

AUV Characterization of Essential Fish Habitat Conservation Areas in Monterey Bay National Marine Sanctuary

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Introduction

Designated in 1992, Monterey Bay National Marine Sanctuary (MBNMS) is a federally protected marine area offshore of California's central coast. Stretching from Marin to Cambria, the sanctuary encompasses a shoreline length of 276 miles and 6,094 square statute miles (4,601 nmi²) of ocean, extending an average distance of 30 miles from shore. The mission of MBNMS is to understand and protect the coastal ecosystem and cultural resources of MBNMS. As part of this mission MBNMS collects baseline data on the distribution, abundance, and health of resources within the marine ecosystems to help manage the ecosystem.

From July 6 to 19, 2017, a National Oceanic and Atmospheric Administration (NOAA) team comprised of staff at the National Marine Fisheries Service (NMFS) and Monterey Bay National Marine Sanctuary (MBNMS) conducted surveys using an Autonomous Underwater Vehicle (AUV) (Figure 1) to image ecologically sensitive areas in the Sanctuary. The areas are defined as Essential Fish Habitat (EFH) Conservation Area modifications or Voluntary Management Areas (VMAs). The project was funded through MBNMS restoration settlement funds and focused on collecting baseline data and comparative data on the distribution, abundance, and condition of deep sea corals and sponge communities.

Using the latest AUV technology, the team collected high-resolution color images aboard the R/V *Fulmar* (Figure 2) to characterize and better understand the Sanctuary's rich undersea habitats. The location of the seven sites sampled (Figure 3) were selected from a 2013 Collaborative EFH proposal¹ developed by local fishermen, conservation groups, and MBNMS to modify EFH areas in order to increase seafloor protections and fishing opportunities in the area. The EFH Conservation Areas and VMAs were identified by the stakeholder group and submitted to the Pacific Fishery Management Council to modify essential fish habitat for groundfish. The areas were officially adopted by the Council in April 2018. Some of the areas intersect with the recently established non-regulatory "Sanctuary Ecologically Significant Areas (SESAs)". SESAs are special areas that encompass remarkable, representative and/or sensitive marine habitats, communities and ecological processes, and MBNMS is focusing research efforts into these areas. The research cruise also gathered some chemical oceanography data such as dissolved oxygen.

Scientific Objectives:

1. Collect and analyze baseline data on the distribution, abundance, size, and condition, of deep sea coral and sponge communities in selected sites within MBNMS
2. Document environmental conditions of Deep Sea Coral and Sponge (DSC&S) habitats, including depth, seafloor substratum types, and seawater temperature, salinity, and dissolved oxygen to help understand factors that influence DSC&S distribution

This report provides a summary of the methods and results from these underwater AUV surveys.

Study Area

The AUV study focused on sites within federal offshore waters of MBNMS (Figure 3), that were selected during collaborative discussions among local fishermen, conservation groups, and Monterey Bay National Marine Sanctuary as part of a 2013 Essential Fish Habitat (EFH) Proposal¹. The dive sites were located between Ascension Canyon to the north and Point Sur Platform to the south within depths of 64 to 670 meters. The AUV study sites focused on collecting data at seven sites in five areas within the proposal that were added to or removed from EFH Conservation areas. The two VMAs (Sites 1 and 3a in Figure 3) are non-regulatory areas that require collection of baseline data. Some sites were selected because they are representative of a unique habitat or ecosystem and would provide baseline data essential to monitoring of the health of MBNMS (Sites 5 and 7 in Figure 3). Some of the locations selected have data that has been previously collected and we can use these historical data to document changes in the diversity and abundance of sponges, corals, and fish (Sites 2, 3b and 4 in Figure 3). Site selection was also constrained by the technical limitations of the AUV. These constraints included that the site had to be less than 45 degrees to collect good imagery, had to be less than 800 meters deep (as installing the other navigation package would have taken too much time) and couldn't include areas where pinnacles could be present to prevent collisions.

Field Survey Methods

The AUV (Figure 1) was equipped with several sensors that either aided in vehicle navigation and subsurface communication or collected environmental data. Navigation is an inertial system integrating a suite of sensors that precisely and accurately measure depth, altitude and relative speed and direction over the seafloor. Altitude and relative speed are measured by a 1200 kHz Navigator Doppler Velocity Log (Teledyne RD Instruments); heading, pitch and roll are measured by an OCTANS fiber optic gyrocompass and motion sensor (iXblue); and depth is determined by a Series 8000 Digiquartz[®] depth sensor (Paroscientific, Inc.). Range and bearing of the AUV relative to the support vessel were provided by a TrackLink 1510 medium accuracy ultrashort baseline acoustic tracking system (LinkQuest, Inc.). Once the AUV was at its target altitude above the seafloor, the live USBL data stream was used to position the vehicle as close as possible to the intended dive start point. Subsurface communication and telemetry data were provided by the WHOI 256008 acoustic micromodem and surface communication by a FreeWave FGR-115 RCRF radio modem. All topside navigational data streams including vessel GPS and heading were integrated in real time and logged using custom software written for Matlab (Simulink, Inc.). Salinity, temperature and pressure were collected using a model 49 FastCat CTD (Seabird Electronics, Inc.) and oxygen concentration was collected using an Oxygen Optode model 4831F 1W (AANDERAA - Xylem Inc./ YSI Inc.). Both were mounted directly on the AUV under the top pontoon. Temperature, depth, and salinity were derived from raw CTD data at one-second intervals. Oxygen saturation was measured every 30 seconds by an optode.

The AUV has three cameras – one angled camera that shoots oblique photos and two that shoot straight down on port and starboard. The AUV was equipped with high dynamic range, digital, color, 5 MP photographic cameras arranged in a stereo pair directed downward and perpendicular to the seafloor. A third high dynamic range, digital, color, 11 MP photographic camera was directed forward at approximately 35° and used for assisting in identifications of animals. Still images were collected from all cameras at a rate of approximately 1 image every 8 seconds and stored on the AUV's internal hard drive for later analysis. Upon completion of the dive, the AUV surfaced and was recovered to the ship.

The AUV was deployed and recovered using the ship's crane. The AUV surveys at a forward speed of 0.25-0.5 m/s (0.5-1.0 kt) for 4-6 hours per dive at a preprogrammed altitude of 3 meters above the seafloor.

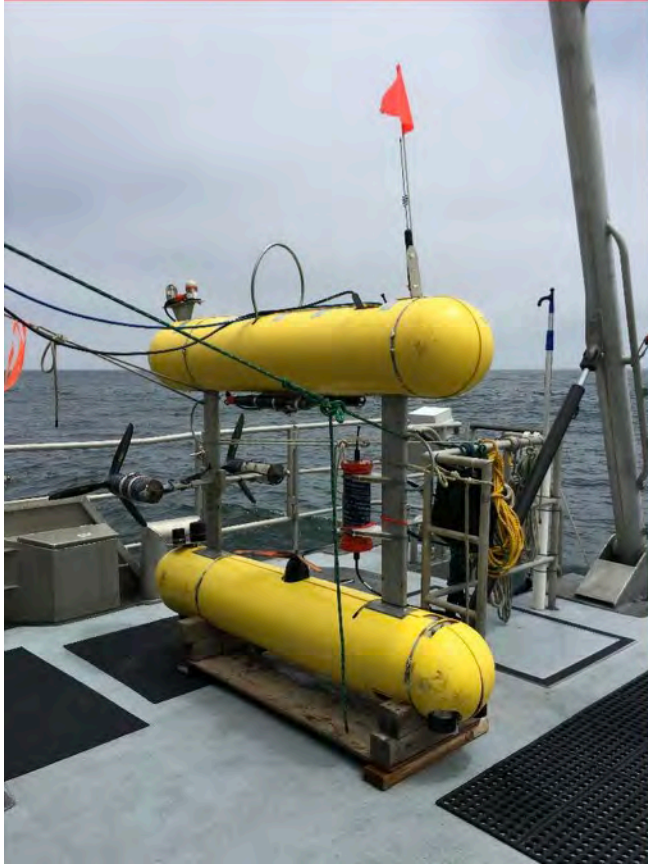


Figure 1. The SeaBED AUV on the back deck of the NOAA Research Vessel *Fulmar*. The SeaBED AUV is unlike other, more traditional AUV's, in that its twin-hull design provides greatly enhanced stability for low-speed photographic surveys.

AUV Data Analysis Methods

At the end of each dive all images and data were downloaded from the AUV. Images were then color corrected. Resultant navigation data was processed to determine the length and location of the AUV track lines. Seafloor habitats were classified by type of substratum, in order of decreasing particle size and vertical relief (as described in Greene et al. 1999): rock ridge (R), boulder (B), cobble (C), flat rock (F), gravel (G), sand (S) and mud (M). A two-character code was used to quantify the habitat type in each image based on the area covered by each substratum. Habitats were grouped into hard (R, B, C, and F in any combination), mixed (one of the hard substrata combined with M or S as either primary or secondary), and soft (the combination of MM or SS).

Corals, sponges, and fishes were identified to the lowest possible taxonomic level and enumerated from expert examination of digital images. Some sponges were classified by general morphology (i.e., foliose, ball, branching, barrel, mound, and vase) when taxonomic identification was difficult. Densities of corals, sponges, and fishes were estimated by dividing total number of each taxon by the area surveyed. Frequency and type of derelict fishing gear also were documented. Other marine debris and any evidence of anthropogenic effects, such as trawling, were also noted.

The oxygen information was synchronized with depth information from the CTD and plotted from the initial transit by the AUV from the surface to the bottom at the beginning of each dive.



Figure 2. NOAA Research Vessel *Fulmar*

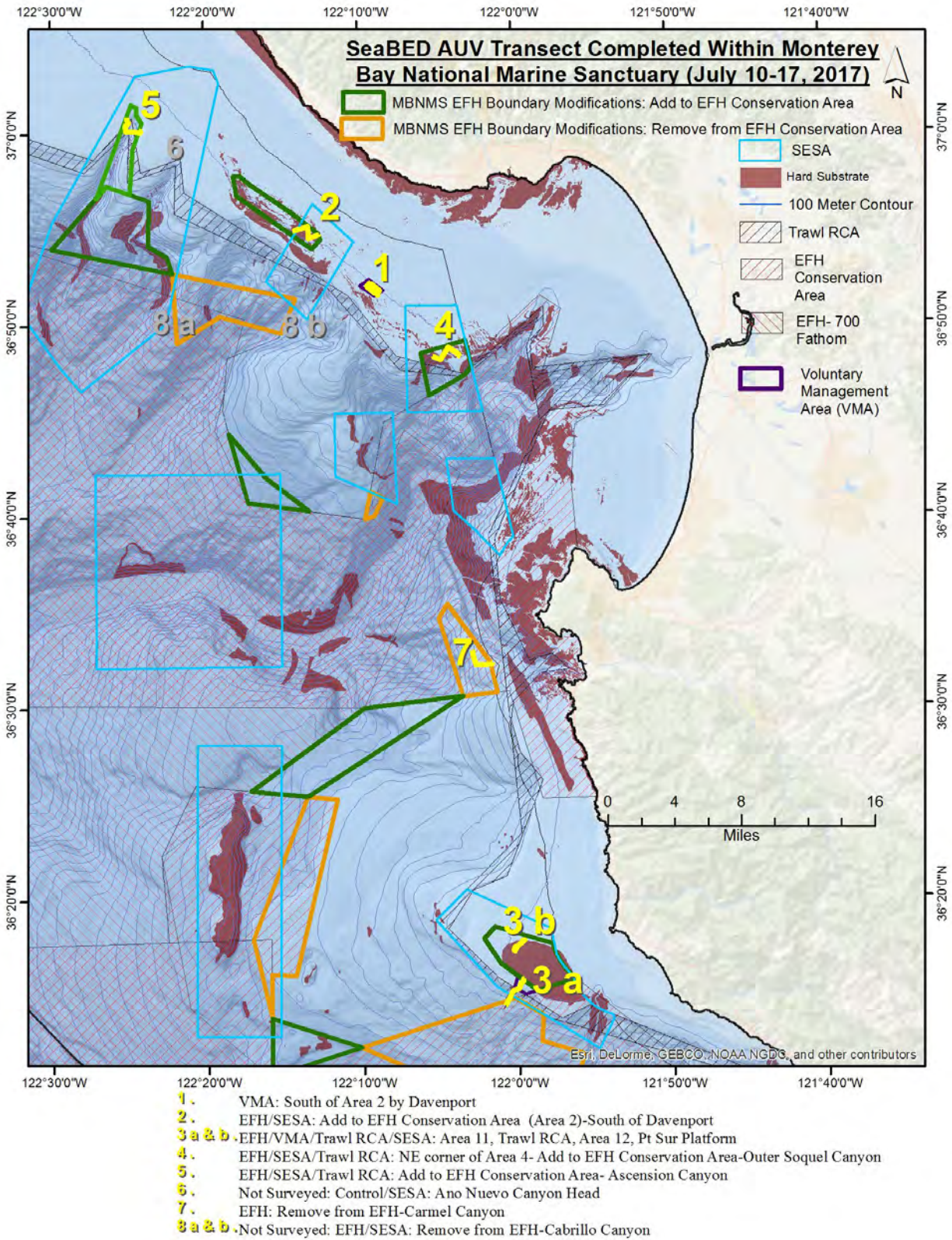


Figure 3. Surveyed sites(indicated by yellow number) and AUV tracklines (yellow lines) during MBNMS/NMFS AUV mission.

Summary of Dives

We were able to survey seven sites over 8 days (Table 1). No dives were attempted on 7/16/17 due to inclement weather.

Table 1. Logistical information from dives using autonomous underwater vehicle (AUV) to survey within Monterey Bay National Marine Sanctuary, July 10-17, 2017.

Date (UTC)	Dive #	Site	Start Time (UTC)	End Time (UTC)	Start Lat (°N)	Start Long (°W)	End Lat (°N)	End Long (°W)	Min Depth (m)	Max Depth (m)
7/10/17	1	4	15:41	20:30	36 48.38	122 03.47	36 48.26	122 05.00	94	361
7/11/17	2	1	15:30	21:09	36 51.59	122 08.77	35 52.22	122 09.50	91	103
7/12/17	3	5	16:19	20:47	37 00.90	122 25.00	37 00.29	122 24.32	135	384
7/13/17	4	3a	15:48	20:13	35 15.79	121 59.71	36 14 .48	122 00.04	83	469
7/14/17	5	2	15:49	20:26	36 54.96	122 14.26	36 54.77	122 12.61	97	83
7/15/17	6	7	14:53	19:53	36 32.37	122 01.57	36 32.90	122 02 .76	440	670
7/17/17	7	3b	15:43	18:43	36 17.85	122 59.74	36 17.22	122 00.23	64	86

Over 10,000 images of the seafloor were collected. One half of the port images were used for quantitative analysis (every other image) to avoid any overlap of images. Over 24,000 m² of habitat was classified. The habitat composition in each dive was very unique, but overall the habitat that the AUV surveyed was 14% hard bottom, 38% soft and 48% mixed bottom. Sixty-eight taxa of fish were identified (Table 2). We also identified 17 taxa or morphotypes (Figures 4-13) of sponges and 13 taxa of corals (Table 3). Overall sponges were much more abundant than corals. Sea cucumbers and spot prawns were some of the other most abundant taxa of invertebrates.

