385 |
| <i>Crossaster</i> spp./ <i>Heterozonius</i> spp. | Unidentified deep-sea sunstar | 1 |
| <i>Hippasteria</i> spp. | Unidentified spiny star | 31 |
| <i>Zoroaster evermanni</i> | Slender star | 1 |
| <i>Brisingella</i> spp. | Lacy-armed star | 57 |
| <i>Dipsacaster eximius</i> | Broad sand star | 4 |
| Asteroidea | Unidentified mud star (<i>Ctenodiscus</i> spp.?) | 3 |
| Galatheoidea | Unidentified Galtheid crab | 35 |
| Decapoda | Unidentified shrimp | 442 |
| Decapoda | Unidentified crab | 12 |
| <i>Psolus squamatus</i> | White-scaled cucumber | 122 |
| <i>Parastichopus</i> spp. | Giant Orange/Giant California cucumber | 8 |
| <i>Pannychia moseleyi</i> | Sloppy cucumber | 4194 |
| Holothuroidea | Unidentified sea cucumber | 2 |
| <i>Brisaster</i> spp./ <i>Brissopsis</i> spp. | Unidentified mud urchin | 1062 |
| <i>Allocentrotus fragilis</i> | Fragile red sea urchin | 11009 |
| <i>Florometra serratissima</i> | Feather star crinoid | 11 |
| <i>Liponema brevicornis</i> | Tentacle shedding anemone | 26 |
| Actinidae | Unidentified anemone | 28 |
| Tunicata | Unidentified tunicates | 43 |
| Unidentified invertebrate | Unidentified invertebrate | 8 |
| <i>Acesta sphoni</i> | Sphon's giant file clam | 52 |
| Cephalopoda | Unidentified octopus | 4 |
| Opisthobranchia | Unidentified nudibranch | 23 |
| <i>Dromalia alexandri</i> | Benthic siphonophore | 549 |

BIOLOGICAL ENVIRONMENT: FISHES

AUV007- Density of Fishes
(65 fishes/ 1,000 m²)



A total of 326 fishes were enumerated, representing 12 different taxonomic groupings during dive AUV007 on Piggy Bank from the NOAA ship *McArthur II*. An overall density of 65 fishes per 1,000 m² was estimated. The *Sebastolobus* spp. grouping, including *Sebastolobus alascanus*, made up 66% of the total density of fishes for dive AUV007. Flatfishes (17%, represented by Dover sole (*Microstomus pacificus*) and

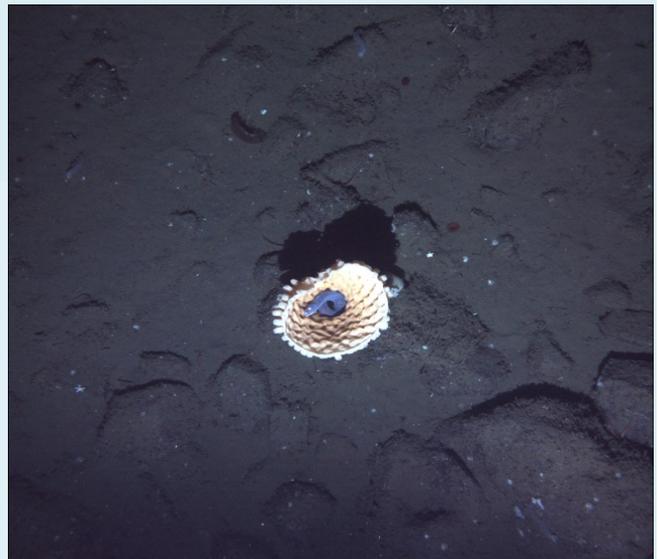
rex sole (*Glyptocephalus zachirus*)) were the next largest density. Poachers (6%, family Agonidae), other (5%, including Liparidae, Macrouridae and unidentified fishes) and hagfishes (4%, Myxinidae) from accounted for portions of the overall density. Rockfishes (*Sebastes melanostomus*) and elasmobranchs (*Raja rhina* and Scyliorhinidae) each accounted for 1% of the overall density. The pie diagram colors match with the list of fish taxa below.

| Scientific Name | Common Name | Count |
|--------------------------------|-------------------------|-------|
| Myxinidae | Unidentified hagfish | 12 |
| <i>Raja rhina</i> | Longnose skate | 1 |
| Scyliorhinidae | Unidentified catshark | 1 |
| Agonidae | Unidentified poachers | 19 |
| Macrouridae | Unidentified grenadiers | 4 |
| Liparidae | Unidentified snailfish | 8 |
| <i>Glyptocephalus zachirus</i> | Rex sole | 1 |
| <i>Microstomus pacificus</i> | Dover sole | 56 |
| Osteichthyes | Unidentified fishes | 6 |
| <i>Sebastes melanostomus</i> | Blackgill rockfish | 2 |
| <i>Sebastolobus alascanus</i> | Shortspine thornyhead | 3 |
| <i>Sebastolobus</i> spp. | Unidentified thornyhead | 213 |

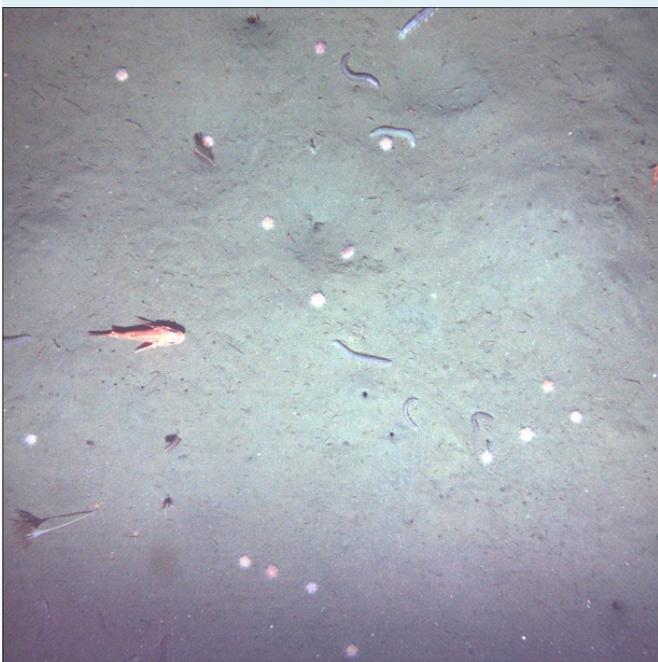
IMAGE GALLERY- AUV007



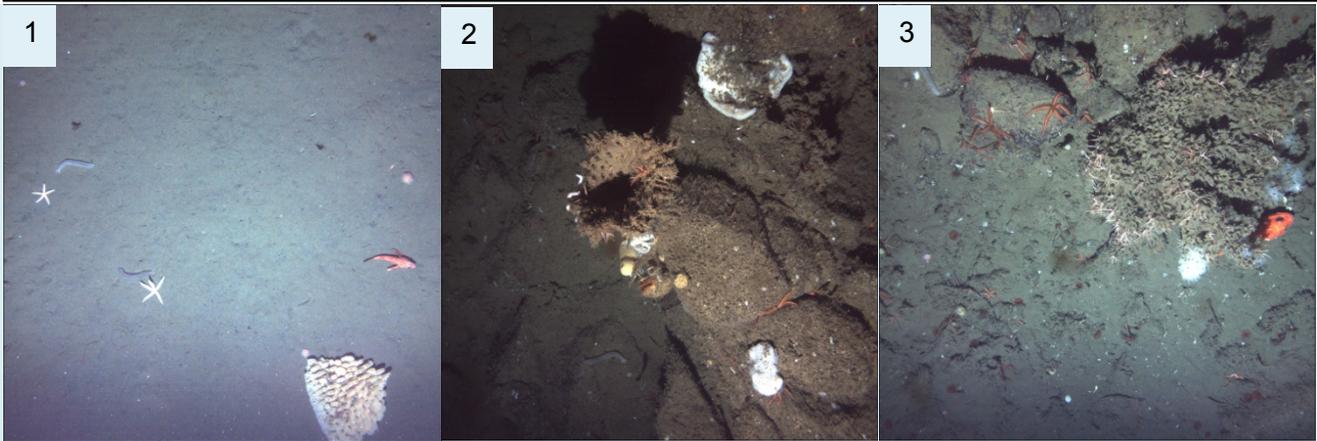
This photo shows vase sponges, barrel sponges and *Umbellula lindahli* on sediment substrate. You can also find a benthic siphonophore (*Dromalia alexandri*), tunicates and *Pannychia moseleyi* sea cucumbers. A thornyhead, *Sebastolobus* spp. rests near the sponges.



This photo shows a sponge, *Heterochrone calyx*, with a hagfish (Myxinidae) taking shelter in the cone. On the mixed substrate (boulder and mud), one can also observe a sea pen (*Anthoptilum grandiflorum*) and sea cucumbers (*Pannychia moseleyi*).



This image shows the unidentified stick-like sea pen that was prevalent throughout AUV007. Also found on the sediment substrate were *Umbellula lindahli*, *Pannychia moseleyi*, *Allocentrotus fragilis* and a shortspine thornyhead (*Sebastolobus alascanus*).



The three images above all show dead or dying sponges. The first photo shows a broken section of *Heterochone calyx*. The second shows a mud covered sponge. The third shows a mostly dead *Farrea occa*, but it still provided shelter for a shortspine thornyhead.

DIVE NUMBER: AUV008

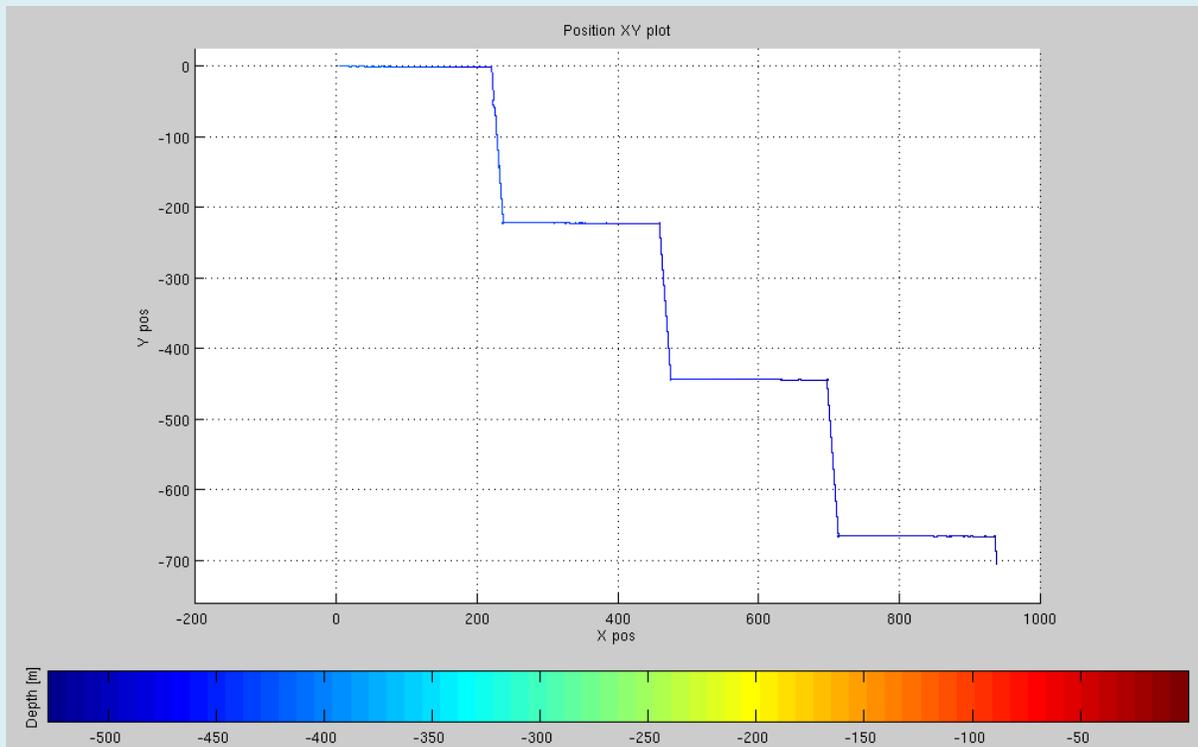
STATION OVERVIEW

| | |
|-----------------------------|--|
| Project | U.S. West Coast Deep Coral Cruise |
| Chief Scientist | M. Elizabeth Clarke |
| Contact Information | NMFS, NWFSC, elizabeth.clarke@noaa.gov |
| Purpose | Survey deep coral communities as Piggy Bank in the CINMS |
| Vessel | NOAA Ship <i>McArthur II</i> , Leg 3; <i>Lucille</i> AUV |
| Team | C. Whitmire, E. Fruh, J. Anderson, J. Taylor |
| Digital Still Photos | 2056 |
| Positioning System | Ship: GPS; AUV: DVL, gyrocompass, USBL |
| CTD Sensor | Yes |