Below we present summaries of the species composition and density of corals, sponges, other invertebrates and fishes and associated seafloor habitats observed by the AUV in MBNMS. We also present depth profiles of sea temperature, salinity, and dissolved oxygen in these areas.

Table 2. Fishes observed from visual surveys conducted with autonomous underwater vehicle (AUV) within Monterey Bay National Marine Sanctuary, July 10-17, 2017.

Scientific Name	Common Name
<i>Myxinidae</i>	Unidentified hagfish
<i>Raja rhina</i>	Longnose skate
<i>Bathyraja trachura</i>	Roughtail skate
<i>Bathyraja kincaidii</i>	Sandpaper skate
<i>Rajidae</i>	Unidentified skate
<i>Rajidae</i>	Skate egg case
<i>Parmaturus xaniurus</i>	Filetail catshark
Scyliorhinidae	Unidentified catshark
Agonidae	Unidentified poachers
Zoarcidae	Unidentified eelpouts
<i>Lycodes cortezianus</i>	Bigfin eelpout
<i>Lycodes diapterus</i>	Black eelpout
Cottidae	Unidentified sculpins
<i>Glyptocephalus zachirus</i>	Rex sole
<i>Microstomus pacificus</i>	Dover sole
<i>Embassichthys bathybius</i>	Deepsea sole
<i>Citharichthys sordidus</i>	Pacific sanddab
<i>Citharichthys</i> spp.	Unidentified sanddab
<i>Eopsetta jordani</i>	Petrals sole
<i>Eopsetta jordani/Hippoglossoides elassodon</i>	Petrals or flathead sole
<i>Lepidopsetta bilineata</i>	Southern rock sole
<i>Parophrys vetulus</i>	English sole
Pleuronectiformes	Unidentified flatfish
Osteichthyes	Unidentified fishes
<i>Sebastes diploproa</i>	Splitnose rockfish
<i>Sebastes diploproa/Sebastes aurora</i>	Splitnose rockfish/Aurora rockfish
<i>Sebastes levis</i>	Cowcod rockfish
<i>Sebastes melanostomus</i>	Blackgill rockfish
<i>Sebastes aurora</i>	Aurora rockfish
<i>Sebastes goodei</i>	Chilipepper rockfish
<i>Sebastes chlorostictus</i>	Greenspotted rockfish
<i>Sebastes elongatus</i>	Greenstriped rockfish
<i>Sebastes hopkinsi</i>	Squarespot rockfish
<i>Sebastes saxicola</i>	Stripetail rockfish
<i>Sebastes caurinis</i>	Copper rockfish
<i>Sebastes wilsoni/Sebastes emphaeus</i>	Pygmy/Puget Sound rockfish
Unidentified Sebastomus	White spotted rockfishes
<i>Sebastes rufus</i>	Bank rockfish
<i>Sebastes miniatus</i>	Vermillion rockfish
<i>Sebastes constellatus</i>	Starry rockfish
<i>Sebastes ruberrimus</i>	Yelloweye rockfish
<i>Sebastes ovalis</i>	Speckled rockfish
<i>Sebastes babcocki</i>	Redbanded
<i>Sebastes rubrivinctus/Sebastes babcocki</i>	Flag/Redbanded rockfish
<i>Sebastes pinniger</i>	Canary rockfish
<i>Sebastes semicinctus</i>	Halfbanded rockfish
<i>Sebastes paucispinis</i>	Bocaccio
<i>Sebastes rubrivinctus</i>	Flag rockfish
<i>Sebastes umbrosus</i>	Honeycomb rockfish
<i>Sebastes rosaceus</i>	Rosy rockfish
<i>Sebastes crameri/Sebastes saxicola/Sebastes zacentrus</i>	Darkblotched/Stripetail/Sharpchin rockfish
<i>Sebastes</i> spp.	Rockfish unidentified/juvenile rockfish
<i>Sebastolobus alascanus</i>	Shortspine thornyhead
<i>Sebastolobus</i> spp.	Unidentified thornyhead

Table 2. Cont.

Scientific Name	Common Name
<i>Anoplopoma fimbria</i>	Sablefish
<i>Zaniolepis</i> spp.	Combfish
<i>Ophiodon elongatus</i>	Lingcod
<i>Nezumia stelgidolepis</i>	California grenadier
<i>Coryphaenoides acrolepis</i>	Pacific grenadier
<i>Hydrolagus colliei</i>	Spotted ratfish
<i>Careproctus melanurus</i>	Blacktail snailfish
Liparidae	Unidentified snailfish
Alepocephalidae	Unidentified slickhead
<i>Hexagrammus decagrammus</i>	Kelp greenling
<i>Rhinogobiops nicholsii</i>	Blackeye goby
Ophidiidae	Cusk-eel
<i>Oxylebius pictus</i>	Painted greenling
<i>Anarrhichthys ocellatus</i>	Wolf-eel

Table 3. Invertebrates observed from visual surveys conducted with autonomous underwater vehicle (AUV) within Monterey Bay National Marine Sanctuary, July 10-17, 2017

Scientific Name	Common Name
Porifera	Mound sponge
<i>Staurocalyptus</i> spp.	Picasso sponge
<i>Poecillastra tenuilaminaris</i>	Shelf sponge
Lyssacine sponge	Glass barrel sponge
Porifera	Branching sponge
Porifera	Yellow sponge #1
Porifera	Vase sponge
Porifera	Foliose sponge
Porifera	Palm frond sponge
<i>Polymastia</i> spp.	Papillae sponge
Porifera	Pipe organ sponge
Porifera	Puff ball sponge
Latrunculiidae	Red deathstar sponge (Red <i>Latrunculia</i> type)
Porifera	Pipe sponge
Porifera	Gray lobed sponge #1
Porifera	Purple sponge #1
Porifera	Unidentified sponge
<i>Psolus</i> sp.	Common sea cucumber
<i>Parastichopus californicus</i>	California sea cucumber
<i>Apostichopus leukothele</i>	Giant orange sea cucumber
<i>Parastichopus</i> spp.	Giant red sea cucumber
<i>Pannychia moseleyi</i>	Bioluminescent sea cucumber
Holothuroidea	Unidentified sea cucumber
<i>Ceramaster patagonicus</i>	Cookie star
<i>Pteraster tessellatus</i>	Slime star
<i>Rathbunaster</i> sp. / <i>Pycnopodia</i> sp.	Sunflower stars
<i>Stylasterias forreri</i>	Velcro star
Crinoids	
Brisingids	Brisingids
Asteroidea	Unidentified sea stars
<i>Echinocardium cordatum</i>	Sea potato
Echinoidea	Unidentified sea urchin
Brachiopods	
<i>Pennatula phosphorea</i>	Common sea pen
<i>Pennatula</i> sp.	Sea pen
<i>Ptilosarcus gurneyi</i>	Fleshy/orange sea pen
Pennatulacea	Unidentified sea pens
Alcyonacea	Unidentified gorgonian
Plexauridae	Swiftia type
<i>Swiftia</i> sp.	Deep water sea fan
<i>Swiftia pacifica</i>	Red sea fan
<i>Stylaster</i> sp.	Lace coral
<i>Clavularia</i> sp.	Star polyps
<i>Halipterus</i> spp.	
Dendrophylliidae	Unidentified cup corals
Anthozoa	Unidentified coral
<i>Urticina columbiana</i>	Crusty red anemones
<i>Urticina</i> sp.	Pink and white spot anemones
<i>Metridium</i> sp.	Plumose anemones
<i>Metridium farcimen</i>	Giant plumose anemones
<i>Liponema brevicornis</i>	Pom-pom anemones
Actiniaria	Unidentified anemones

Table 3. Cont.

Scientific Name	Common Name
<i>Cancer sp.</i>	Unidentified crab
<i>Cancer productus</i>	Red rock crab
<i>Chionoecetes tanneri</i>	Grooved tanner crab
<i>Chorilia longipes</i>	Longnose decorator crab
<i>Metacarcinus magister</i>	Dungeness crab
<i>Paralithodes rathbuni</i>	Spiny king crab
Paguroidea	Hermit crab
<i>Pandalus platyceros</i>	Spot prawn
Nudibranchia	Unidentified nudibranchs
Tritonia spp.	Tritonia nudibranch
Octopodiformes	Unidentified Octopus
<i>Enteroctopus dofleini</i>	Giant Pacific Octopus
Decapodiformes	Unidentified squid
Salpida	Unidentified salp
Medusozoa	Unknown jellyfish
Unidentified invertebrates	

Sponges were identified at this stage primarily by morphotype. Work is underway assign specific names to these morphologies. Below is an image gallery of sponge types present during surveys.

Sponge Image Gallery



Figure 4. “Puff ball” sponge circled in green and indicated by red arrow. (Image 20170710.201043.05962, latitude: 36.80568, longitude: -122.087, depth: 232.33 m, substrate: FM)



Figure 5. Vase sponge circled in red. (Image 20170711.200713.06090), latitude: 36.866684, longitude: -122.155303, depth: 99.92 m, substrate: MC)

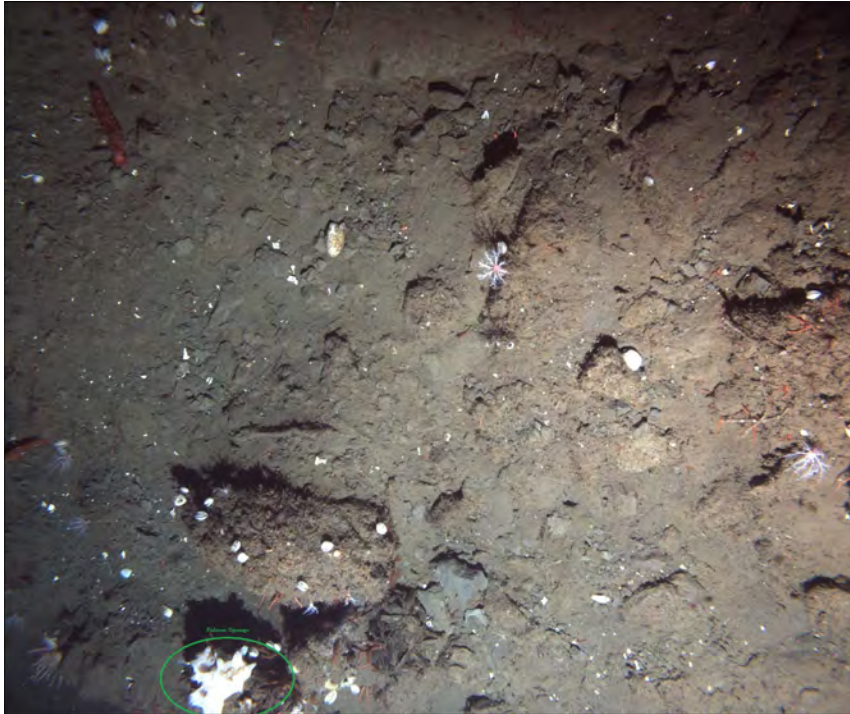


Figure 6. Foliose sponge circled in green (Image 20170710.190218.04423, latitude: 36.80306, longitude: -122.079, depth: 291.92 m, substrate: MC)

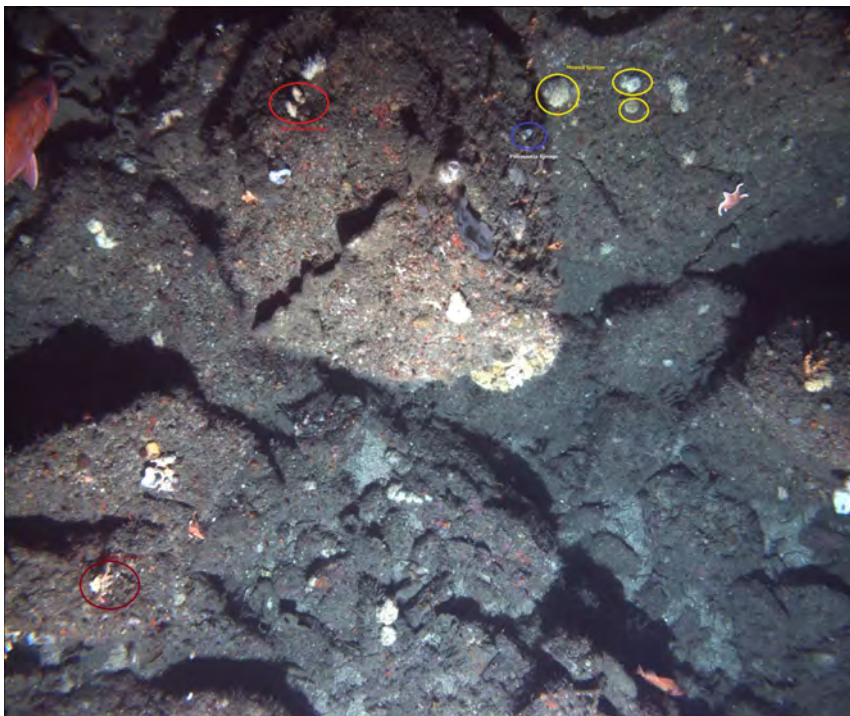


Figure 7. Branching sponge circled in red, *Polymastia sp.* in blue and mound sponge in yellow (Image 20170713.155435.00073, latitude: 36.26381, longitude: -121.995, depth: 84.34 m, substrate: BB)

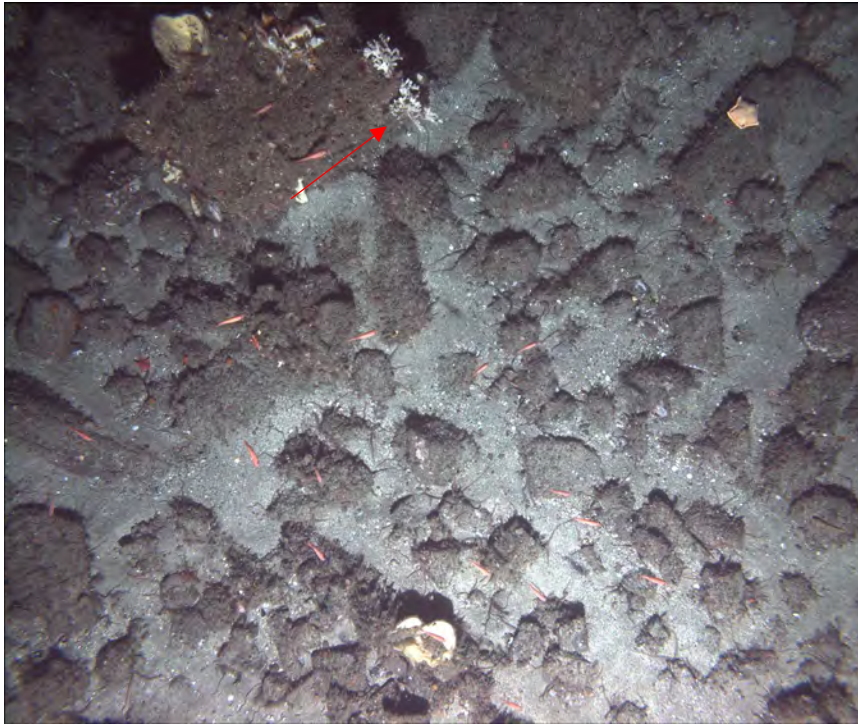


Figure 8. Branching sponge (Image 20170713.161003.00421 36.26177: , -121.996 : , depth: 100 m, substrate: CG)