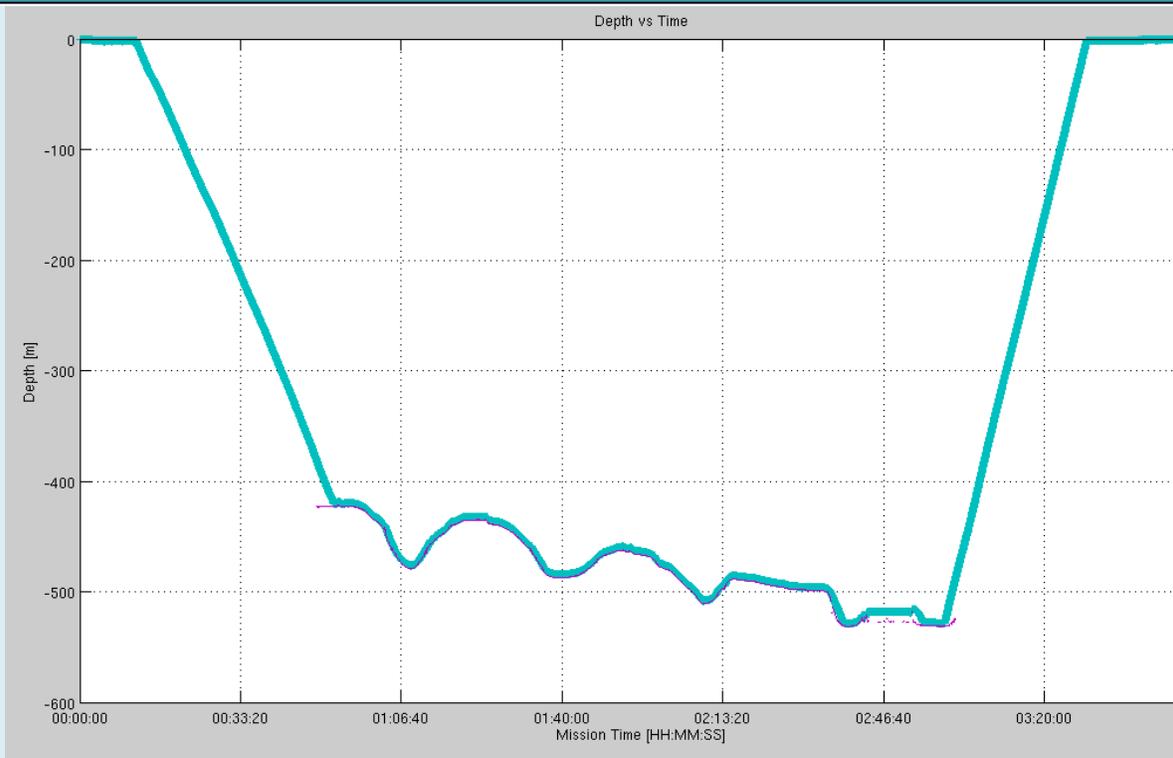
DIVE DATA

| | | | |
|--------------------------|--------------|------------------------|------------|
| Date | 01 July 2010 | Starting Latitude (N) | 33°54.77' |
| Maximum Bottom Depth (m) | 532 | Starting Longitude (W) | 119°27.76' |
| Start Time (UTC) | 03:55 | Ending Latitude (N) | 33°54.28' |
| End Time (UTC) | 06:43 | Ending Longitude (W) | 119°26.99' |

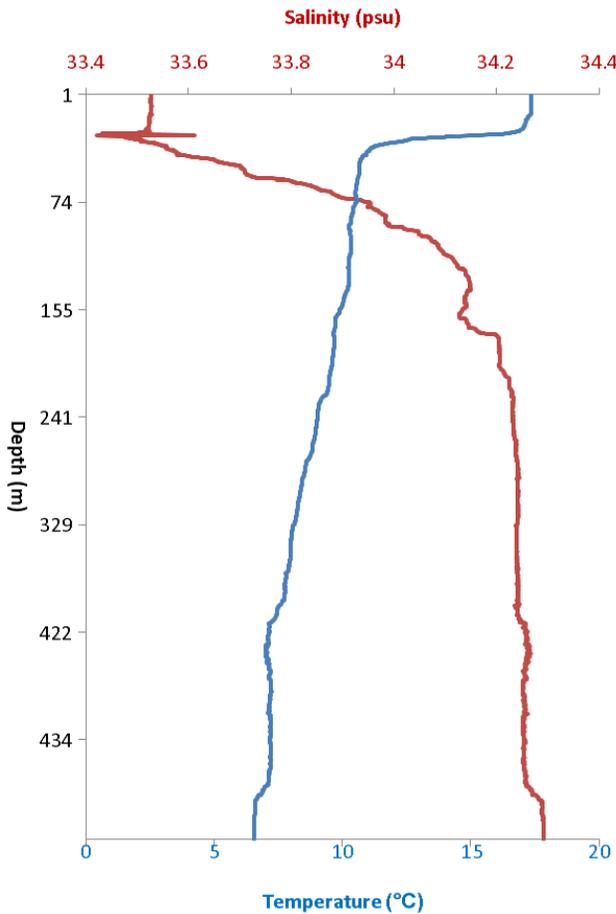
GENERAL LOCATION AND DIVE TRACK



Survey track of dive AUV008.



Depth track of dive AUV008 showing bottom in pink (—) and vehicle tracking bottom in teal (—).

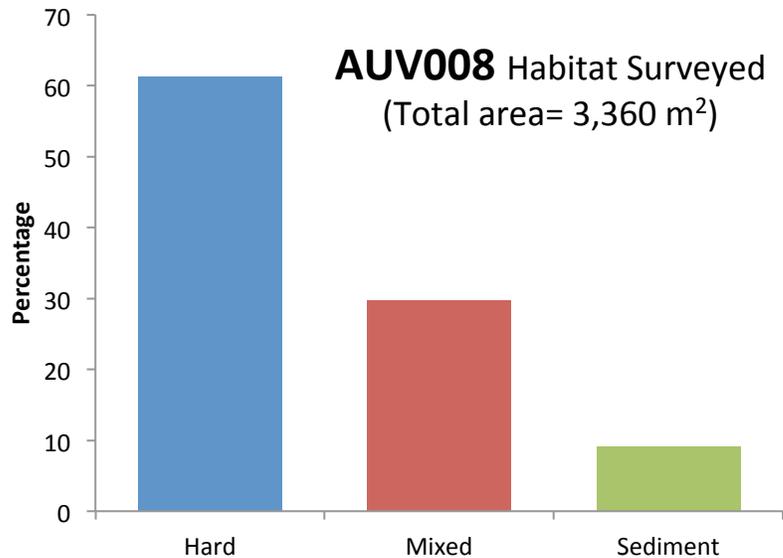


PHYSICAL ENVIRONMENT

The AUV was equipped with an onboard Sea-Bird model 49 FastCat CTD that collected temperature and salinity information throughout the AUV’s descent as well as along the dive track. During the dive AUV008 descent, the temperature varied from 17.36 to 6.6°C and salinity varied from 33.5 to 34.3 (psu) (Figure x).

Dive AUV008 descent temperature and salinity profiles.

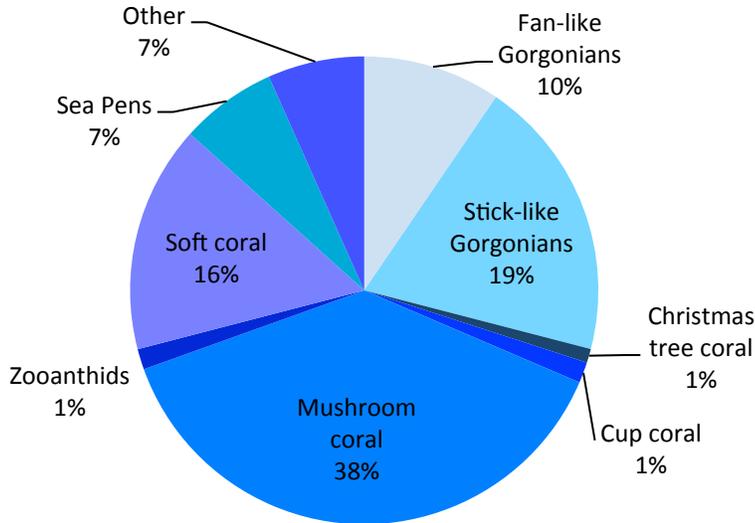
In total, 3,360 m² of sea floor were surveyed during dive AUV008 using the *Lucille* AUV deployed from the NOAA ship *McArthur II* on the Piggy Bank off southern California. Habitat types were classified as (1) Hard (61% of the total area surveyed), which included boulders, flat rock, ridge and cobble; (2) Mixed (30% of the total area surveyed), which included mud appearing with rock, boulder or cobble; and (3) Sediment (9% of the total area surveyed), which consisted of mud. This mission was flown at an altitude of 3 meters.



BIOLOGICAL ENVIRONMENT: CORALS

AUV008- Density of Corals

(63 corals/ 1,000 m²)



A total of 210 individual corals were enumerated from the 750 frames sampled from dive AUV008 conducted on the Piggy Bank from the NOAA vessel *McArthur II*. They represented 13 taxonomic groups. An overall density of 63 corals per 1,000 m² of seafloor was estimated. Mushroom corals (*Anthomastus ritteri*) accounted for 38% of the overall coral density. Stick-like gorgonians (19%, Plexuridae and *Swiftia* spp.) and soft corals (16%, *Clavularia* spp.) were the next most abundant groupings. Fan-like gorgonians (*Paragorgia* spp., *Parastenella* spp., and *Plumerella*

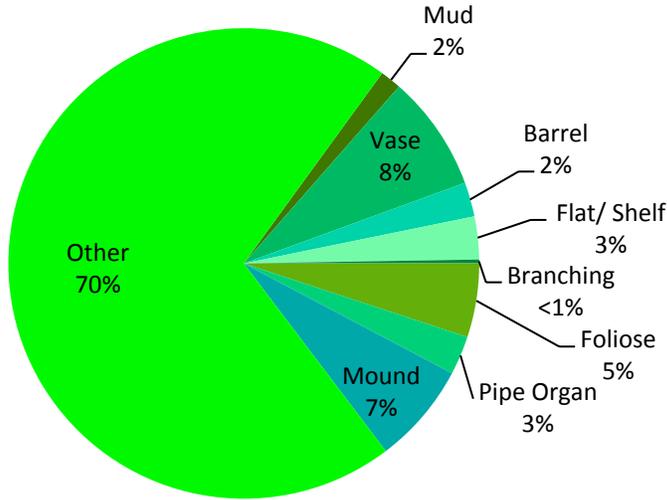
spp.) accounted for 10% of the overall coral density. Sea pens (*Anthoptilum grandiflorum*) and other unidentified corals each accounted for 7% of the total density. Zooanthids, cup corals (*Lophelia* spp., and Caryophyllidae) and Christmas tree black coral (*Antipathes dendrochristos*) each made up 1% of the overall coral density. Other than sea pens, these coral groups occurred on mixed or hard substrates. Colors in the pie chart above match the list of coral taxa following.

| Scientific Name | Common Name | Count |
|----------------------------------|-----------------------------|-------|
| <i>Paragorgia</i> spp. | Sea fan | 11 |
| <i>Parastenella</i> spp. | Primnoid | 6 |
| <i>Plumerella</i> spp. | Primnoid | 3 |
| Plexauridae | Sea fan | 37 |
| <i>Swiftia</i> spp. | Sea fan | 4 |
| <i>Antipathes dendrochristos</i> | Christmas tree black coral | 2 |
| <i>Lopheila</i> spp. | White cup coral | 2 |
| Caryophyllidae | Unidentified cup corals | 1 |
| <i>Anthomastus ritteri</i> | Mushroom coral | 80 |
| Zoantharia | Unidentified zooanthids | 3 |
| <i>Clavularia</i> spp. | Soft coral | 33 |
| <i>Anthoptilum grandiflorum</i> | Feather boa sea pen | 14 |
| Anthozoa | Unidentified coral/ sea pen | 14 |

BIOLOGICAL ENVIRONMENT: SPONGES

A total of 3,563 individual sponges from 19 different taxonomic classifications were observed during the 750 frames sampled from dive AUV008 on Piggy Bank from the NOAA vessel *McArthur II*. An overall density of 1,060 sponges per 1,000 m² of seafloor was estimated.