Figure 9. Yellow sponge #1 circled in yellow (Image 20170713.155643.00121, latitude: 36.26354, longitude: 121.995, depth: 87.31 m, substrate: BC)

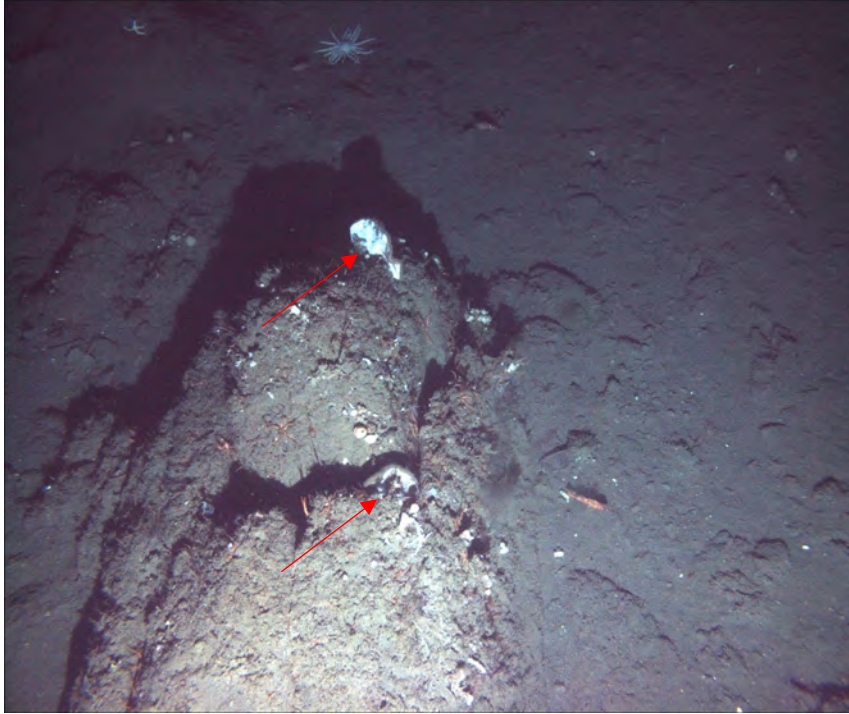


Figure 10. *Poecillastra tenuilaminaris* indicated by red arrow (Image 20170710.185049.04165), latitude: 36.80424, longitude: -122.078, depth: 186.25 m, substrate: MF)



Figure 11. Lyssacine barrel sponge circled in green (Image 20170711.174351.02866, latitude: 36.86478, longitude: -122.149, depth: 95.07 m, substrate: BB).

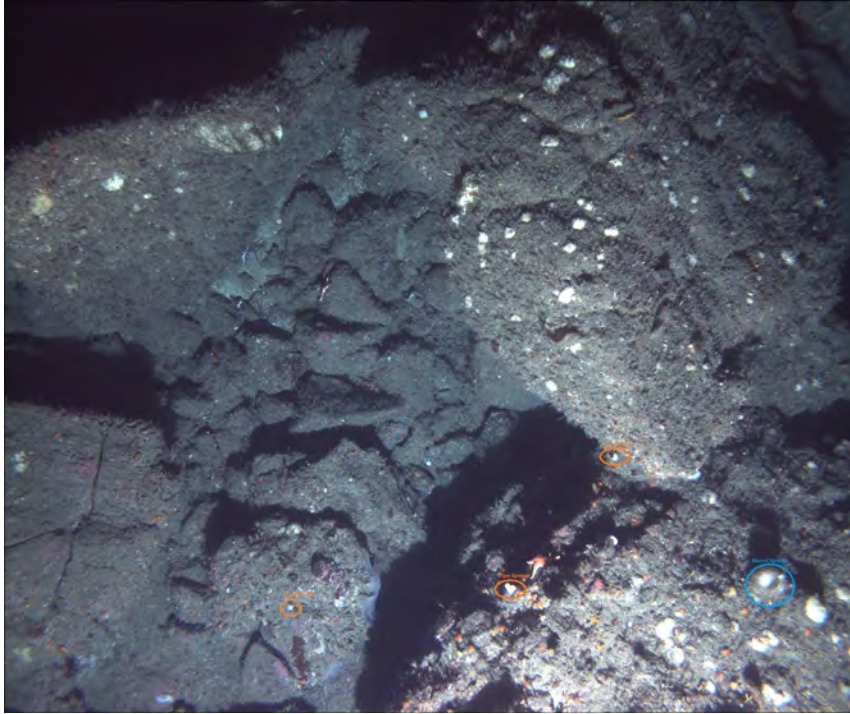


Figure 12. Pipe barrel circled in red and small barrel sponge circled in blue (Image 20170713.155451.00079, latitude: 36.263777, longitude: -121.995139, depth: 84.10 m, substrate: BB).

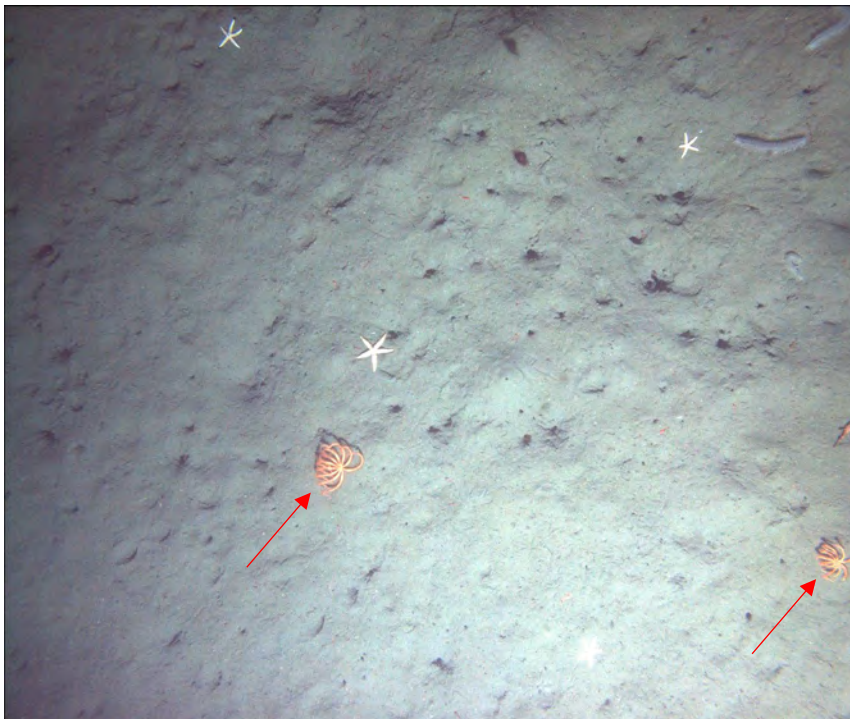


Figure 13. Two orange brisingids on mud bottom (Image 20170715.175134.03355, latitude: 36.541682, longitude -122.045115, depth: 657.66 M, substrate: MM).

AUV01 – Site 4 – Outer Soquel Canyon

General Location and Dive Tracks

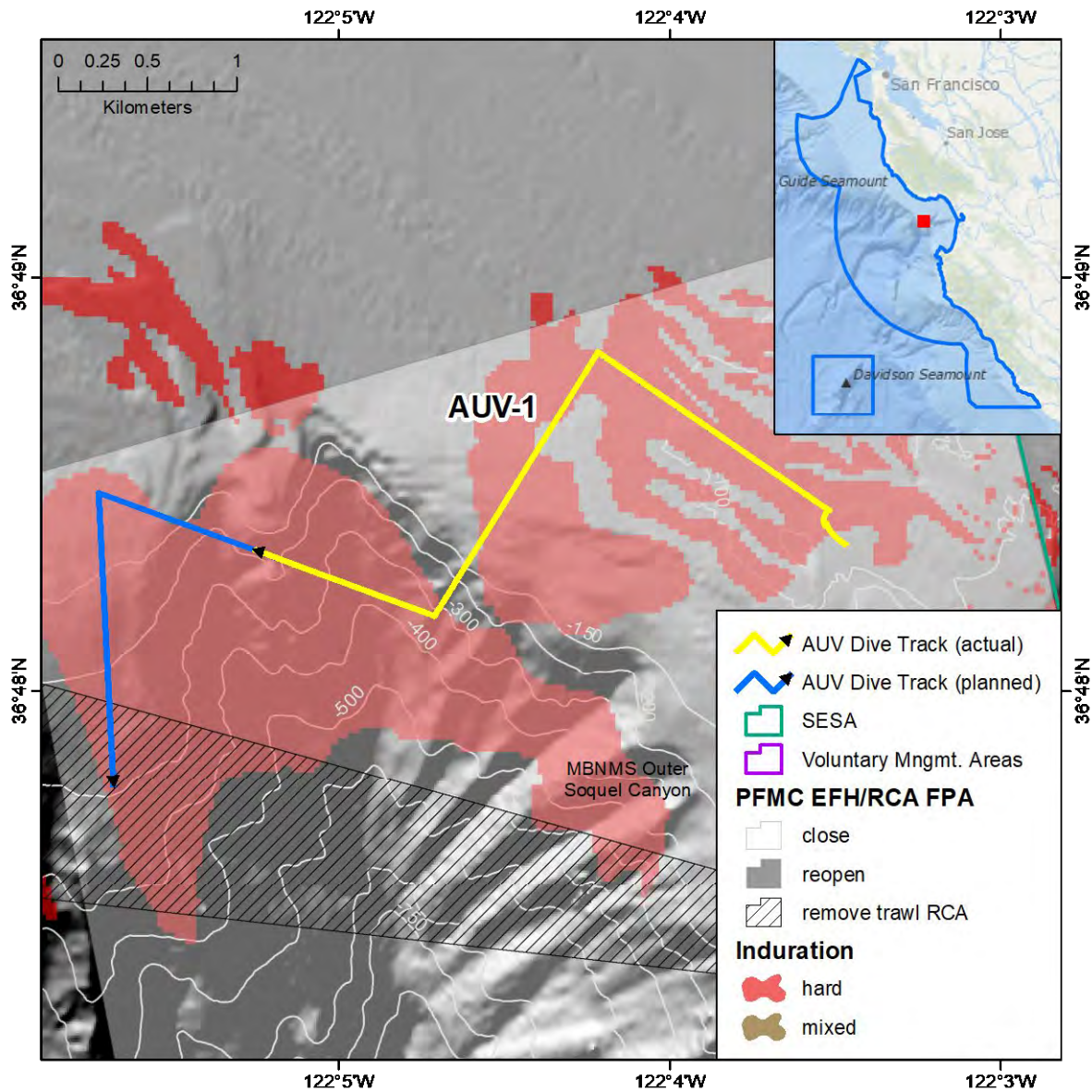


Figure 14. Dive 1, Site 4 Outer Soquel Canyon. Locations of planned and actual dive tracks of the autonomous underwater vehicle (AUV). Depth contours are in meters.

Site Overview

Table 4. Summary site data for Site 4 – AUV01 Outer Soquel Canyon.

Contact Information	NOAA NWFSC elizabeth.clarke@noaa.gov
Purpose	Survey fish, deep coral and sponge communities in areas of interest to MBNMS managers
Vessel	NOAA Research Vessel <i>Fulmar</i>
Science Observers	M. Elizabeth Clarke, Erica Fruh, Karen Grimmer, Sophie De Beukelaer, Curt Whitmire
External Video Tapes	None
Internal Video Tapes	None
Digital Still Photos	6608 images (port, starboard and angled)
Positioning System	Ship: GPS; AUV: USBL
CTD Sensors	Yes
O₂ Sensor	Yes
pH Sensor	No
Specimens collected	No
Maximum depth	361 meters
Minimum depth	94 meters
Time arrived at bottom (UTC)	2017/07/10 15:49:27
Time departed bottom (UTC)	2017/07/10 19:22:10
Duration of mission	3:32:24
Report Authors	M. Elizabeth Clarke, Erica Fruh, Karen Grimmer, Sophie De Beukelaer, Curt Whitmire, Abigail Powell

This dive was zig-zag pattern starting on a flat area at about 90 meters depth (Table 4) at the top of Soquel Canyon. The dive then proceeded down the canyon to about 360 meters depth and then up the canyon wall (Figure 14). After two-thirds of the dive had been completed, the AUV hit a rock or ledge and was unable to navigate forward. The dive was aborted and the AUV was recovered with no damage.

Physical Environment

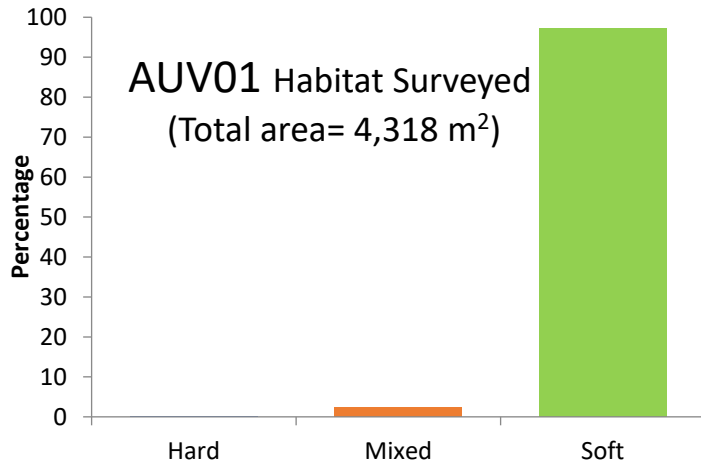


Figure 15. Percent habitat (hard, mixed, sediment) observed along quantitative segments.

A total of 4,813 m² of seafloor was surveyed by the AUV (Figure 15). Habitat types classified from the AUV images comprised mostly (>97%) soft habitat (mud or mixed mud and sand) and essentially no < 0.5% hard habitat and low amounts (2.5%) of mixed habit.

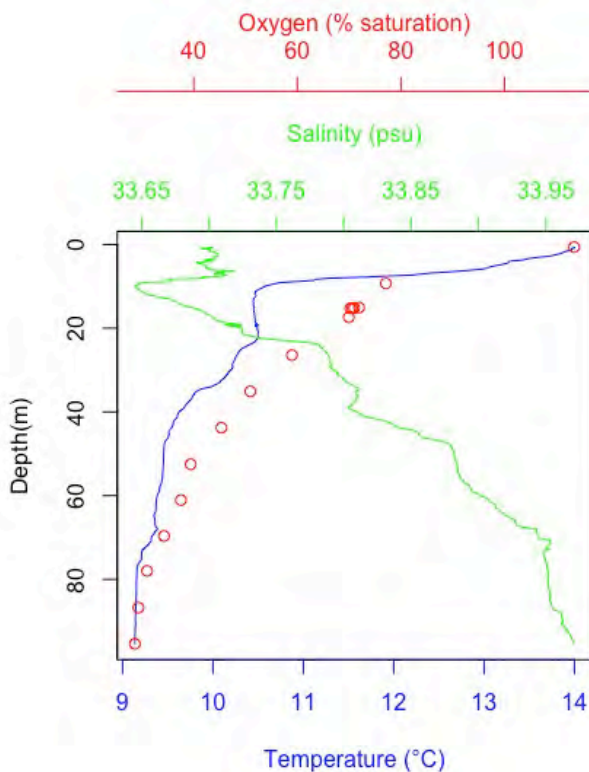


Figure 16. Salinity, temperature, and oxygen saturation by depth on AUV01 during descent.

We collected data on depth, temperature, conductivity, and dissolved oxygen during the AUV dive. We plotted the vertical profile of temperature, salinity, and oxygen during the descent of the AUV (Figure 16). There was evidence of a halocline and thermocline at 10 meters. Oxygen saturation declined from 98% saturation at the surface to 20% saturation at depth. While the AUV was at depth oxygen saturation ranged from 20% to 12% saturation

Biological Environment

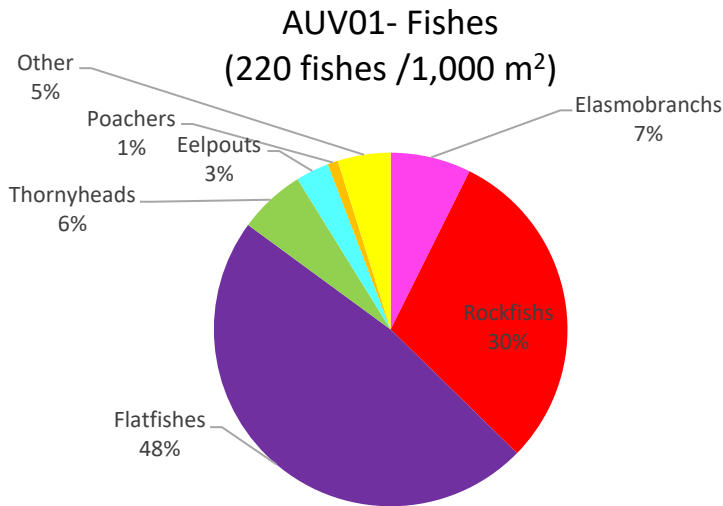


Figure 17. Percentage of fishes by group for AUV01 (Colors in pie diagram match the colors in the Table 5 below)

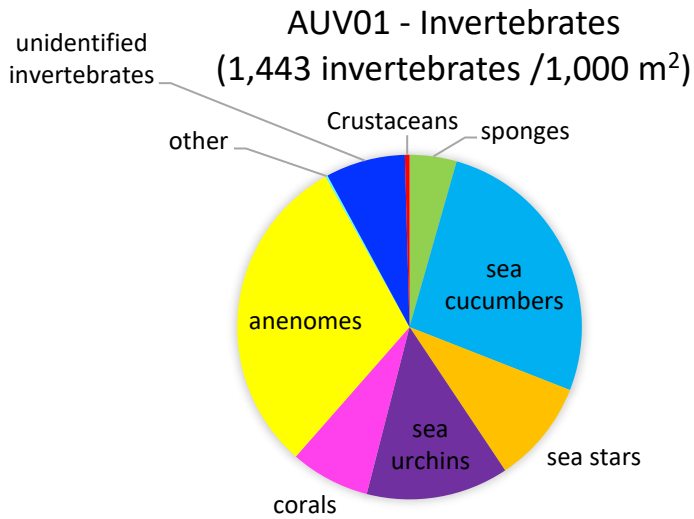


Figure 18. Percentage of invertebrates by group for AUV01 (Colors in pie diagram match the colors in the Table 6 below)

A total of 951 fishes comprised 23 taxa. We estimated a density 220 fishes per 1,000 m² in the AUV surveys (Table 5) . The assemblages were dominated by flatfishes, in particular by sanddabs and unidentified and juvenile rockfishes (Figure 17). Skate egg cases, unidentified thornyheads, and eelpouts were also abundant.

Unlike the subsequent dives, in this case, most of the identifiable macroinvertebrates were counted. The invertebrate biota was dominated by sea cucumbers and anemones (Table 6). Sea stars, sea pens, sea urchins, brachiopods and sponges were also abundant (Figure 18). Mound sponges were the most abundant sponge. Small numbers of spot prawns also were seen.

Table 5. Fish taxa and abundance AUV01

	Scientific Name	Common Name	Count
	Rajidae	Skate egg case	70
	Agonidae	Unidentified poachers	9
	Zoarcidae	Unidentified eelpouts	1
	<i>Lycodes diapterus</i>	Black eelpout	28
	Cottidae	Unidentified sculpins	6
	<i>Citharichthys sordidus</i>	Pacific sanddab	5
	<i>Citharichthys</i> spp.	Unidentified sanddab	282
	<i>Eopsetta jordani</i>	Petrale sole	30
	<i>Eopsetta jordani/Hippoglossoides elassodon</i>	Petrale or flathead sole	6
	<i>Lepidopsetta bilineata</i>	Southern rock sole	2
	<i>Parophrys vetulus</i>	English sole	12
	Pleuronectiformes	Unidentified flatfish	117
	Osteichthyes	Unidentified fishes	39
	<i>Sebastes goodei</i>	Chilipepper rockfish	1
	<i>Sebastes elongatus</i>	Greestriped rockfish	82
	<i>Sebastes hopkinsi</i>	Squarespot rockfish	2
	<i>Sebastes saxicola</i>	Stripetail rockfish	8
	<i>Sebastes wilsoni/Sebastes emphaeus</i>	Pygmy/Puget Sound rockfish	10
	Unidentified Sebastomus	White spotted rockfishes	51
	<i>Sebastes</i> spp.	Rockfish Unidentified/juvenile rockfish	131
	<i>Sebastolobus alascanus</i>	Shortspine thornyhead	1
	<i>Sebastolobus</i> spp.	Unidentified thornyhead	57
	<i>Zaniolepis</i> spp.	Combfish	1

Table 6. Invertebrate taxa and abundance AUV01

	Scientific Name	Common Name	Count
	Porifera	Mound sponge	1
	<i>Poecillastra tenuilaminaris</i>	Fringed shelf sponge	2
	Porifera	Unidentified sponge	272
	<i>Psolus sp.</i>	Common sea cucumber	1237
	<i>Parastichopus californicus</i>	California sea cucumber	13
	<i>Apostichopus leukothele</i>	Giant orange sea cucumber	261
	<i>Parastichopus spp.</i>	Giant red sea cucumber	3
	Holothuroidea	Unidentified sea cucumber	138
	<i>Ceramaster patagonicus</i>	Cookie star	1
	<i>Pteraster tesselatus</i>	Slime star	1
	<i>Rathbunaster sp./Pycnopodia sp.</i>	Sunflower stars	278
	<i>Stylasterias forreri</i>	Velcro star	36
	Asteroidea	Unidentified sea stars	287
	<i>Echinocardium cordatum</i>	Sea potato	1
	Echinoidea	Unidentified sea urchin	831
	<i>Pennatula phosphorea</i>	Common sea pen	7
	<i>Pennatula sp.</i>	Sea pen	48
	<i>Ptilosarcus gurneyi</i>	Fleshy/orange sea pen	11
	Pennatulacea	Unidentified sea pens	2
	Alcyonacea	Unidentified gorgonian	395
	Dendrophylliidae	Unidentified cup corals	2
	<i>Urticina columbiana</i>	Crusty red anemone	5
	<i>Urticina sp.</i>	Pink and white spot anemone	10
	<i>Metridium sp.</i>	Plumose anemone	8
	Actiniaria	Unidentified anemone	1872
	<i>Cancer sp.</i>	Unidentified crab	9
	<i>Pandalus platyceros</i>	Spot prawns	18
	Nudibranchia	Unidentified nudibranchs	1
	<i>Tritonia spp.</i>	Tritonia nudibranch	6
	Unidentified Octopoda	Octopus	5
	Unidentified invertebrates		465

Marine debris and anthropogenic impacts

Several derelict prawn traps were seen (Figure 19) during the AUV dive and an unidentified small torpedo shaped object (Figure 20) and there was evidence of a drag mark that may have been caused by fishing gear (Figure 21). This area has been historically fished so it is not surprising that some fishing gear was evident.

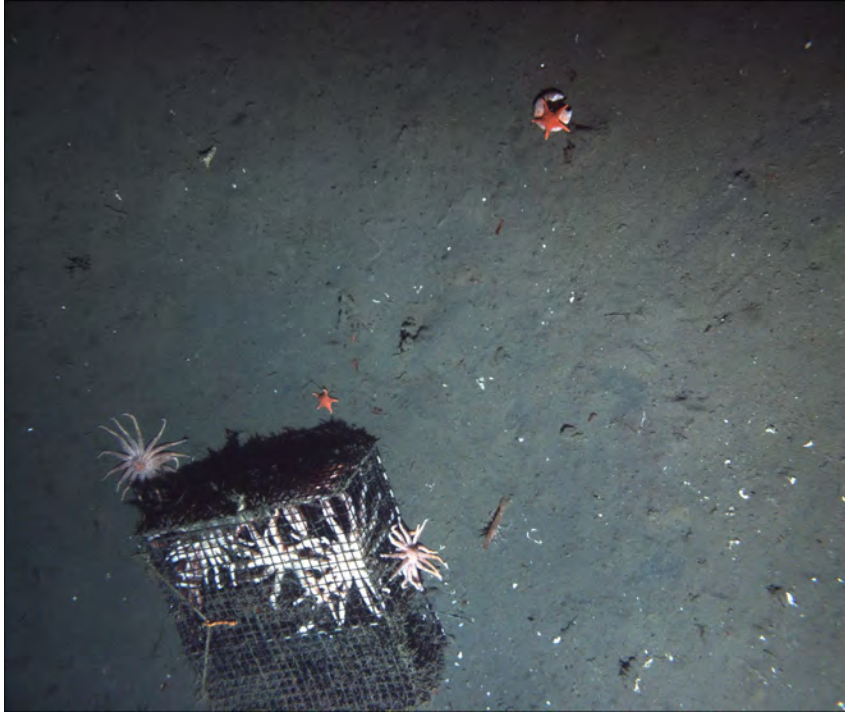


Figure 19. Derelict prawn trap (Image 20170710.194458.05383, latitude: 36.80503, longitude: -122.085, depth: 250.07 m, substrate: MM)



Figure 20. Small blue torpedo shaped debris (possibly corroded metal - could be ordinance) (Image 20170710.171632.02044, latitude: 36.81275, longitude: -122.069, depth: 98.96 m, substrate: MM)



Figure 21. Anthropogenic drag mark on the seafloor (Image 20170710.165416.01543, latitude: 36.81106, longitude: -122.066, depth: 95.38 m, substrate: MM)

Image gallery AUV01



Pennatula phosphorea (Image 20170710.182617.03613, latitude: 36.80705, longitude: -122.075, depth: 105.06 m, substrate: MM)



Chilipepper rockfish (Image : 20170710.184721.04087, latitude: 36.80464, longitude: -122.077, depth: 145.82 m, substrate: MM)



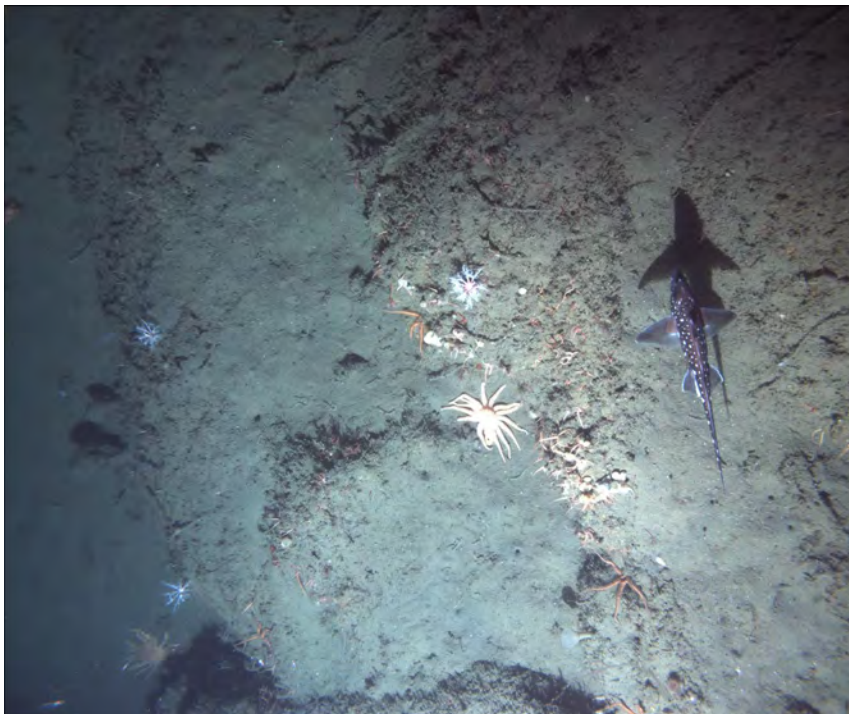
Petrale sole, *Ptilosarcus gurneyi*, combfish, and unidentified rockfish (Image: 20170710.182657.03627, latitude:36.806973 longitude: -122.075427 depth: 106 m, substrate: MM)



Juvenile yelloweye rockfish, pygmy rockfish and skate egg case (Image 20170710.184745.04096, latitude: 36.80459, longitude: -122.077, depth: 146.66 m, substrate: MM)



Greenspotted rockfish near large boulder (Image 20170710.194730.05439, latitude: 36.805098, longitude: -122.08560 depth: 236 m, substrate: MR)



Ratfish in flat rock habitat (Image 20170710.193106.05070, latitude: 36.804391, longitude: -122.083143, depth: 345 m, substrate: FF)