AUV008- Density of Sponges
(1,060 sponges/ 1,000 m²)



Unidentified and other (including *Asbestopluma* spp.) sponges were found to be the most abundant, accounting for 70% of the total density. Vase sponges (including *Staurocalyptus* spp. and *Heterochone calyx*) made up 8% of the overall sponge density. Unidentified mound sponges accounted for 7% of the total density. Foliose sponges (5%, including *Thenea muricata* and *Farrea occa*), unidentified pipe organ sponges (3%, possibly *Oceanapia* spp.), and Flat/ shelf sponges (2%, including *Mycale* spp.), mud covered sponges

(2%) and barrel sponges (2%) were the next most abundant taxa. Branching sponges accounted for <1% of the overall density. Colors in the pie chart above match the list of sponge taxa following.

| Scientific Name | Common Name | Count |
|-----------------------------|-----------------------------------|-------|
| Mud Covered | | 52 |
| Porifera | Unidentified vase sponges | 225 |
| <i>Staurocalyptus</i> spp. | Unidentified vase sponge (yellow) | 12 |
| <i>Heterochone calyx</i> | Fingered goblet vase sponge | 47 |
| Porifera | Unidentified barrel sponges | 84 |
| Porifera | Unidentified upright flat sponges | 12 |
| Porifera | Unidentified shelf sponges | 5 |
| <i>Mycale</i> spp. | Upright flat sponge (yellow) | 88 |
| Porifera | Unidentified branching sponges | 2 |
| Porifera | Unidentified branching sponge | 7 |
| <i>Thenea muricata</i> | Foliose Sponge (clear) | 164 |
| <i>Farrea occa</i> | Lace (or cloud) foliose sponge | 17 |
| Porifera | Unidentified pipe organ sponge | 95 |
| Porifera | Unidentified small mound sponges | 6 |
| Porifera | Unidentified mound sponges | 242 |
| Porifera | Unidentified sponges (blue/white) | 84 |
| <i>Asbestopluma</i> spp. #1 | Pipe Cleaner Sponge | 100 |
| <i>Asbestopluma</i> spp. #2 | Predatory sponge (clear) | 6 |
| Porifera | Unidentified sponges | 2315 |

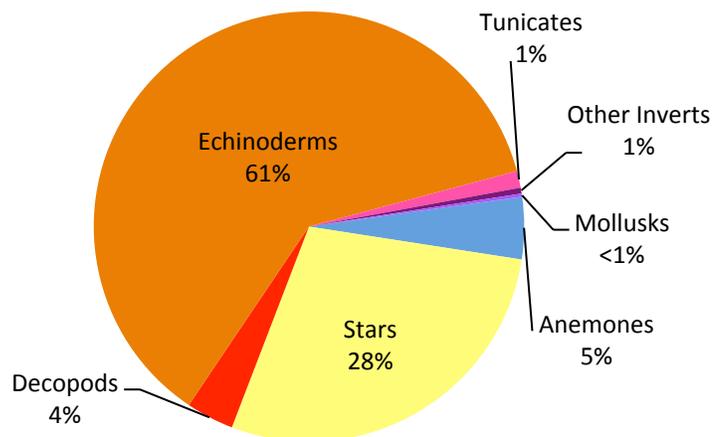
BIOLOGICAL ENVIRONMENT: OTHER INVERTEBRATES

A total of 5,179 invertebrates representing 29 taxa were enumerated for dive AUV008 from the NOAA vessel *McArthur II* on the Piggy Bank. An overall density of 1,541 invertebrates per 1,000 m² of seafloor was estimated. Echinoderms (the urchins, *Allocentrotus fragilis* and *Brisaster* spp./ *Brissopsis* spp. and the cucumbers *Psolus squamatus* and *Pannychia moseleyi*) were the most abundant invertebrates representing 61% of the overall density. The sea star grouping was made up of 12 genera or species pairings, including

Rathbunaster californicus, *Thrissacanthius penicillatus* and *Nearchaster/Cheiraster* spp.; and represented 28% of the overall invertebrate density. This percentage did not include individuals from the family Ophiocanthidae, which were present, but we were unable to get an

AUV008- Density of Other Invertebrates

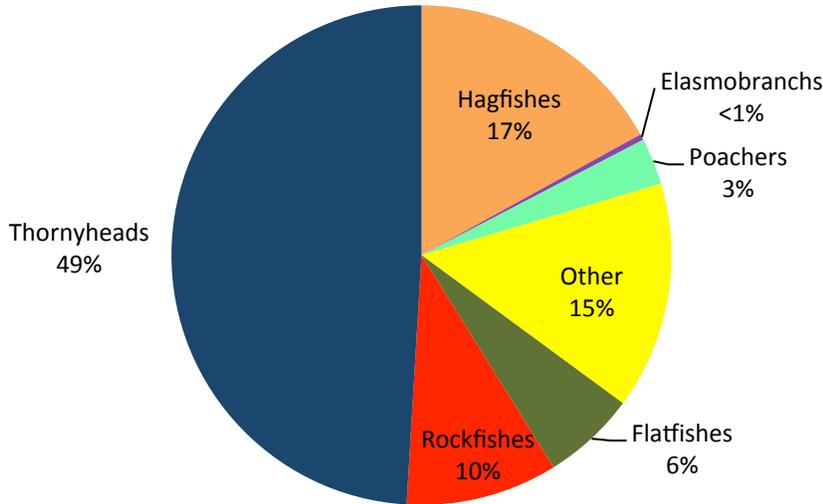
(1,541 invertebrates/ 1,000 m²)



accurate count. Decapods, comprised of galatheid crabs (squat lobsters), unidentified crabs and unidentified shrimp accounted for 4% of the invertebrate density. Anemones (5%, including *Liponema brevicornis*), mollusks (<1%, unidentified octopus and nudibranchs), and tunicates (1%) were groupings encountered in this dive. The other group, which included the benthic siphonophore, *Dromalia alexandri*, accounted for 1% of the overall density. Invertebrates were distributed throughout all habitat types. The pie diagram colors match with the list of invertebrate taxa below.

| Scientific Name | Common Name | Count |
|--|---|-------|
| Asteroidea | Unidentified Sea star | 835 |
| <i>Rathbunaster californicus</i> | Deep-sea sunflower star | 220 |
| <i>Ceramaster</i> spp. | Cookie star | 3 |
| <i>Pteraster</i> spp. | Slime star | 23 |
| <i>Thrissacanthius penicillatus</i> | Carpet star | 134 |
| Asteroidea | <i>Nearchaster/Cheiraster</i> spp. | 202 |
| <i>Solaster</i> spp. | Deep-sea sunstar | 4 |
| <i>Crossaster</i> spp./ <i>Heterozonius</i> spp. | Unidentified deep-sea sunstar | 23 |
| <i>Hippasteria</i> spp. | Unidentified spiny star | 4 |
| <i>Zoroaster evermanni</i> | Slender star | 2 |
| <i>Brisingella</i> spp. | Lacy-armed star | 1 |
| Asteroidea | Unidentified mud star (<i>Ctenodiscus</i> spp.?) | 19 |
| Galatheoidea | Unidentified Galatheid crab | 164 |
| Decapoda | Unidentified crab | 3 |
| Decapoda | Unidentified shrimp | 19 |
| <i>Psolus squamatus</i> | White-scaled cucumber | 401 |
| <i>Parastichopus</i> spp. | Giant Orange/Giant California cucumber | 164 |
| <i>Pannychia moseleyi</i> | Sloppy cucumber | 555 |
| Holothuroidea | Unidentified sea cucumber | 5 |
| <i>Brisaster</i> spp./ <i>Brissopsis</i> spp. | Unidentified mud urchin | 494 |
| <i>Allocentrotus fragilis</i> | Fragile red sea urchin | 1504 |
| <i>Florometra serratissima</i> | Feather star crinoid | 58 |
| <i>Liponema brevicornis</i> | Tentacle shedding anemone | 74 |
| Actinidae | Unidentified anemone | 168 |
| Tunicata | Unidentified tunicates | 65 |
| Unidentified invertebrate | Unidentified invertebrate | 9 |
| Cephalopoda | Unidentified octopus | 7 |
| Opisthobranchia | Unidentified nudibranch | 5 |
| <i>Dromalia alexandri</i> | Benthic siphonophore | 14 |

AUV008- Density of Fishes
(79 fishes/ 1,000 m²)



BIOLOGICAL ENVIRONMENT: FISHES

A total of 26 fishes were enumerated, representing 9 different taxonomic groupings during dive AUV008 on Piggy Bank from the NOAA ship *McArthur II*. An overall density of 78 fishes per 1,000 m² was estimated. The *Sebastolobus* spp. grouping made up 49% of the total density of fishes for dive AUV008. Hagfishes (17%) and other unidentified fishes (15%, including family

Cottidae) were the next most abundant groupings. Rockfishes, including *Sebastes melanostomus*, accounted for 10% of the overall fish density. Flatfishes (6%, represented by Dover sole (*Microstomus pacificus*), and deep-sea sole (*Embassichthys bathybius*)), poachers (3%, family Agonidae) and elasmobranchs (<1%, represented by *Raja rhina*) were the remaining fish groupings. The pie diagram colors match with the list of fish taxa below.

| Scientific Name | Common Name | Count |
|------------------------------|-------------------------|-------|
| Myxinidae | Unidentified hagfish | 45 |
| <i>Raja rhina</i> | Longnose skate | 1 |
| Agonidae | Unidentified poachers | 8 |
| Cottidae | Unidentified sculpins | 1 |
| <i>Microstomus pacificus</i> | Dover sole | 14 |
| Osteichthyes | Unidentified fishes | 38 |
| <i>Sebastes melanostomus</i> | Blackgill rockfish | 9 |
| <i>Sebastes spp.</i> | Rockfish Unid. | 17 |
| <i>Sebastolobus spp.</i> | Unidentified thornyhead | 130 |

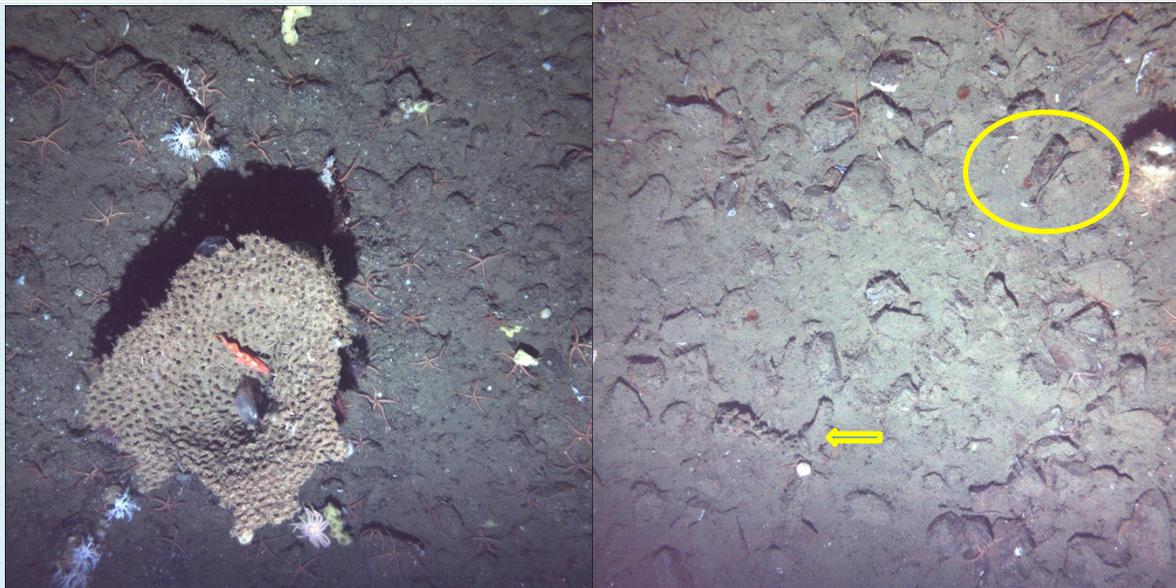
IMAGE GALLERY- AUV008



The image to the left shows ridge and cobble (hard) habitat, offering an attachment for *Farrea occa*, unidentified sponges and unidentified anemones. The rocks are also providing shelter for a blackgill rockfish (*Sebastes melanostomus*).