AUV02 – Site 1 – Davenport Reef, VMA Closure

General Location and Dive Tracks

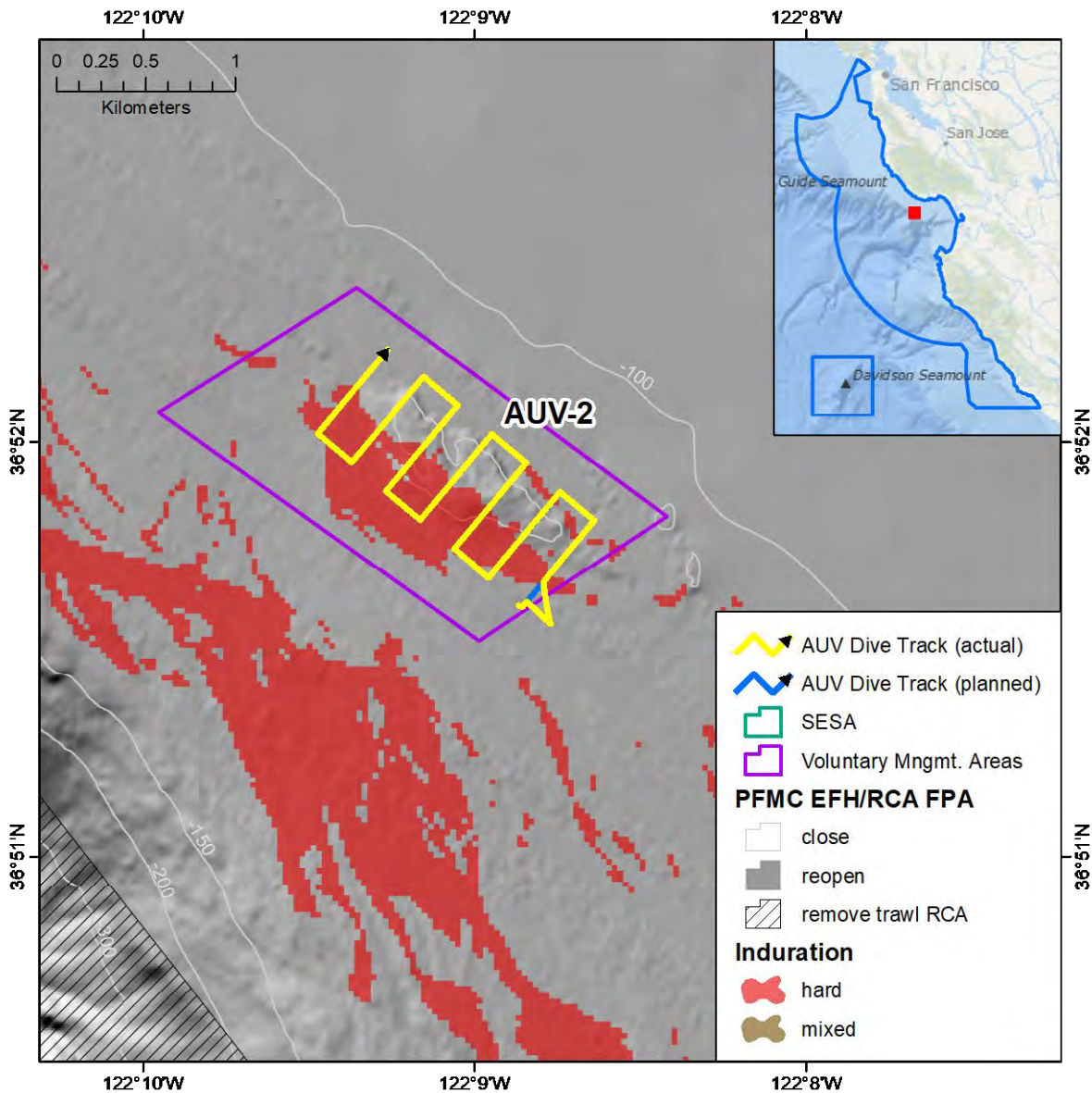


Figure 22. AUV02 - Site 1 Davenport Reef, proposed Voluntary Management Area (VMA) closure. Locations of planned and actual dive tracks of the autonomous underwater vehicle (AUV). Depth contours are in meters.

Site Overview

Table 7. Summary Site Data for Site 1 – AUV02

Contact Information	NOAA NWFSC elizabeth.clarke@noaa.gov
Purpose	Survey fish, deep coral and sponge communities in areas of interest to MBNMS managers
Vessel	NOAA Research Vessel <i>Fulmar</i>
Science Observers	M. Elizabeth Clarke, Erica Fruh, Karen Grimmer, Sophie De Beukelaer, Curt Whitmire
External Video Tapes	None
Internal Video Tapes	None
Digital Still Photos	5927 (Angled, port, and starboard)
Positioning System	Ship: GPS; AUV: USBL
CTD Sensors	Yes
O₂ Sensor	Yes
pH Sensor	No
Specimens collected	No
Maximum Depth	103 meters
Minimum Depth	91 meters
Time arrived bottom (UTC)	2017/07/11 15:39:26
Time depart bottom (UTC)	2017/07/11 21:02:18
Duration of Mission	05:22:52
Authors of Report	M. Elizabeth Clarke, Erica Fruh, Karen Grimmer, Sophie De Beukelaer, Curt Whitmire, Abigail Powell

AUV02 was a sparse grid dive offshore of Davenport and south of Davenport reef, from 91 to 103 meters (Table 7). The dive started at the southeast end of the reef and proceeded in a series of legs in a sparse grid pattern toward the top of the shallow reef (Figure 22). This dive encompassed most of a voluntary management area, which was selected by trawl fishermen and the Monterey Collaborative group as an “area to avoid”.

Physical Environment

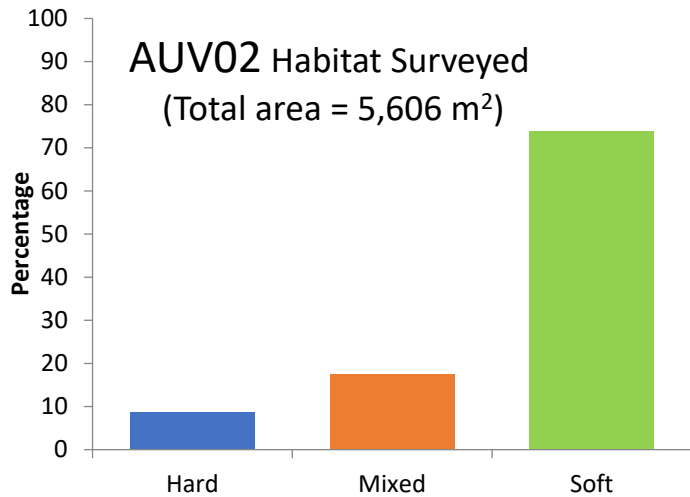


Figure 23. Relative amounts of hard, mixed and soft habitats at AUV02.

Approximately 5,606 m² of area was categorized as either hard, soft, or mixed at Site 1 (Figure 23). Most of the habitat was categorized as soft (75%), however a significant amount of the habitat was mixed (17%) and hard (9%).

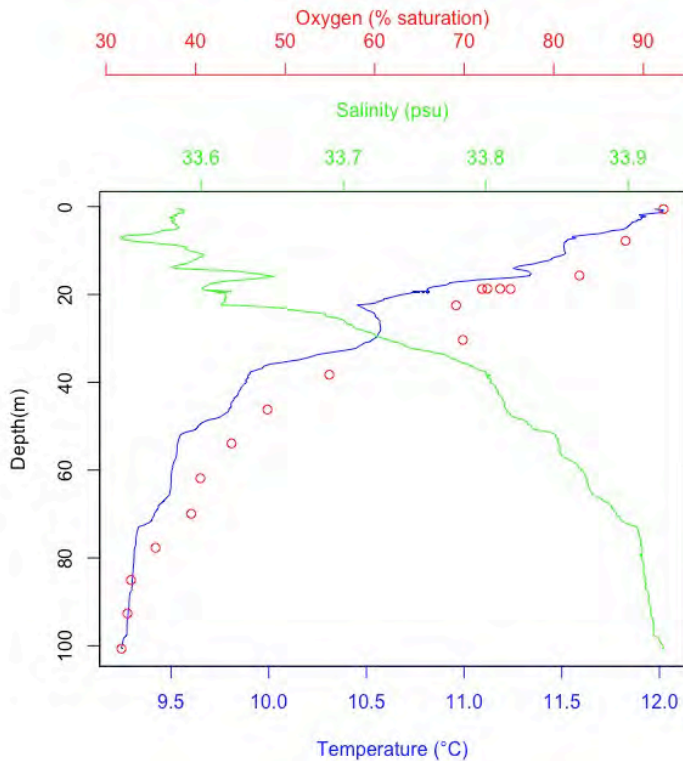


Figure 24. Salinity, temperature, and oxygen saturation by depth on AUV02 during descent.

There was no evidence of a strong thermocline at this site. Oxygen saturation declined from 98% saturation at the surface to 32% at 100 meters (Figure 24). The saturation declined to 30% over the course of the dive along the seafloor.

Biological Environment

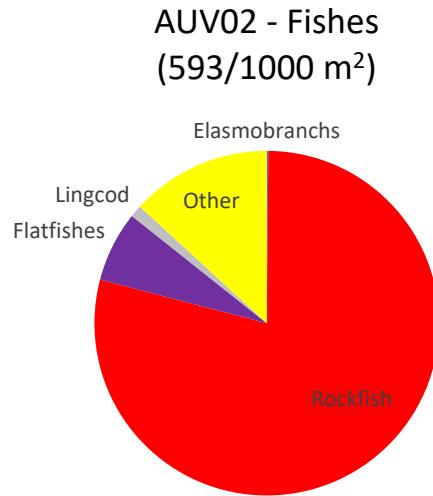


Figure 25. Percentage of fishes by group for AUV02 (Colors in pie diagram match the colors in the Table 8 below)

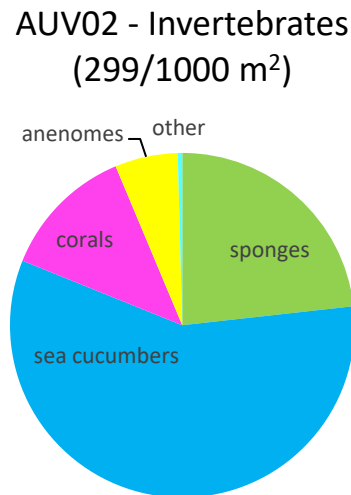


Figure 26. Percentage of invertebrates by group for AUV02 (Colors in pie diagram match the colors in the Table 9 below)

A total of 3,326 fish in 30 taxa were identified on this dive (Table 8). Fish abundance during this dive was estimated to be 593/1000m² (Figure 25). Unidentified rockfish and juvenile rockfish (Figure 27) were the most abundant fish. Flatfishes were also abundant. Water clarity was poor during this dive and may have contributed, along with the small size of many of the rockfish, to our inability to identify small rockfishes. A number of overfished rockfish species (OFS) such as yelloweye and cowcod were observed.

Sea pens, sea cucumbers, and sponges (primarily unidentified small sponges) were the predominant invertebrates at this site (Figure 26, Table 9). Crinoids were also abundant (Figure 28) but not enumerated.

Table 8. Fish taxa and abundance AUV02

	Scientific Name	Common Name	Count
	Rajidae	Unidentified skate	1
	Rajidae	Skate egg case	4
	Agonidae	Unidentified poachers	1
	Cottidae	Unidentified sculpins	3
	<i>Glyptocephalus zachirus</i>	Rex sole	1
	<i>Microstomus pacificus</i>	Dover sole	1
	<i>Citharichthys</i> spp.	Unidentified sanddab	33
	<i>Eopsetta jordani/Hippoglossoides elassodon</i>	Petrале or flathead sole	1
	<i>Lepidopsetta bilineata</i>	Southern rock sole	1
	<i>Parophrys vetulus</i>	English sole	8
	Pleuronectiformes	Unidentified flatfish	175
	Osteichthyes	Unidentified fishes	432
	<i>Sebastes diploproa</i>	Splitnose rockfish	6
	<i>Sebastes levis</i>	Cowcod rockfish	3
	<i>Sebastes chlorostictus</i>	Greenspotted rockfish	5
	<i>Sebastes elongatus</i>	Greenstriped rockfish	38
	<i>Sebastes hopkinsi</i>	Squarespot rockfish	29
	<i>Sebastes saxicola</i>	Stripetail rockfish	4
	<i>Sebastes wilsoni/Sebastes emphaeus</i>	Pygmy/Puget Sound rockfish	15
	Unidentified Sebastomus	White spotted rockfishes	144
	<i>Sebastes miniatus</i>	Vermillion rockfish	3
	<i>Sebastes constellatus</i>	Starry rockfish	10
	<i>Sebastes ruberrimus</i>	Yelloweye rockfish	4
	<i>Sebastes ovalis</i>	Speckled rockfish	1
	<i>Sebastes babcocki</i>	Redbanded	11
	<i>Sebastes rubrivinctus/Sebastes babcocki</i>	Flag/Redbanded rockfish	2
	<i>Sebastes paucispinis</i>	Bocaccio	6
	<i>Sebastes</i> spp.	Rockfish Unidentified/juvenile rockfish	2344
	<i>Zaniolepis</i> spp.	Combfish	2
	<i>Ophiodon elongatus</i>	Lingcod	38

Table 9. Invertebrate taxa and abundance AUV02

	Scientific Name	Common Name	Count
	Porifera	Mound sponge	11
	<i>Poecillastra tenuilaminaris</i>	Fringed shelf sponge	31
	Lyssacine sponge	Glass barrel sponge	4
	Porifera	Branching sponge	3
	Porifera	Yellow sponge #1	1
	Porifera	Vase sponge	4
	Porifera	Foliose sponge	7
	Porifera	Palm frond sponge	1
	Porifera	Unidentified sponge	328
	<i>Parastichopus</i> spp.	Giant red sea cucumber	945
	Holothuroidea	Unidentified sea cucumber	26
	<i>Pennatula</i> sp.	Sea pen	4
	<i>Ptilosarcus gurneyi</i>	Fleshy/orange sea pen	2
	Pennatulacea	Unidentified sea pens	169
	Alcyonacea	Unidentified gorgonian	35
	<i>Swiftia</i> sp.	Deep water sea fan	1
	<i>Metridium</i> sp.	Plumose anemone	96
	<i>Metridium farcimen</i>	Giant plumose anemone	3
	<i>Cancer</i> sp.	Unidentified crab	2
	Nudibranchia	Unidentified nudibranchs	5



Figure 27. School of small unidentified rockfish (Image 20170711.164318.01504, latitude: 36.86365, longitude: -122.147, depth: 96.32 m, substrate: BM)



Figure 28. A starry skate, feathery crinoids and two unidentified rockfish in 100 m depth rocky habitat that will be voluntarily avoided in the future by the trawl fishery. (Image 20170711.173311.02626, latitude: 36.86368, longitude: -122.15, depth: 94)

Marine Debris and Anthropogenic Impacts

A rope or cable, a small rectangular object, and a rag were the only marine debris encountered (Figures 29-31) at this site.