The image to the right shows *Mycale* spp. sponges, unidentified vase sponges and mound sponges. A Dover sole (*Microstomus pacificus*) and a deep-sea sole (*Embassichthys bathybius*) take cover among the sponges. *Psolus squamatus* cucumbers and *Rathbunaster californicus* sea stars are also present.





These images show stresses in the Piggy Bank environment, the left image shows a mud covered vase sponge that is possibly dead or dying. The right image shows a brown glass bottle and the broken bottom of a vase sponge.

DIVE NUMBER: AUV009

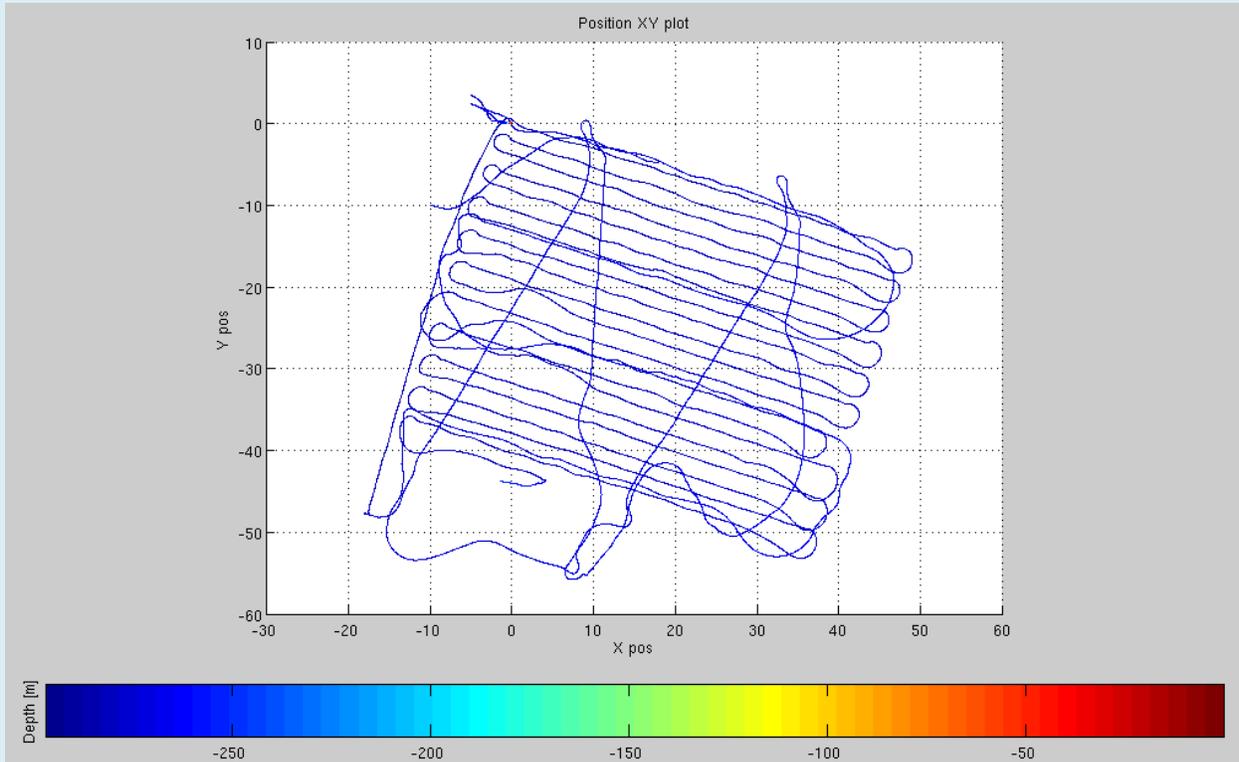
STATION OVERVIEW

| | |
|-----------------------------|--|
| Project | U.S. West Coast Deep Coral Cruise |
| Chief Scientist | M. Elizabeth Clarke |
| Contact Information | NMFS, NWFSC, elizabeth.clarke@noaa.gov |
| Purpose | Survey deep coral communities as Piggy Bank in the CINMS |
| Vessel | NOAA Ship <i>McArthur II</i> , Leg 3; <i>Lucille</i> AUV |
| Team | C. Whitmire, E. Fruh, J. Anderson, J. Taylor |
| Digital Still Photos | 2529 |
| Positioning System | Ship: GPS; AUV: DVL, gyrocompass, USBL |
| CTD Sensor | Yes |

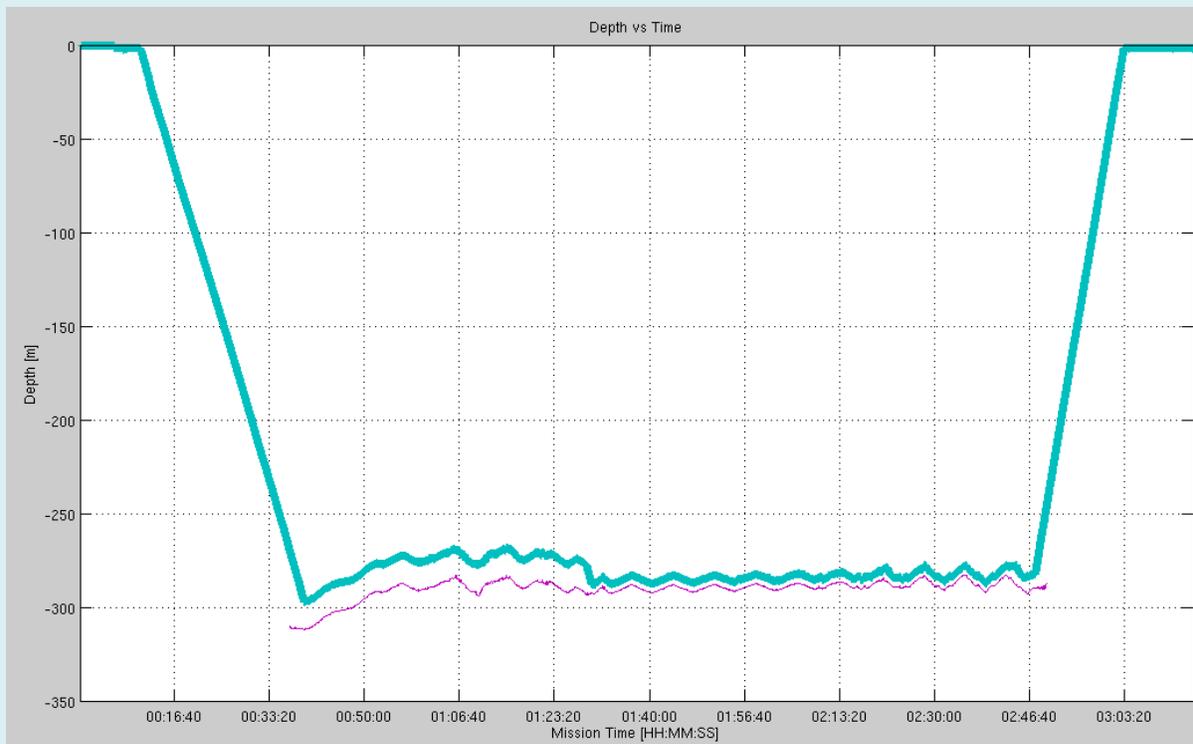
DIVE DATA

| | | | |
|--------------------------|--------------|------------------------|------------|
| Date | 01 July 2010 | Starting Latitude (N) | 33°55.28' |
| Maximum Bottom Depth (m) | 298 | Starting Longitude (W) | 119°28.86' |
| Start Time (UTC) | 10:08 | Ending Latitude (N) | 33°55.25' |
| End Time (UTC) | 12:45 | Ending Longitude (W) | 119°28.85' |

GENERAL LOCATION AND DIVE TRACK



Survey track for dive AUV009. This dive included a multibeam survey and a photo-mosaic.

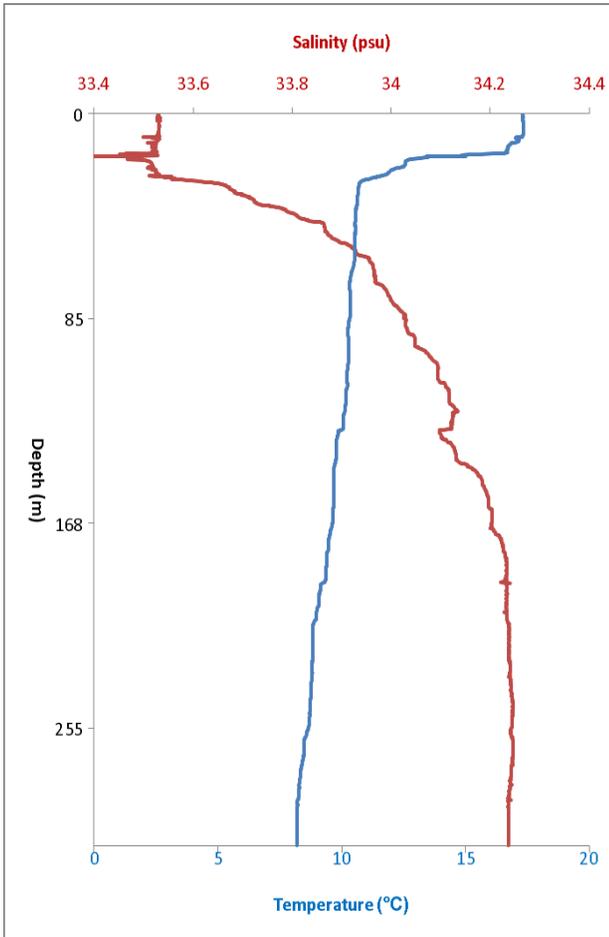


Depth track of dive AUV009 showing bottom in pink (—) and vehicle tracking bottom in teal (—).

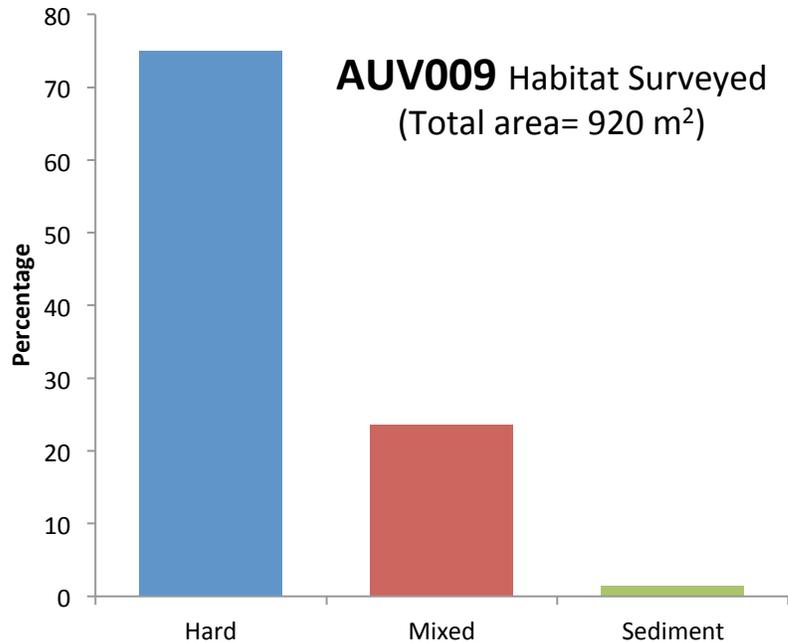
PHYSICAL ENVIRONMENT

The AUV was equipped with an onboard Sea-Bird model 49 FastCat CTD that collected temperature and salinity information throughout the AUV's descent as well as along the dive track. During the dive AUV009 descent, the temperature varied from 17.32 to 8.2°C and salinity varied from 33.5 to 34.2 (psu) (Figure x).