Figure 29. A rope or cable on large boulders (Image 20170711.164742.01603, latitude: 36.8632, longitude: -122.147, depth: 94.77 m, substrate: BM)



Figure 30. Rectangular piece of debris (Image 20170711.160646.00682, latitude: 36.86216, longitude: -122.145, depth: 97.67 m, substrate: BM)

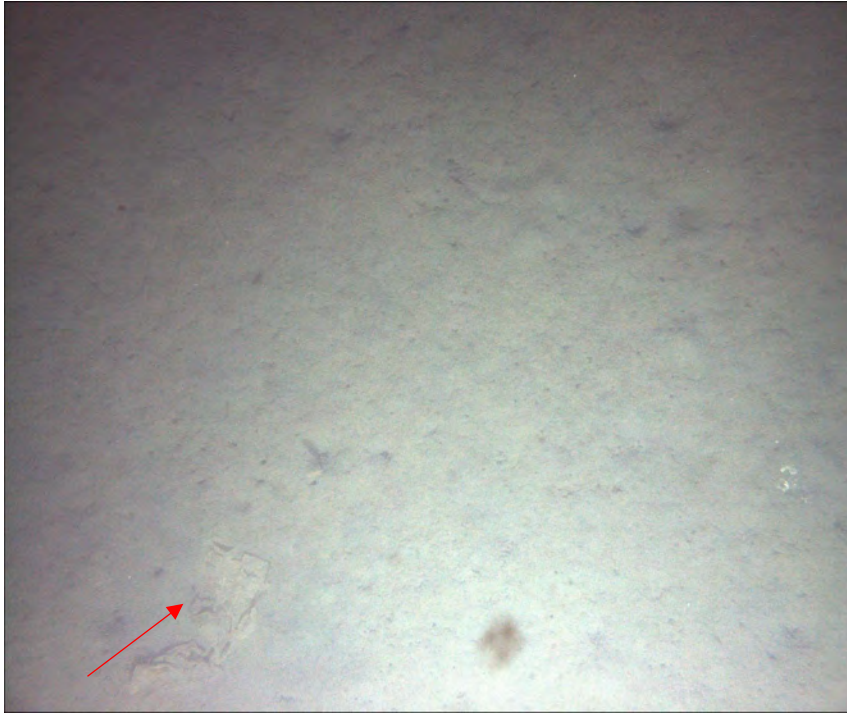
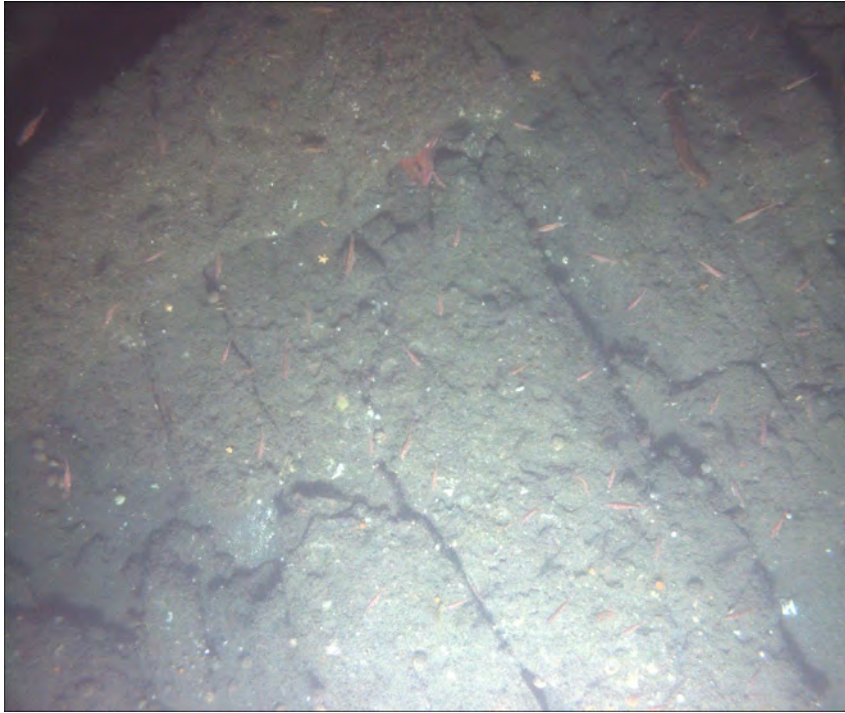


Figure 31. A rag on the seafloor (Image 20170711.194121.05509, latitude: 36.86926, longitude: -122.153, depth: 98.58 m, substrate: MM)

Image Gallery AUV02



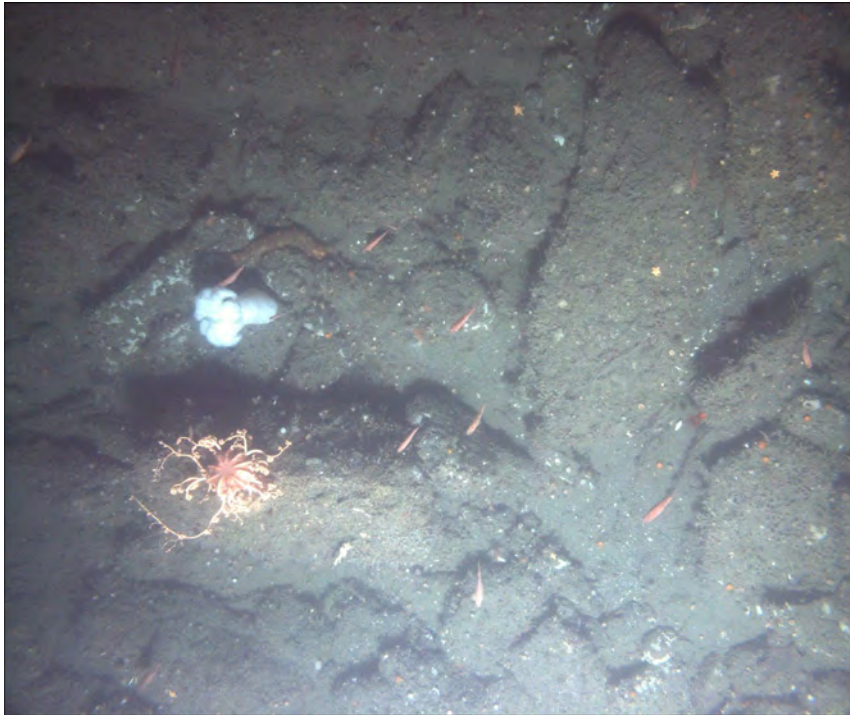
Numerous little red rockfish and a larger unidentified rockfish peeking out from rocks (Image 20170711.164534.01555, latitude: 36.86342, longitude: -122.147, depth: 93.55 m, substrate: FF)



Vermillion rockfish, bocaccio rockfishes and lingcod on flat rock (Image 20170711.172343.02413, latitude: 36.86271, longitude: -122.151, depth: 100.7 m, substrate: FF)



Flatfish on soft bottom (Image 20170710.170448.01780, latitude: 36.81186, longitude: -122.067, depth: 97.42 m, substrate: MM)



Metridium sp., basketstar, little red rockfish and *Parastichopus sp.* on boulders (Image 20170711.195145.05743, latitude: 36.86828, longitude: -122.154, depth: 97.69 m, substrate: CB)

AUV03 – Site 5 – Ascension Canyon, EFH Closure

General Location and Dive Tracks

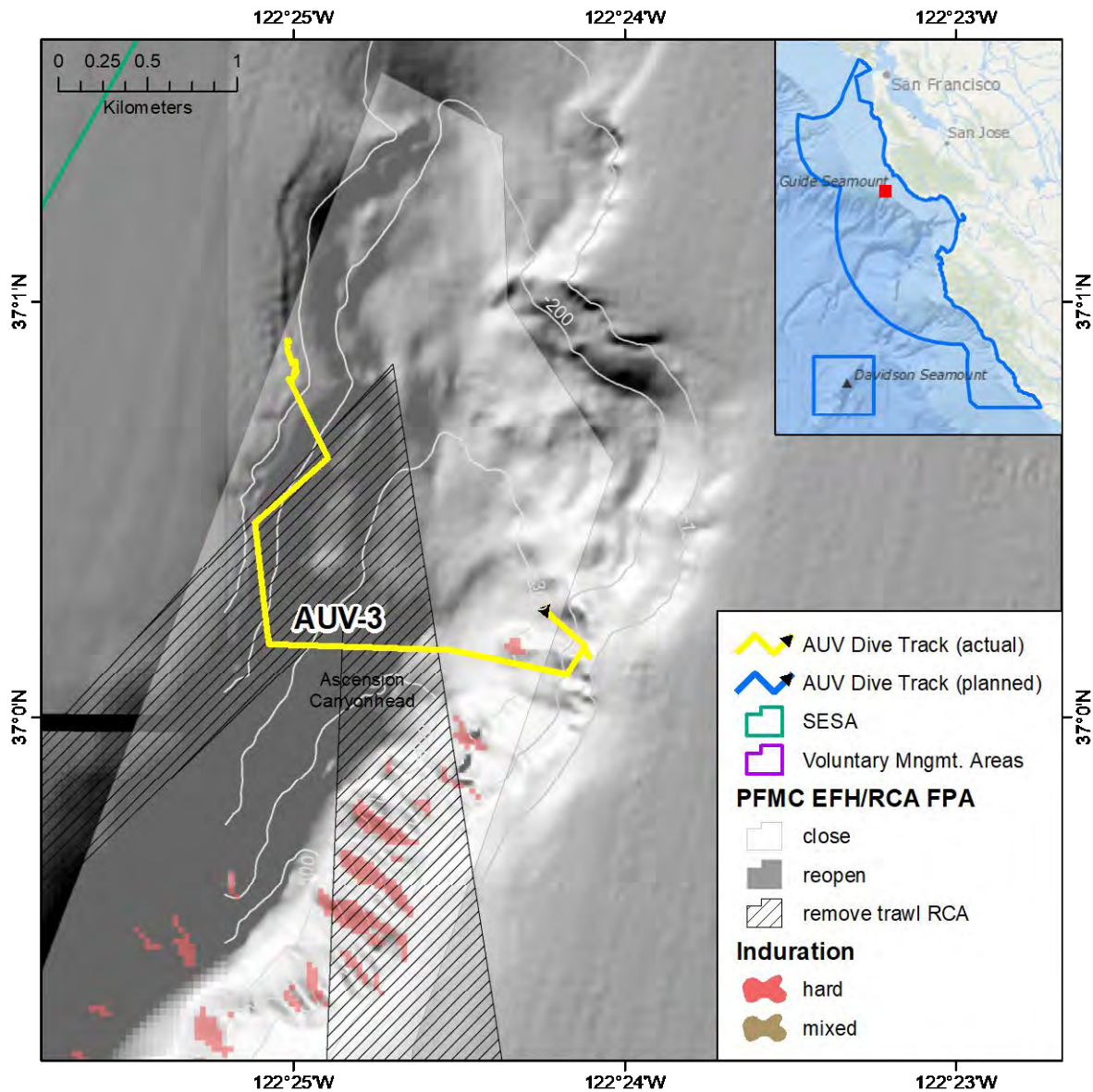


Figure 32. Dive 3, Site 5, Ascension Canyon, proposed for an EFH closure for trawl fishery. Locations of planned and actual dive tracks of the autonomous underwater vehicle (AUV). Depth contours are in meters.

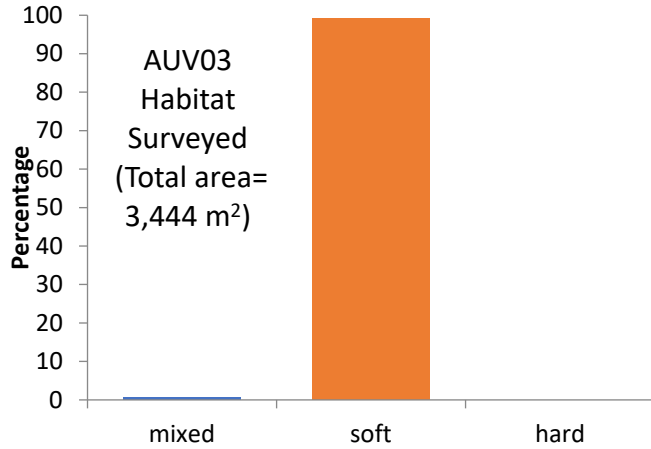
Site Overview

Table 10. Summary site data for Site 5 – AUV03.

Contact Information	NOAA NWFSC elizabeth.clarke@noaa.gov
Purpose	Survey fish, deep coral and sponge communities in areas of interest to MBNMS managers
Vessel	NOAA Research Vessel <i>Fulmar</i>
Science Observers	M. Elizabeth Clarke, Erica Fruh, Karen Grimmer, Sophie De Beukelaer, Curt Whitmire
External Video Tapes	None
Internal Video Tapes	None
Digital Still Photos	6062 (Angled, port, and starboard).
Positioning System	Ship: GPS; AUV: USBL
CTD Sensors	Yes
O₂ Sensor	Yes
pH Sensor	No
Specimens collected	No
Maximum Depth	384 meters
Minimum Depth	134 meters
Time arrived at bottom (UTC)	2017/07/12 16:28:53
Time departed bottom (UTC)	2017/07/12 20:00:16
Duration of mission	03:31:23
Authors of report	M. Elizabeth Clarke, Erica Fruh, Karen Grimmer, Sophie De Beukelaer, Curt Whitmire, Abigail Powell

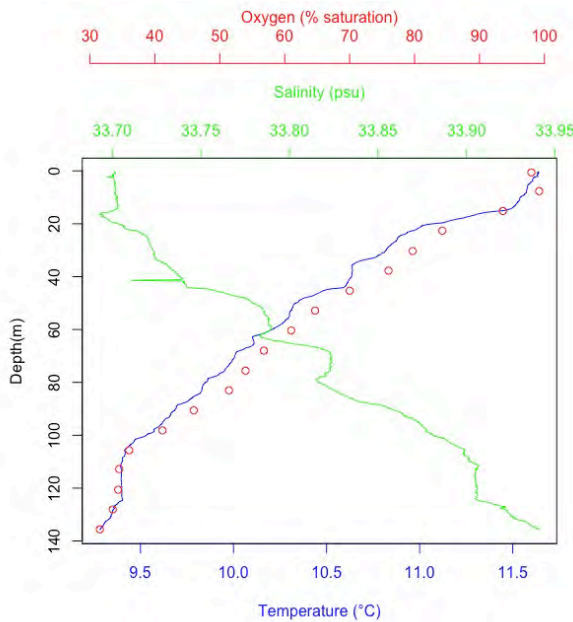
Dive AUV03 was a haphazard set of segments that started from the top of Ascension Canyon and moved across a Rockfish Conservation Area (RCA) into waters as deep as 384 meters (Table 10). The dive then continued up a slope north of the RCA (Figure 3). At about 1:30pm the vehicle gave a signal that it was in the same place, and then began to ascend. The survey ended and it was discovered that the AUV had lost the 8lb ballast weight when it bumped into a ledge or wall in the canyon.

Physical Environment



A total of 3,444 m² was categorized as either mixed, soft, or hard. Almost all the habitat was categorized as soft. None of the habitat was categorized as hard and less than 1% was mixed (Figure 33).

Figure 33. Relative amounts of hard, mixed and soft habitats at AUV03.



We collected data on depth, temperature, conductivity, and dissolved oxygen during the AUV dive. We plotted the vertical profile of temperature, salinity, and oxygen during the descent of the AUV (Figure 34). There was no clear thermocline. Oxygen saturation declined from 98% saturation at the surface to 30% saturation at depth. While the AUV was a depth, oxygen saturation varied only slightly from 30% to 28.5%.

Figure 34. Salinity, temperature, and oxygen saturation by depth on AUV03 descent.

Biological Environment

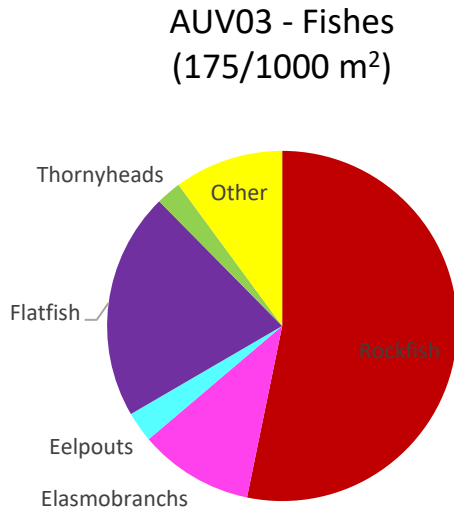


Figure 35. Percentage of fish by group for AUV03. Colors in pie diagram match the colors in the Table 11 below.

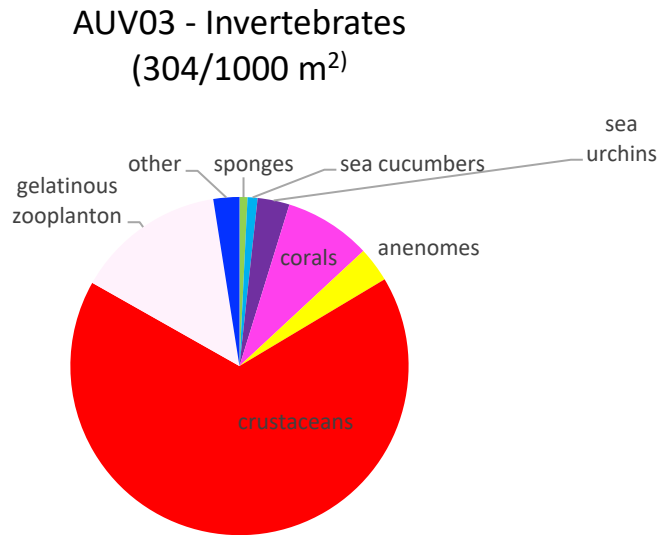


Figure 36. Percentage of invertebrates by group for AUV03. Colors in pie diagram match the colors in the Table 12 below.

A total 605 fishes in 21 taxa were identified. The overall density of fish was 175/1000 m² (Figure 35, Table 11). Unidentified and juvenile rockfish were the most abundant fish taxon. Rockfish along with flatfish comprised 74% of the total fish.

This area was characterized by high numbers of spot prawns. Spot prawns were the dominant invertebrates at Site 5 (Figure 36 and 37, Table 12). Spot prawns were seen in large groups generally facing in the same direction. While transiting in the water column many jellyfish were seen (possibly a cross jellyfish *Mitrocoma sp.*) and some jellyfish were also observed on the sea floor.

Table 11. Fish taxa and abundance AUV03.

	Scientific Name	Common Name	Count
	<i>Myxinidae</i>	Unidentified hagfish	1
	<i>Raja rhina</i>	Longnose skate	2
	Rajidae	Unidentified skate	3
	Rajidae	Skate egg case	59
	Agonidae	Unidentified poachers	4
	Zoarcidae	Unidentified eelpouts	1
	<i>Lycodes cortezianus</i>	Bigfin eelpout	2
	<i>Lycodes diapterus</i>	Black eelpout	14
	<i>Glyptocephalus zachirus</i>	Rex sole	30
	<i>Microstomus pacificus</i>	Dover sole	18
	Pleuronectiformes	Unidentified flatfish	79
	Osteichthyes	Unidentified fishes	46
	<i>Sebastes elongatus</i>	Greenstriped rockfish	12
	<i>Sebastes saxicola</i>	Stripetail rockfish	30
	Unidentified Sebastomus	White spotted rockfishes	10
	<i>Sebastes paucispinis</i>	Bocaccio	3
	<i>Sebastes crameri/Sebastes saxicola/Sebastes zacentrus</i>	Darkblotched/Stripetail/Sharpchin rockfish	57
	<i>Sebastes spp.</i>	Rockfish Unidentified./juvenile rockfish	210
	<i>Sebastolobus spp.</i>	Unidentified thornyhead	14
	<i>Zaniolepis spp.</i>	Combfish	7
	<i>Ophiodon elongatus</i>	Lingcod	3

Table 12. Invertebrate taxa and abundance AUV03.

	Scientific Name	Common Name	Count
	Porifera	Mound sponge	1
	<i>Poecillastra tenuilaminaris</i>	Fringed shelf sponge	1
	Porifera	Unidentified sponge	6
	<i>Parastichopus</i> spp.	Giant red sea cucumber	9
	Holothuroidea	Unidentified sea cucumber	1
	Echinoidea	Unidentified sea urchin	32
	<i>Pennatula phosphorea</i>	Common sea pen	21
	<i>Pennatula</i> sp.	Sea pen	27
	<i>Ptilosarcus gurneyi</i>	Fleshy/orange sea pen	1
	Pennatulacea	Unidentified sea pens	33
	Alcyonacea	Unidentified gorgonian	5
	<i>Metridium</i> sp.	Plumose anemone	35
	<i>Cancer</i> sp.	Unidentified crab	8
	<i>Metacarcinus magister</i>	Dungeness crab	1
	<i>Paralithodes rathbuni</i>	Spiny king crab	3
	<i>Pandalus platyceros</i>	Spot prawn	687
	Octopodiformes	Unidentified Octopus	11
	Decapodiformes	Unidentified squid	1
	Salpida	Unidentified salp	3
	Medusozoa	Unknown jellyfish	147
	Unidentified invertebrates		14



Figure 37. “Army” of prawns (Image 20170712.174318.01753, latitude: 37.007536, longitude: -122.418562, depth: 145.93 m, substrate: MM)

Marine Debris and Anthropogenic Impacts

Marks on the seafloor were seen on this dive (Figures 38 and 39). These drag marks may be the result of fishing activity, likely trawl fishing. A small torpedo shaped piece of debris was found. This looked to be the same as debris found during AUV01 but in both cases the debris could not be identified (Figure 40). Close examination indicates that it may be corroded copper or bronze material. One bottle was found as well (Figure 41).



Figure 38. Fishing gear drag marks on seafloor (Image 20170712.163109.00130 latitude: 37.014962, longitude: -122.417005, depth 134.98 M, substrate MM).

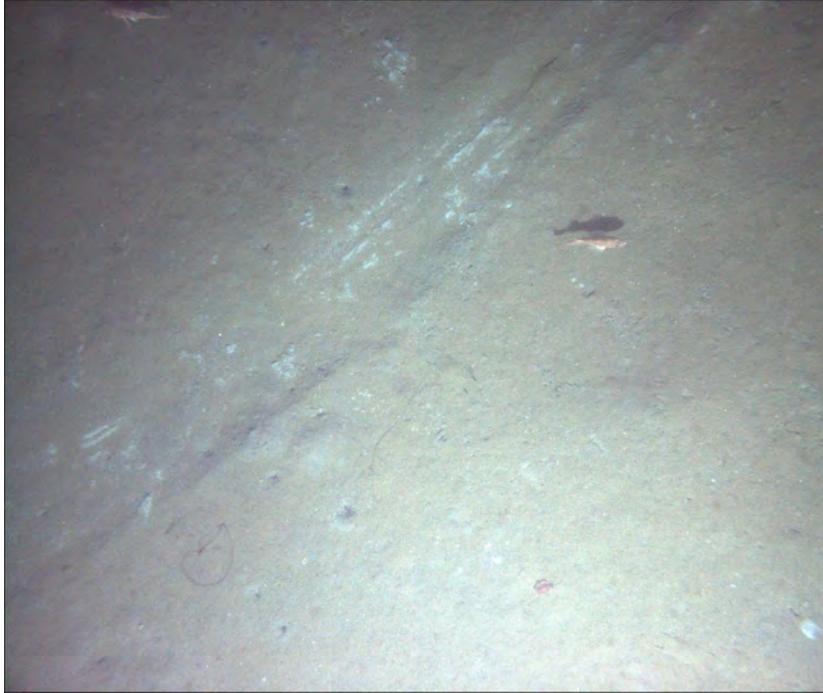


Figure 39. Fishing gear drag marks on seafloor (Image 20170712.163101.00127, latitude: 37.015036 longitude: -122.416946, depth: 135.01 m, substrate: MM)



Figure 40. Light blue torpedo shaped debris (Image 20170712.173902.01657, latitude: 37.007969, longitude: -122.418348, depth: 153.09 m, substrate: MM)



Figure 41. Green bottle debris (Image 20170712.195128.04636, latitude: 37.002132, longitude: -122.402567, depth: 212.39 m, substrate: MM)

Image Gallery AUV03



Spot prawn and rockfish standoff (Image 20170712.174246.01741 latitude: 37.007608 , longitude: -122.418573, depth: 146.14 m, substrate: MM)



Spot prawns and skate egg case (Image 20170712.174014.01684, latitude: 37.007862, longitude: -122.418498, depth: 150.58 m, substrate: MM)



Lingcod, jellyfish and crinoids (Image 20170712.194424.04477, latitude: 37.001809, longitude: -122.40346, depth: 248.82 m, substrate: MB)

AUV04 - Site 3a -South of Pt Sur Platform, VMA Closure

General Location and Dive Tracks

Figure 42. AUV04, Site 3, at a yet-to-be-named canyon south of Point Sur Platform. Locations of planned and actual dive tracks of the autonomous underwater vehicle (AUV). Depth contours are in meters. The Voluntary Management Area is located at the head of the slot canyons, between a closed EFH area and the RCA.

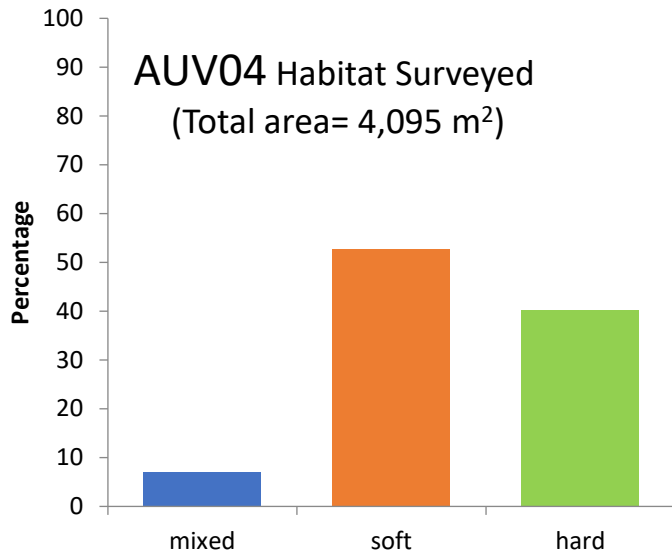
Site Overview

Table 13. Summary site data for Site 3 – AUV04.

Contact Information	NOAA NWFSC elizabeth.clarke@noaa.gov
Purpose	Survey fish, deep coral and sponge communities in areas of interest to MBNMS managers
Vessel	NOAA Research Vessel <i>Fulmar</i>
Science Observers	M. Elizabeth Clarke, Erica Fruh, Karen Grimmer, Sophie De Beukelaer, Curt Whitmire
External Video Tapes	None
Internal Video Tapes	None
Digital Still Photos	5129 (Angled, port, and starboard)
Positioning System	Ship: GPS; AUV: USBL
CTD Sensors	Yes
O₂ Sensor	Yes
pH Sensor	No
Specimens collected	No
Maximum Depth	469 meters
Minimum Depth	83 meters
Time arrived at bottom (UTC)	2017/07/13 15:54:19
Time departed bottom (UTC)	2017/07/13 19:39:18
Mission duration	03:44:59
Authors of the report	M. Elizabeth Clarke, Erica Fruh, Karen Grimmer, Sophie De Beukelaer, Curt Whitmire, Abigail Powell

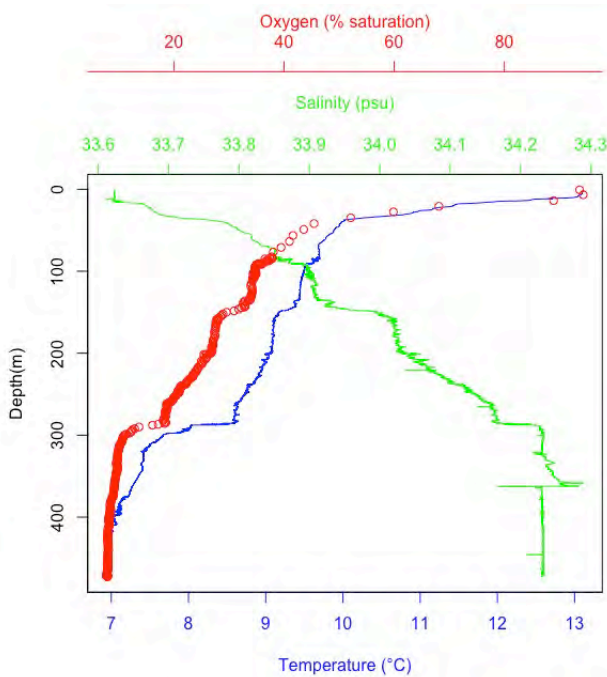
Dive AUV04 started at the Point Sur platform and proceeded in a zig-zag pattern through a Voluntary Management Area into the Rockfish Conservation Area (RCA) (Figure 42). The dive continued into the deeper waters (469 meters) (Table 13) of the Sur slot canyons, into an area proposed for reopening to historic trawl fishing (Figure 38). Until this survey, there has been little survey effort in this area.

Physical Environment



The habitat in 4,095 m² of area was categorized from images collected during this dive (Figure 43). Soft habitat comprised 53%, hard habitat 40 % and mixed habitat 7%.

Figure 43. Relative amounts of hard, mixed and soft habitats at AUV04.



Temperature values collected during the descent of the AUV indicated both a shallow (at 15 meters) (Figure 44) and deep thermocline (300 meters). Oxygen saturation declined from 95% at the surface to 8% at depth of 470 m.

Figure 44. Salinity, temperature, and oxygen saturation by depth on AUV04 descent.