Dive AUV009 descent temperature and salinity profiles.

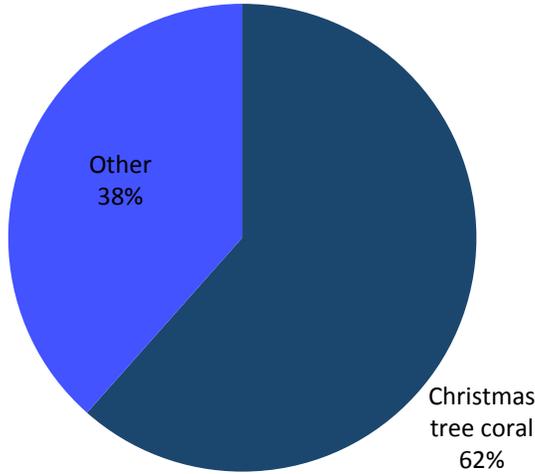


In total, 920 m² of sea floor were surveyed during dive AUV009 using the *Lucille* AUV deployed from the NOAA ship *McArthur II* on the Piggy Bank off southern California. Habitat types were classified as (1) Hard (75% of the total area surveyed), which included boulders, ridge and cobble; (2) Mixed (24% of the total area surveyed), which included mud appearing with rock, boulder or cobble; and (3) Sediment (1% of the total area surveyed), which consisted of mud. This mission was flown at an altitude of 5 m.



BIOLOGICAL ENVIRONMENT: CORALS

AUV009- Density of Corals
(28 corals/ 1,000 m²)



A total of 26 individual corals were enumerated from the 72 frames sampled from dive AUV009 conducted on the Piggy Bank from the NOAA ship *McArthur II*. This mission was conducted at an altitude of 5 meters above the seafloor. This distance did not allow for the precise level of identification of individual organisms found with the other dives. Corals were counted, allowing us to estimate a coral density of 28 corals per 1,000 m². The taxa encountered were Christmas tree black coral (*Antipathes dendrochristos*), which comprised 62% of the overall density, and unidentified corals, which accounted for 38% of the

overall density. Cup corals (Caryophyllidae) were observed in two frames from this dive and their presence was noted, however, enumeration proved impossible due to the altitude. The pie diagram colors match with the list of coral taxa below.

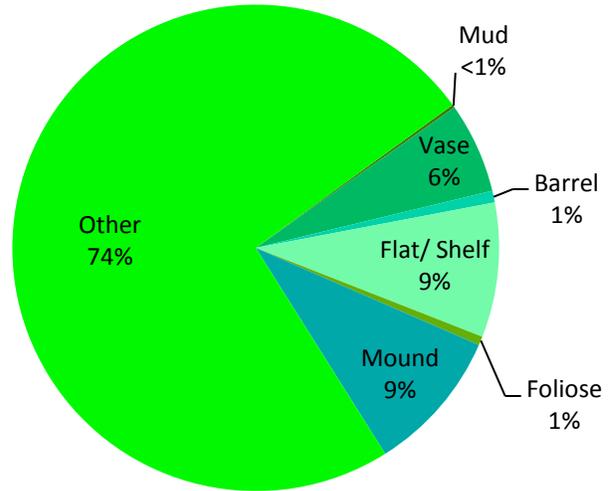
| Scientific Name | Common Name | Count |
|----------------------------------|-----------------------------|----------|
| <i>Antipathes dendrochristos</i> | Christmas tree black coral | 16 |
| Caryophyllidae | Unidentified cup corals | presence |
| Anthozoa | Unidentified coral/ sea pen | 10 |

Dive AUV009 was designed to include both a multi-beam survey at 15 m altitude and a dense photographic survey at 5 m altitude. We counted the fauna in a non-overlapping subset from the photo mosaic portion of the dive. This altitude was not ideal for species enumeration, but allowed for gross identification and classification of habitat, invertebrates and fishes.

**BIOLOGICAL ENVIRONMENT:
SPONGES**

A total of 514 individual sponges were enumerated from the 72 frames sampled from dive AUV009 conducted on the Piggy Bank from the NOAA ship *McArthur II*. This allowed us to estimate an overall sponge density of 558 sponges per 1,000 m². This mission was conducted at an altitude of 5 meters above the seafloor. This distance did not allow for the same level of identification of individual organisms found with the other dives. Unidentified sponges (including *Asbestopluma* spp.) accounted for

AUV009- Density of Sponges
(558 sponges/ 1,000 m²)



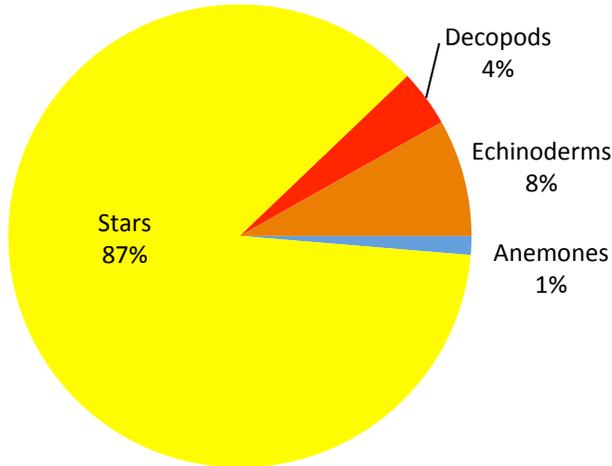
74% of the overall sponge density. Mound sponges and flat/ shelf sponges each accounted for 9% of the overall sponge density. Vase sponges (including *Staurocalyptus* spp.) comprised 6% of the density. Barrel sponges (1%), foliose sponges (1%, *Farrea occa* and *Polymastia* spp.), and mud covered sponges (<1%) complete the remaining taxa identified. The pie diagram colors match with the list of sponge taxa below.

| Scientific Name | Common Name | Count |
|-----------------------------|-----------------------------------|-------|
| Mud Covered | | 1 |
| Porifera | Unidentified vase sponges | 30 |
| <i>Staurocalyptus</i> spp. | Unidentified vase sponge (yellow) | 1 |
| Porifera | Unidentified barrel sponges | 4 |
| Porifera | Unidentified upright flat sponges | 46 |
| <i>Polymastia</i> sp. | Nipple foliose sponges | 2 |
| <i>Farrea occa</i> | Lace (or cloud) foliose sponge | 1 |
| Porifera | Unidentified small mound sponges | 2 |
| Porifera | Unidentified mound sponges | 47 |
| <i>Asbestopluma</i> spp. #1 | Pipe Cleaner Sponge | 3 |
| Porifera | Unidentified sponges | 377 |

BIOLOGICAL ENVIRONMENT: OTHER INVERTEBRATES

AUV009- Density of Other Invertebrates

(411 invertebrates/ 1,000 m²)



A total of 374 individual invertebrates were enumerated from the 72 frames sampled from dive AUV009 conducted on the Piggy Bank from the NOAA ship *McArthur II*. This allowed us to calculate an overall invertebrate density of 411 invertebrates per 1,000 m². Sea stars comprised 87% of the overall invertebrate density and dominated by basket stars, *Gorgonocephalus eucnemis*. Echinoderms made up 8% of the invertebrate density; primarily sea cucumbers (*Parastichopus* spp., and *Holothuroidea*). Decapods, represented by galatheid crabs

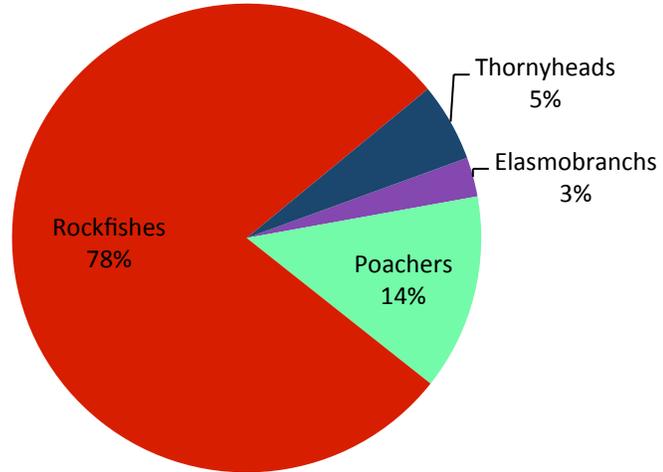
(squat lobsters) made up 4% of the overall density. *Liponema brevicornis* and other unidentified anemones made up the final 1% of the invertebrate density. The pie diagram colors match with the list of invertebrate taxa below.

| Scientific Name | Common Name | Count |
|----------------------------------|--|-------|
| Asteroidea | Unidentified Sea star | 60 |
| <i>Gorgonocephalus eucnemis</i> | Basket Star | 231 |
| <i>Rathbunaster californicus</i> | Deep-sea sunflower star | 36 |
| <i>Solaster</i> spp. | Deep-sea sunstar | 1 |
| Galatheoidea | Unidentified Galatheid crab | 15 |
| <i>Psolus squamatus</i> | White-scaled cucumber | 1 |
| <i>Parastichopus</i> spp. | Giant Orange/Giant California cucumber | 15 |
| <i>Pannychia moseleyi</i> | Sloppy cucumber | 1 |
| Holothuroidea | Unidentified sea cucumber | 10 |
| <i>Allocentrotus fragilis</i> | Fragile red sea urchin | 4 |
| <i>Liponema brevicornis</i> | Tentacle shedding anemone | 1 |
| Actinidae | Unidentified anemone | 4 |

BIOLOGICAL ENVIRONMENT: FISHES

A total of 37 fishes were identified from the 72 frames sampled from dive AUV009 conducted on the Piggy Bank from the NOAA ship *McArthur II*. This allowed us to estimate an overall fish density of 40 fishes per 1,000 m². Rockfishes, both unidentified and *Sebastomus* (unidentified whitespotted rockfish) made up 78% of the overall fish density. The rockfish were primarily encountered over hard substrate. Poachers (family Agonidae) comprised 14% of the overall fish density, and were found over sediment or mixed substrates. Unidentified and shortspine thornyheads accounted for 5% of fish density. Elasmobranchs (family Scyliorhinidae; unidentified catshark) made up 3% of the overall density of fishes. The pie diagram colors match with the list of fish taxa below.

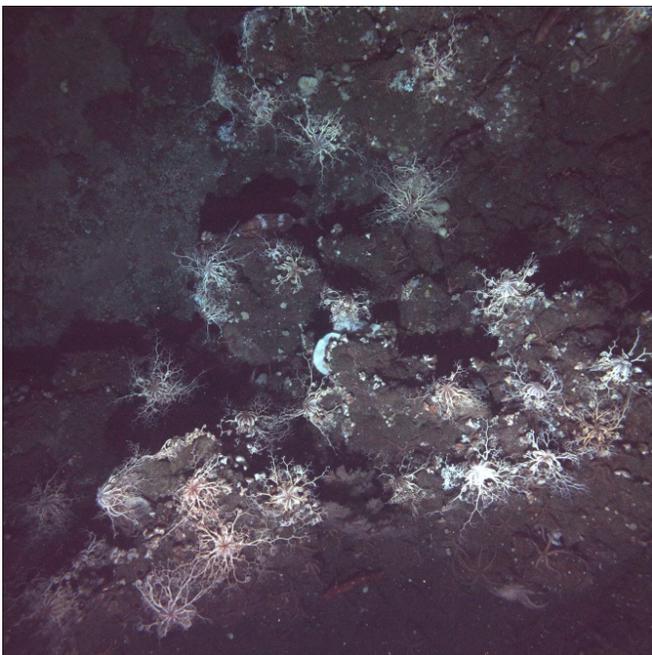
AUV009- Density of Fishes
(40 fishes/ 1,000 m²)



Unidentified and shortspine thornyheads accounted for 5% of fish density. Elasmobranchs (family Scyliorhinidae; unidentified catshark) made up 3% of the overall density of fishes. The pie diagram colors match with the list of fish taxa below.

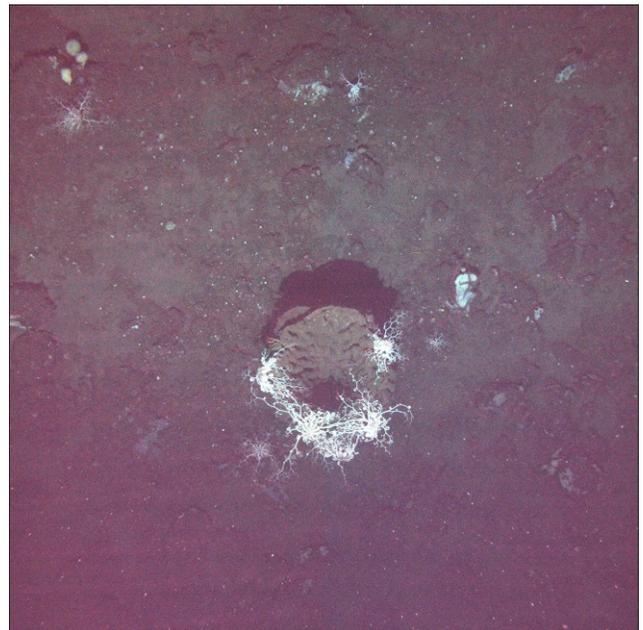
| Scientific Name | Common Name | Count |
|-------------------------------|-------------------------------|-------|
| Scyliorhinidae | Unidentified catshark | 1 |
| Agonidae | Unidentified poachers | 5 |
| <i>Sebastes spp.</i> | Rockfish Unid. | 2 |
| <i>Sebastomus</i> | Unidentified White-spotted RF | 27 |
| <i>Sebastolobus alascanus</i> | Shortspine thornyhead | 1 |
| <i>Sebastolobus spp.</i> | Unidentified thornyhead | 1 |

IMAGE GALLERY- AUV009



This image shows the prevalence of the basket star, *Gorgonocephalus eucnemis*. The habitat in this image was classified as hard substrate. Whitespotted and unidentified rockfish can also be seen in this photo.

This image shows a mud covered sponge on mixed substrate. Mound sponges, galatheid crabs and basket stars (*Gorgonocephalus eucnemis*) can also be identified.



This image shows an unidentified vase sponge, basket stars (*Gorgonocephalus eucnemis*) and an unidentified thornyhead (*Sebastolobus* spp.). There are also two stands of Christmas tree black coral (*Antipathes dendrochristos*) found here on mixed substrate.





This image shows marine debris on a boulder substrate. It is an aluminum beverage can.

DIVE NUMBER: AUV010

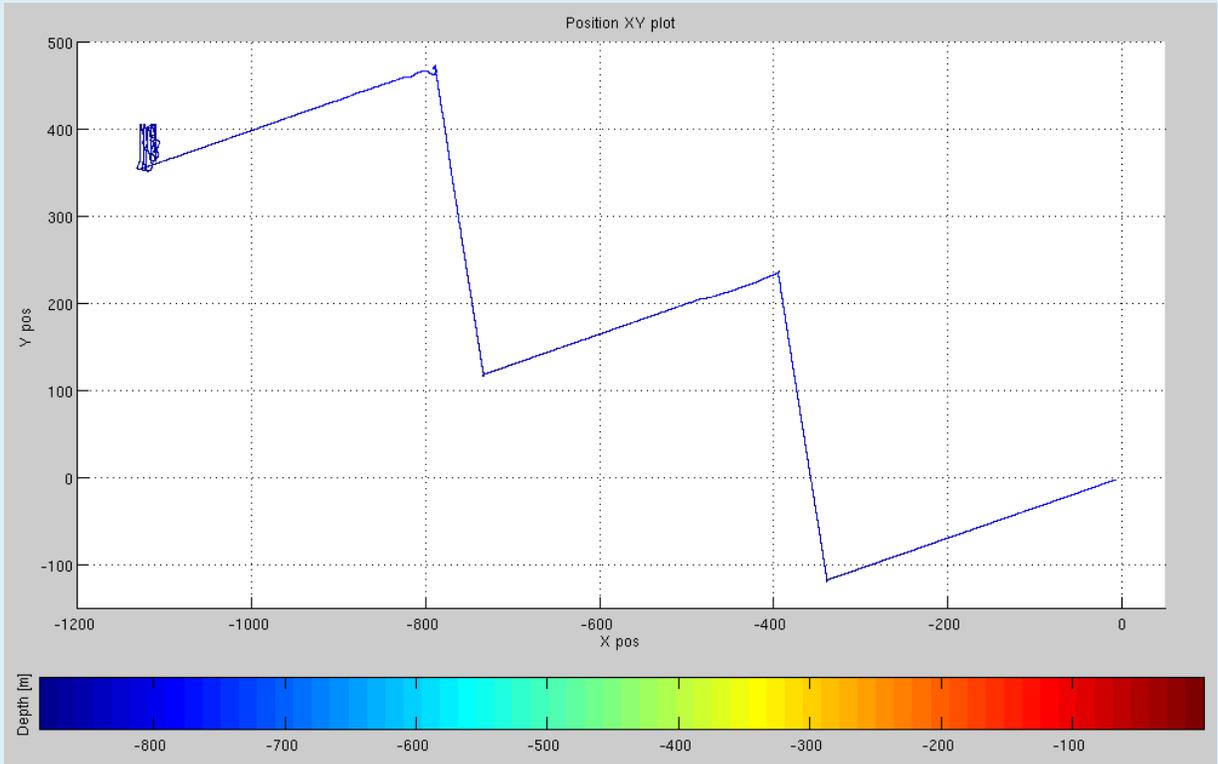
STATION OVERVIEW

| | |
|-----------------------------|--|
| Project | U.S. West Coast Deep Coral Cruise |
| Chief Scientist | M. Elizabeth Clarke |
| Contact Information | NMFS, NWFSC, elizabeth.clarke@noaa.gov |
| Purpose | Survey deep coral communities as Piggy Bank in the CINMS |
| Vessel | NOAA Ship <i>McArthur II</i> , Leg 3; <i>Lucille</i> AUV |
| Team | C. Whitmire, E. Fruh, J. Anderson, J. Taylor |
| Digital Still Photos | 4181 |
| Positioning System | Ship: GPS; AUV: DVL, gyrocompass, USBL |
| CTD Sensor | Yes |

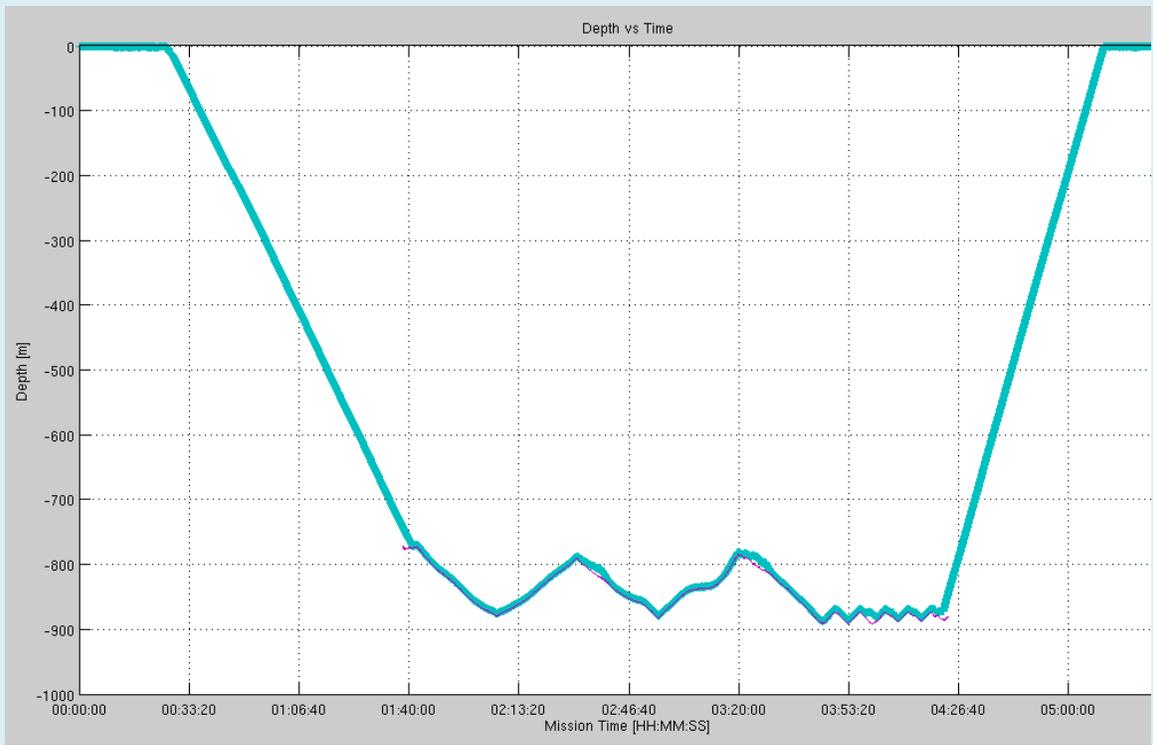
DIVE DATA

| | | | |
|--------------------------|--------------|------------------------|------------|
| Date | 02 July 2010 | Starting Latitude (N) | 33°54.39' |
| Maximum Bottom Depth (m) | 884 | Starting Longitude (W) | 119°29.44' |
| Start Time (UTC) | 03:22 | Ending Latitude (N) | 33°54.53' |
| End Time (UTC) | 08:06 | Ending Longitude (W) | 119°30.19' |

GENERAL LOCATION AND DIVE TRACK

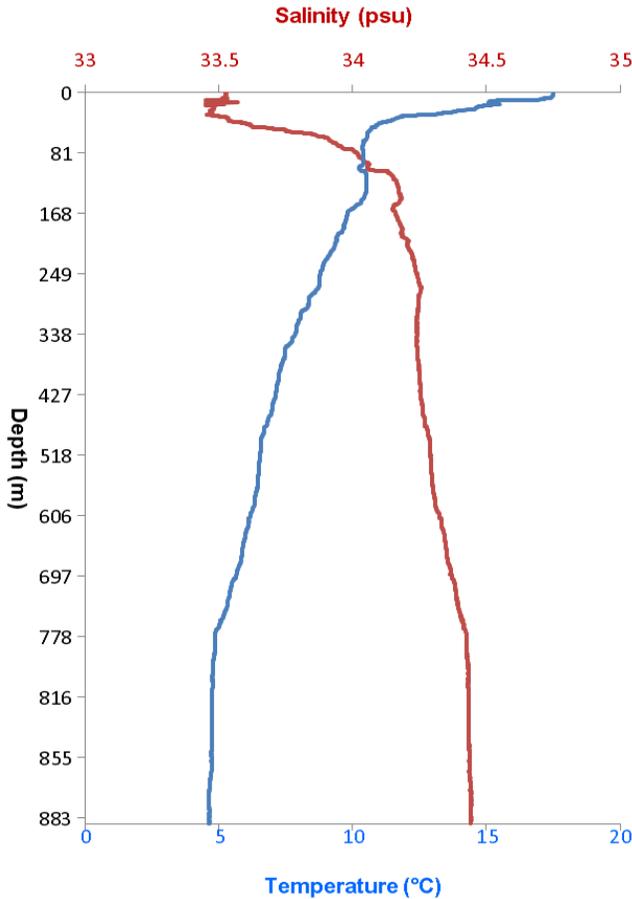


Survey track for dive AUV010. This dive went to a new depth maximum of 884 meters.



Depth track of dive AUV010 showing bottom in pink (—) and vehicle tracking bottom in teal (—).

PHYSICAL ENVIRONMENT

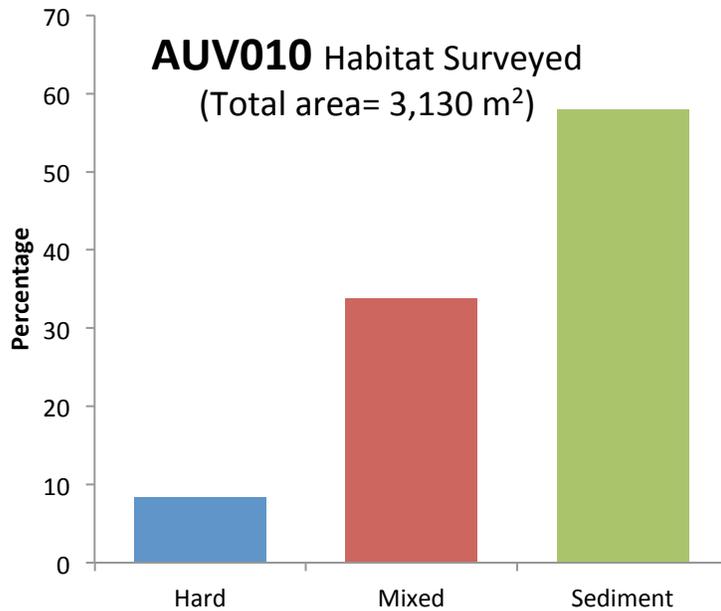


The AUV was equipped with an onboard Sea-Bird model 49 FastCat CTD that collected temperature and salinity information throughout the AUV's descent as well as along the dive track. During the dive AUV010 descent, the temperature varied from 17.5 to 4.65°C and salinity varied from 33.5 to 34.4 (psu) (Figure x).

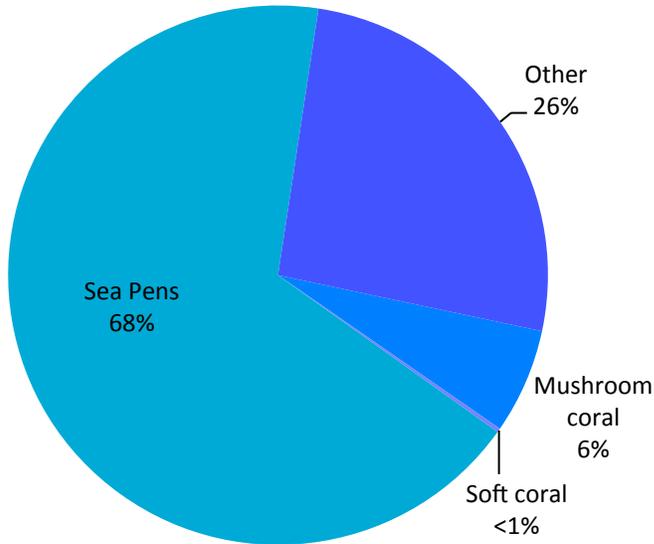
Dive AUV010 descent temperature and salinity profiles.

In total, 3,129 m² of sea floor were surveyed during dive AUV010 using the *Lucille* AUV deployed from the NOAA ship *McArthur II* on the Piggy Bank off southern California. Habitat types were classified as (1) Hard (8% of the total area surveyed), which included boulders, ridge and cobble; (2) Mixed (34% of the total area surveyed), which included mud or sand appearing with rock, boulder or cobble; and (3) Sediment (58% of the total area surveyed), which consisted of mud and/or sand. This mission was flown at an altitude of 3 meters.

AUV010 Habitat Surveyed
(Total area= 3,130 m²)



AUV010- Density of Corals
(137 corals/ 1,000 m²)



**BIOLOGICAL ENVIRONMENT:
CORALS**

A total of 428 individual corals were enumerated from the 703 frames sampled from dive AUV010 conducted on the Piggy Bank from the NOAA ship *McArthur II*. This mission was conducted at an altitude of 3 meters above the seafloor. Corals were counted, allowing us to estimate a coral density of 137 corals per 1,000 m². The taxa encountered were sea pens, comprised of Pennatulacea (unidentified sea pens), *Pennatula* spp, and *Umbellula* spp. making up 68% of the overall coral density. Other unidentified corals made up 26% of the coral density. Mushroom coral,

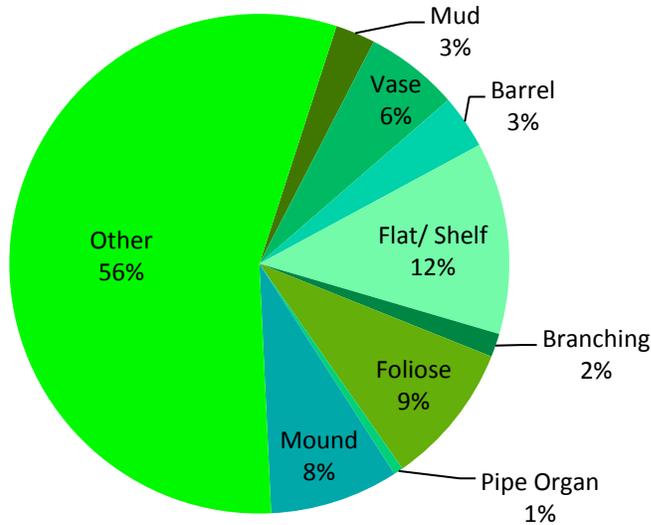
Anthomastus ritteri made up 6% of the overall coral density and one occurrence of *Clavularia* spp. accounted for the final <1% of the overall density. The pie diagram colors match with the list of coral taxa below.

| Scientific Name | Common Name | Count |
|----------------------------|----------------------|-------|
| <i>Anthomastus ritteri</i> | Mushroom coral | 27 |
| <i>Clavularia</i> spp. | Soft coral | 1 |
| Pennatulacea | Unidentified sea pen | 193 |
| <i>Pennatula</i> spp. | Deep-sea sea pen | 1 |
| <i>Umbellula lindahli</i> | Droopy sea pen | 95 |
| Anthozoa | Unidentified coral | 111 |

BIOLOGICAL ENVIRONMENT: SPONGES

AUV010- Density of Sponges

(211 sponges/ 1,000 m²)



A total of 660 individual sponges from 14 different taxonomic classifications were observed during the 703 frames sampled from dive AUV010 on Piggy Bank from the NOAA vessel *McArthur II*. An overall density of 211 sponges per 1,000 m² of seafloor was estimated. Unidentified and other (including *Asbestopluma* spp.) sponges were found to be the most abundant, accounting for 56% of the total density. Flat/ shelf type sponges were the second most numerous, accounting for 12% of the sponge density. Foliose sponges (9%, consisting of *Thenea muricata*), unidentified mound sponges (8%), and

vase sponges (6%, including *Staurocalyptus* spp. and *Heterochone calyx*) were the next most abundant taxa. Mud covered sponges (3%), barrel sponges (3%), branching sponges (2%) and unidentified pipe organ sponges (1%, possibly *Oceanapia* spp.) accounted for the remaining total density. Sponges were found on all substrate types, but increased with the presence of hard or mixed substrate. Colors in the pie chart above match the list of sponge taxa following.

| Scientific Name | Common Name | Count |
|-----------------------------|-----------------------------------|-------|
| Mud Covered | | 17 |
| Porifera | Unidentified vase sponges | 36 |
| <i>Staurocalyptus</i> spp. | Unidentified vase sponge (yellow) | 2 |
| <i>Heterochone calyx</i> | Fingered goblet vase sponge | 2 |
| Porifera | Unidentified barrel sponges | 23 |
| Porifera | Unidentified upright flat sponges | 81 |
| Porifera | Unidentified shelf sponges | 1 |
| Porifera | Unidentified branching sponge | 10 |
| <i>Thenea muricata</i> | Foliose Sponge (clear) | 61 |
| Porifera | Unidentified pipe organ sponge | 4 |
| Porifera | Unidentified small mound sponges | 33 |
| Porifera | Unidentified mound sponges | 22 |
| <i>Asbestopluma</i> spp. #1 | Pipe Cleaner Sponge | 16 |
| Porifera | Unidentified sponges | 352 |

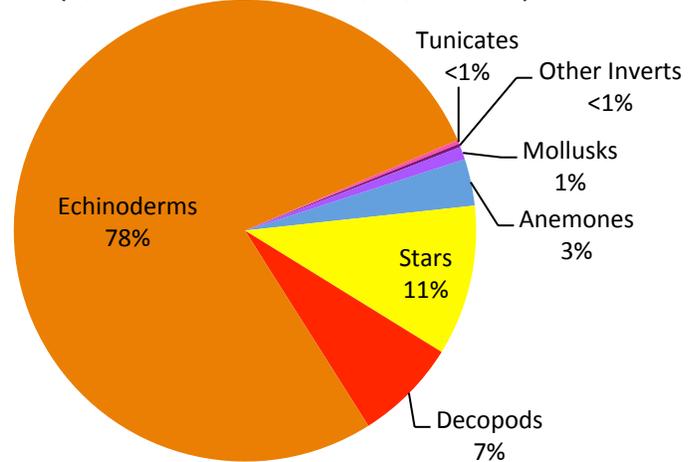
BIOLOGICAL ENVIRONMENT: OTHER INVERTEBRATES

In total, 4,583 invertebrates were enumerated during dive AUV010. This gave us an invertebrate density estimate of 1,465 invertebrates per 1,000 m². The abundance of the fragile urchin, *Allocentrotus fragilis*, and brittlestars (Ophiocanthidae) was noted, but the individuals proved too numerous for specific counts. Other Echinoderms, comprised mostly of the sea cucumbers *Pannychia moseleyi* and *Psolus squamatus*, made up 78% of the overall invertebrate density. Sea stars accounted for 11% of the total invertebrate density. The most

abundant were unidentified Asteroidea and *Brisengella* spp. Decapods, including *Chorilia longipes* and galatheid crabs (squat lobsters) made up 7% of the total invertebrate density. *Liponema brevicornis* and other unidentified anemones accounted for 3% of the total density. Mollusks (1%, primarily *Acesta sponi* and unidentified nudibranchs), tunicates (<1%), and other inverts (<1%) were the remainder of the overall invertebrate density. Colors in the pie chart above match the list of invertebrate taxa following.

AUV010- Density of Other Invertebrates

(1,465 invertebrates/ 1,000 m²)



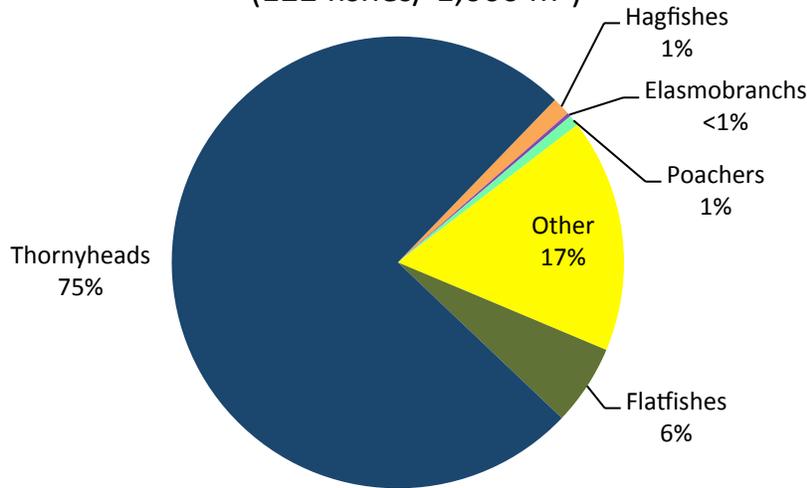
| Scientific Name | Common Name | Count |
|---|--|----------|
| Asteroidea | Unidentified Sea star | 296 |
| Ophiocanthidae | Unidentified brittlestar | presence |
| <i>Ceramaster</i> spp. | Cookie star | 13 |
| <i>Pteraster</i> spp. | Slime star | 14 |
| <i>Thrissacanthius penicillatus</i> | Carpet star | 22 |
| Asteroidea | Myxoderma platycanthum-like | 6 |
| <i>Hippasteria</i> spp. | Unidentified spiny star | 5 |
| <i>Zoroaster evermanni</i> | Slender star | 15 |
| <i>Dipsacaster eximius</i> | Broad sand star | 9 |
| <i>Brisingella</i> spp. | Lacy-armed star | 102 |
| Asteroidea | Unidentified mud star | 1 |
| Galatheoidea | Unidentified Galtheid crab | 88 |
| <i>Chorilia longipes</i> | Long-horned decorator crab | 235 |
| Decapoda | Unidentified shrimp | 6 |
| Decapoda | Unidentified crab | 2 |
| <i>Psolus squamatus</i> | White-scaled cucumber | 31 |
| <i>Parastichopus</i> spp. | Giant Orange/Giant California cucumber | 8 |
| <i>Pannychia moseleyi</i> | Sloppy cucumber | 3493 |
| Holothuroidea | Unidentified sea cucumber | 2 |
| <i>Brisaster</i> spp./ <i>Brissopsis</i> spp. | Unidentified mud urchin | 8 |
| <i>Allocentrotus fragilis</i> | Fragile red sea urchin | presence |
| <i>Florometra serratissima</i> | Feather star crinoid | 13 |
| <i>Liponema brevicornis</i> | Tentacle shedding anemone | 12 |
| Actinidae | Unidentified anemone | 138 |
| Tunicata | Unidentified tunicates | 12 |
| Unidentified invertebrate | Unidentified invertebrate | 4 |
| <i>Acesta sphoni</i> | Sphon's giant file clam | 36 |
| Opisthobranchia | Unidentified nudibranch | 5 |
| <i>Dromalia alexandri</i> | Benthic siphonophore | 7 |

BIOLOGICAL ENVIRONMENT: FISHES

A total of 382 fishes were enumerated for dive AUV010. This provided an estimated fish

density of 122 fishes per 1,000 m². The most abundant fish taxa were the thornyheads, representing 75% of the overall fish density. This is most likely due to the depth of this dive and prevalence of sediment as a habitat type. The category made up of other taxa accounted for 17% of the total fish density. This group consisted of Zoaracidae (unidentified eelpouts), Liparidae (unidentified snailfish),

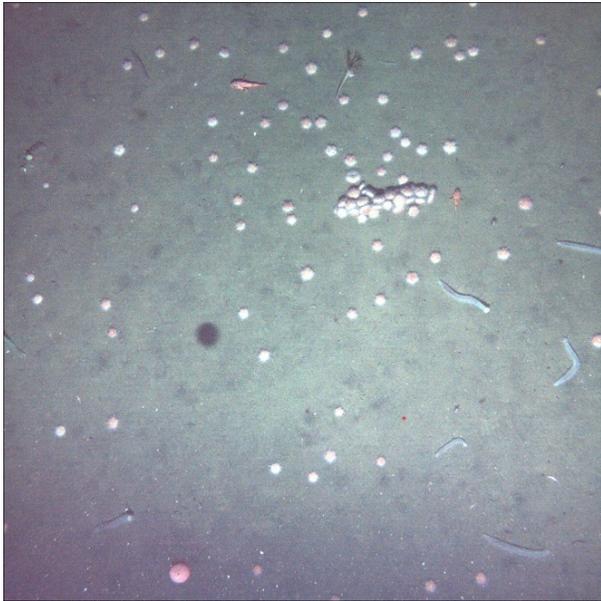
AUV010- Density of Fishes
(122 fishes/ 1,000 m²)



Alepocephalidae (unidentified slickheads) and other unidentified Osteichthyes. Flatfishes, including *Microstomus pacificus* (Dover sole) and *Embassichthys bathybius* (deep-sea sole), made up 6% of the total fish density. Myxinidae (hagfishes) accounted for 1% and elasmobranchs (unidentified catsharks) accounted for the remaining <1% of the overall fish density. Colors in the pie chart above match the list of fish taxa following.

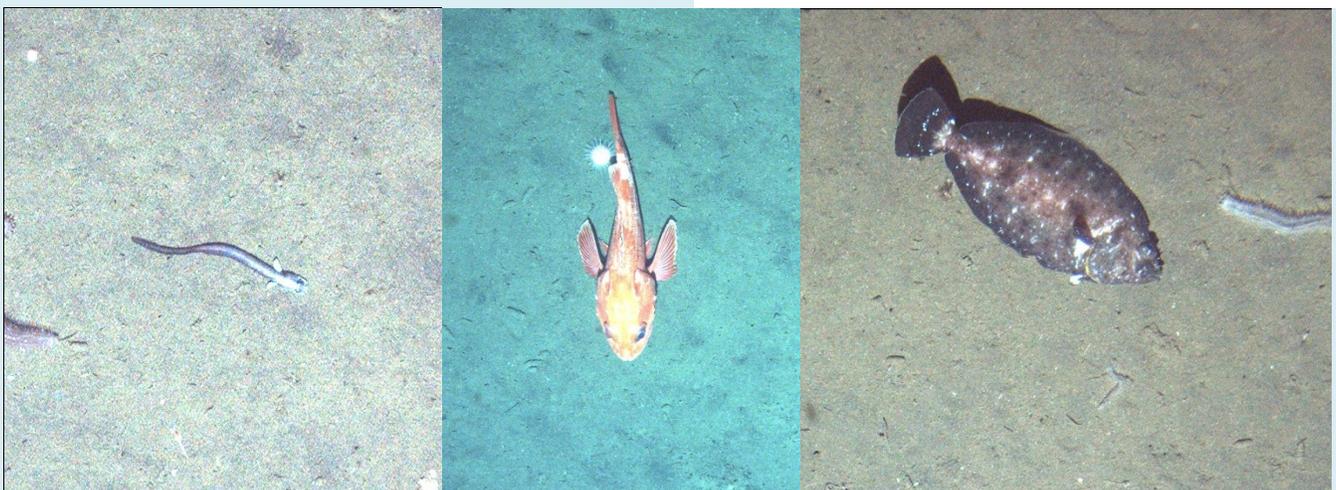
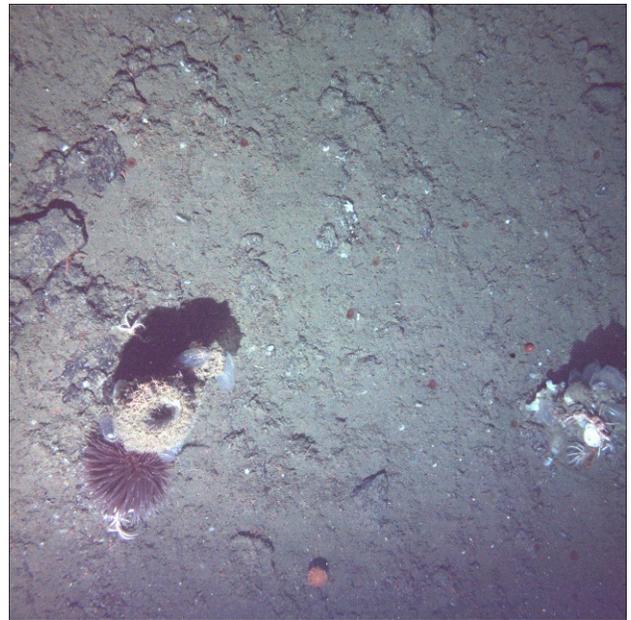
| Scientific Name | Common Name | Count |
|--------------------------------|-------------------------|-------|
| Myxinidae | Unidentified hagfish | 5 |
| Scyliorhinidae | Unidentified catshark | 1 |
| Agonidae | Unidentified poachers | 3 |
| Zoaracidae | Unidentified eelpout | 34 |
| Liparidae | Unidentified snailfish | 2 |
| Alepocephalidae | Unidentified slickheads | 5 |
| Osteichthyes | Unidentified fishes | 23 |
| <i>Embassichthys bathybius</i> | Deep-sea sole | 2 |
| <i>Microstomus pacificus</i> | Dover sole | 20 |
| <i>Sebastolobus alascanus</i> | Shortspine thornyhead | 38 |
| <i>Sebastolobus</i> spp. | Unidentified thornyhead | 249 |

IMAGE GALLERY- AUV010

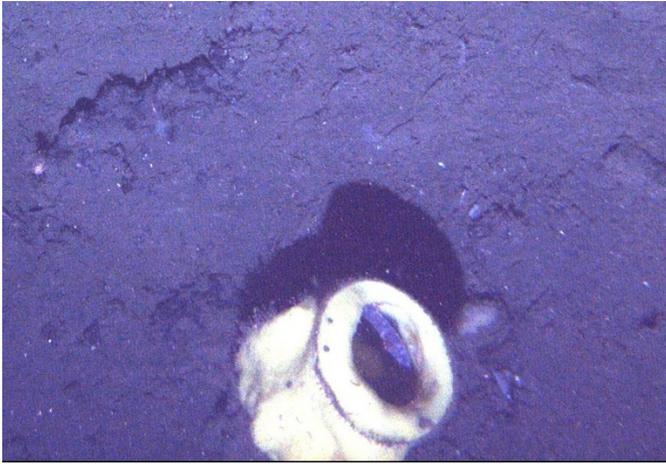


This image shows the prevalence of *Allocentrotus fragilis* urchins. Also in the image are *Pannychia moseleyi* (sloppy sea cucumbers), *Umbellula lindahli* (droopy sea pen), and *Sebastolobus* spp. (thornyheads). This image shows a typical example of the sediment habitat encountered throughout this dive.

This image shows mixed substrate with an unidentified barrel sponge, a *Liponema brevicornis* anemone, and multiple tunicates. In the bottom of the frame you will notice a benthic siphonophore (*Dromalia alexandri*). There are also several *Brisingella* spp. sea stars and a *Chorilia longipes* decorator crab in this frame.



These images show some of the more abundant fish taxa from dive AUV010. They include, from left to right, an unidentified eelpout (family Zoarcidae), a shortspine thornyhead (*Sebastolobus alascanus*) and a Dover sole (*Microstomus pacificus*), all of these fishes are shown on soft sediment substrate.



This image shows an unidentified hagfish (Myxinidae) taking shelter in a *Staurocalyptus* spp. vase sponge.

This image shows the deep water clam, *Acesta sphoni* (Sphon's giant file clam) on mixed substrate.



CONCLUSIONS

From these AUV dives we were able to establish the presence of 21 taxa of sponges, 16 taxa of corals, 40 taxa of invertebrates and 22 taxa of fishes, many of these identified to the species level. The ecosystem in this area was diverse, with high densities of deep-sea corals and sponges in some locations. Densities ranged from 28-1,595 corals/1,000m² and 182-1,852 sponges/1,000m². However, densities and species of both corals and sponges varied between sites. The highest densities of coral, sponges and fish were at one of the shallowest dive sites (AUV003). This area also had the highest percentage of mixed habitat. The coral community was characterized by a high density of cup corals. However, a slightly shallower dive (AUV009) had the lowest density of fish and coral. At this site a very high percentage of the area (75%) was categorized as rock. This dive was also unique since the extent track of this dive was very limited. This dive was designed to conduct detailed multibeam mapping in combination with a photographic survey of a limited area. The next lowest abundance of fish was found during dive AUV007. At this site over 75% of the area was sediment. Coral abundance was still quite high because the prevalence of sea pens. Ninety-eight percent of the corals were sea pens. Christmas tree corals were present at several sites but were the predominate species only at dive site AUV006.

There was evidence of human impacts at many of the sites. Marine debris included beverage cans and derelict fishing gear. There was also evidence of broken sponges and corals in some areas.

CITATIONS

Love, M. S., M. Yoklavich, and D. M. Schroeder. 2009. Demersal fish assemblages in the Southern California Bight based on visual surveys in deep water. *Environmental Biology Fishes* 84:55-68.

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