Biological Environment

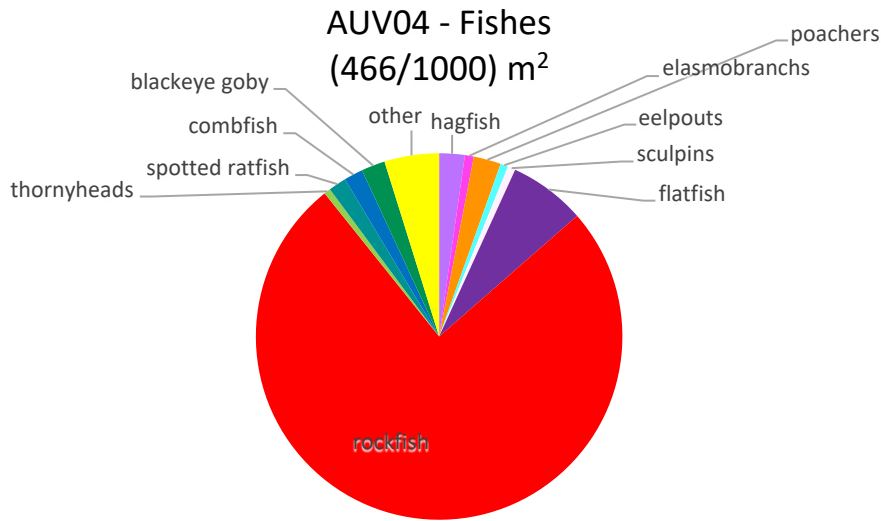


Figure 45. Percentage of fishes by group for AUV04. Colors in pie diagram match the colors in the Table 14 below.

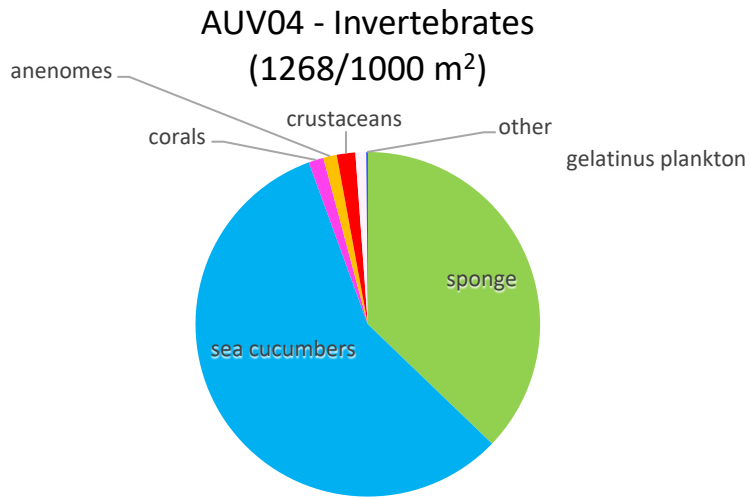


Figure 46. Percentage of invertebrates by group for AUV04. Colors in pie diagram match the colors in the Table 15 below.

At Site 3 the overall density of fish was 466/m² (Figure 45, Table 14). The most abundant fishes were rockfish, followed by flatfish, poachers, hagfish, blackeye gobies, spotted ratfish and combfish.

The sponges (Figures 46 – 48, Table 15) and the sea cucumber, *Pannychia moseleyi*, (Figure 49) were the most abundant invertebrates that were quantified and comprised over 94% of the total invertebrates counted. Some of the sponges were sediment covered and dead or dying (Figure 47).

Table 14. Fish taxa and abundance AUV04.

	Scientific Name	Common Name	Count
	<i>Myxinidae</i>	Unidentified hagfish	43
	<i>Raja rhina</i>	Longnose skate	3
	<i>Bathyraja trachura</i>	Roughtail skate	1
	<i>Bathyraja kincaidii</i>	Sandpaper skate	3
	Rajidae	Unidentified skate	6
	Rajidae	Skate egg case	2
	Agonidae	Unidentified poachers	46
	Zoarcidae	Unidentified eelpouts	6
	<i>Lycodes diapterus</i>	Black eelpout	7
	Cottidae	Unidentified sculpins	13
	<i>Glyptocephalus zachirus</i>	Rex sole	34
	<i>Microstomus pacificus</i>	Dover sole	64
	Pleuronectiformes	Unidentified flatfish	31
	Osteichthyes	Unidentified fishes	83
	<i>Sebastes melanostomus</i>	Blackgill rockfish	8
	<i>Sebastes chlorostictus</i>	Greenspotted rockfish	3
	<i>Sebastes elongatus</i>	Greenstriped rockfish	30
	<i>Sebastes saxicola</i>	Stripetail rockfish	1
	<i>Sebastes wilsoni/Sebastes emphaeus</i>	Pygmy/Puget Sound rockfish	29
	Unidentified Sebastomus	White spotted rockfishes	294
	<i>Sebastes rufus</i>	Bank rockfish	1
	<i>Sebastes miniatus</i>	Vermillion rockfish	3
	<i>Sebastes constellatus</i>	Starry rockfish	16
	<i>Sebastes ruberrimus</i>	Yelloweye rockfish	4
	<i>Sebastes ovalis</i>	Speckled rockfish	1
	<i>Sebastes babcocki</i>	Redbanded	3
	<i>Sebastes rosaceus</i>	Rosy rockfish	2
	<i>Sebastes crameri/saxicola/zacentrus</i>	Darkblotched/Stripetail/Sharpchin rockfish	42
	<i>Sebastes spp.</i>	Rockfish unidentified./juvenile rockfish	1008
	<i>Sebastolobus spp.</i>	Unidentified thornyhead	11
	<i>Anoplopoma fimbria</i>	Sablefish	2
	<i>Zaniolepis spp.</i>	Combfish	32
	<i>Ophiodon elongatus</i>	Lingcod	5
	<i>Hydrolagus colliei</i>	Spotted ratfish	30
	<i>Rhinogobiops nicholsii</i>	Blackeye goby	40
	Ophidiidae	Cusk-eel	1
	<i>Anarrhichthys ocellatus</i>	Wolf-eel	1

Table 15. Invertebrate taxa and abundance AUV04

	Scientific Name	Common Name	Count
	Porifera	Mound sponge	892
	<i>Poecillastra tenuilaminaris</i>	Fringed shelf sponge	301
	Lyssacine sponge	Glass barrel sponge	45
	Porifera	Branching sponge	75
	Porifera	Yellow sponge #1	33
	Porifera	Vase sponge	14
	Porifera	Foliose sponge	34
	Porifera	Pipe sponge	185
	Porifera	Gray lobed sponge #1	1
	Porifera	Unidentified sponge	351
	<i>Pannychia moseleyi</i>	Bioluminescent sea cucumber	2890
	Holothuroidea	Unidentified sea cucumber	83
	<i>Pennatula sp.</i>	Sea pen	16
	Alcyonacea	Unidentified gorgonian	2
	Plexauridae	Swiftia type	5
	Anthozoa	Unidentified coral	50
	<i>Metridium sp.</i>	Plumose anemone	66
	<i>Paralithodes rathbuni</i>	Spiny king crab	3
	Paguroidea	Hermit crab	2
	<i>Pandalus platyceros</i>	Spot prawn	85
	Octopodiformes	Unidentified octopus	7
	Salpida	Unidentified salp	2
	Medusozoa	Unknown jellyfish	35

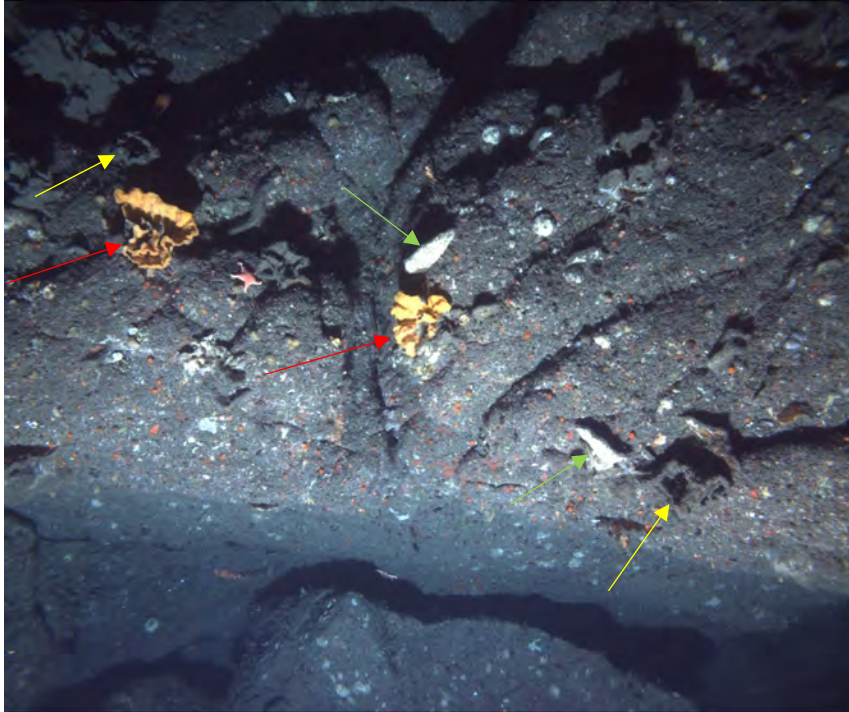


Figure 47. A sponge patch which includes *Poecillastra tenuilaminaris* (green arrows), *Heterochone calyx* (red arrows) and some dead, sediment covered sponges (yellow arrows). (Image: 20170713.155923.00181, latitude: 36.26319 longitude: -121.995327 depth: 85.0 m substrate: FF)

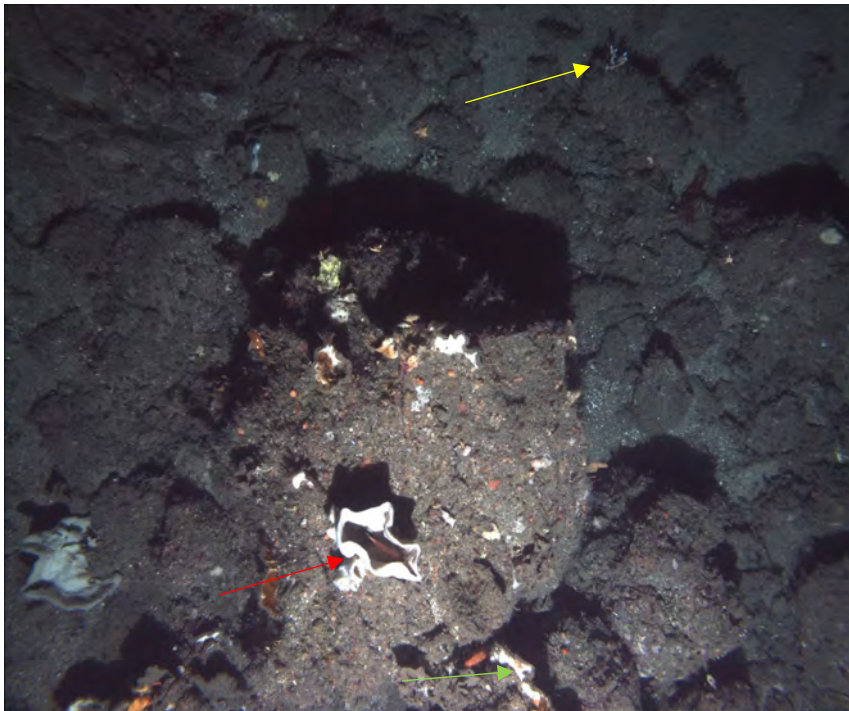


Figure 48. Boulder areas with sponges. Note the fish with the vase sponge (red arrow) and the small coral, probably *Paragorgia* (yellow arrow). Several other identifiable sponges are also present including *Poecillastra tenuilaminaris* (green arrow) (Image: 20170713.160155.00238, latitude: 36.26285 longitude: -121.99539 depth: 90.49 M substrate: BB).



Figure 49. Rex sole, pink sea urchins (*Strongylocentrotus fragili*) and bioluminescent sea cucumber *Pannychia moseleyi* Image: 20170713.181204.04060, latitude: 36.24617, longitude: -122.011286, Depth: 421 M substrate: MM.

Marine Debris and Anthropogenic Impacts

Discarded bottles were seen at six different locations at this site (Figures 50 and 51). A large torpedo shaped item (Figure 52) was also observed. *Metridium sp.* was growing on this item indicating it had been on the seafloor for some time.



Figure 50. Brown bottle marine debris (Image 20170713.172516.02113, latitude: 36.25443, longitude: -122.003, depth: 269.1 m, substrate: GG)



Figure 51. Brown bottle marine debris (Image 20170713.173716.02383, latitude: 36.25406, longitude: -122.005, depth: 300.66 m, substrate: CC)



Figure 52. Orange torpedo shaped item with *Metridium* sp. growing on it (Image 20170713.182125.03376, latitude: 36.24981, longitude: -122.009, depth: 381.75 m, substrate: MM)

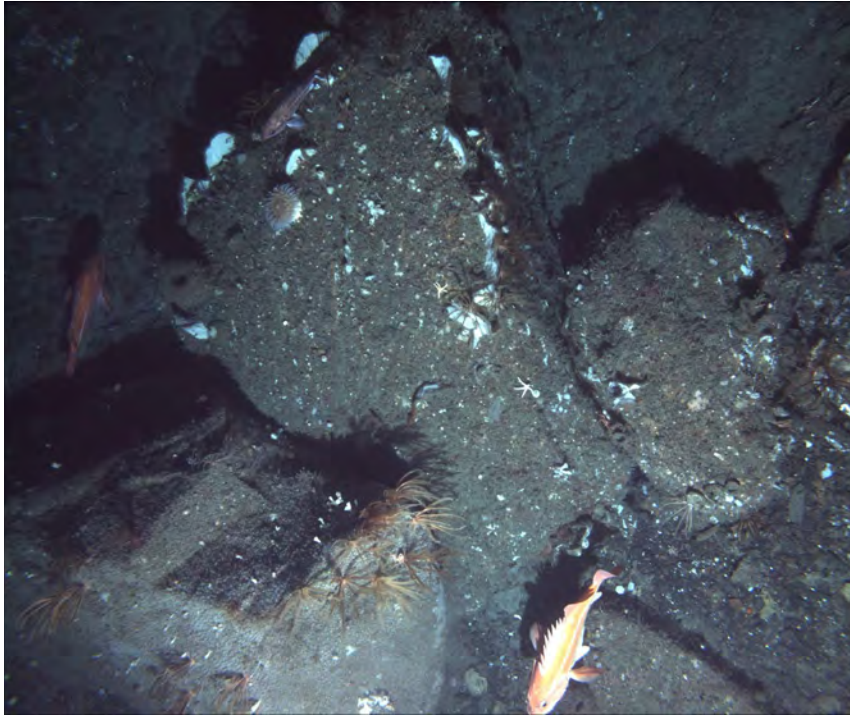
Image Gallery AUV04



Spiny king crab *Paralithodes rathbuni*, spot prawns *Pandalus platyceros* and sea cucumber *Parastichopus spp.* (Image: 20170713.173644.02371 latitude: 36.25408 longitude: 1122.0044 depth: 299.43 m substrate: MM)



Vermillion rockfish and unidentified *Sebastomus* on boulders (Image 20170713.155443.00076, latitude: 36.26379, longitude: -121.995, depth: 83.71 m, substrate: BB)



Bank rockfish and crinoids on boulders (Image 20170713.163331.00949, latitude: 36.25981, longitude: -121.998, depth: 152.93 m, substrate: BB)

AUV05 – Site 2 –Davenport Reef, EFH Closure

Location and Dive Tracks

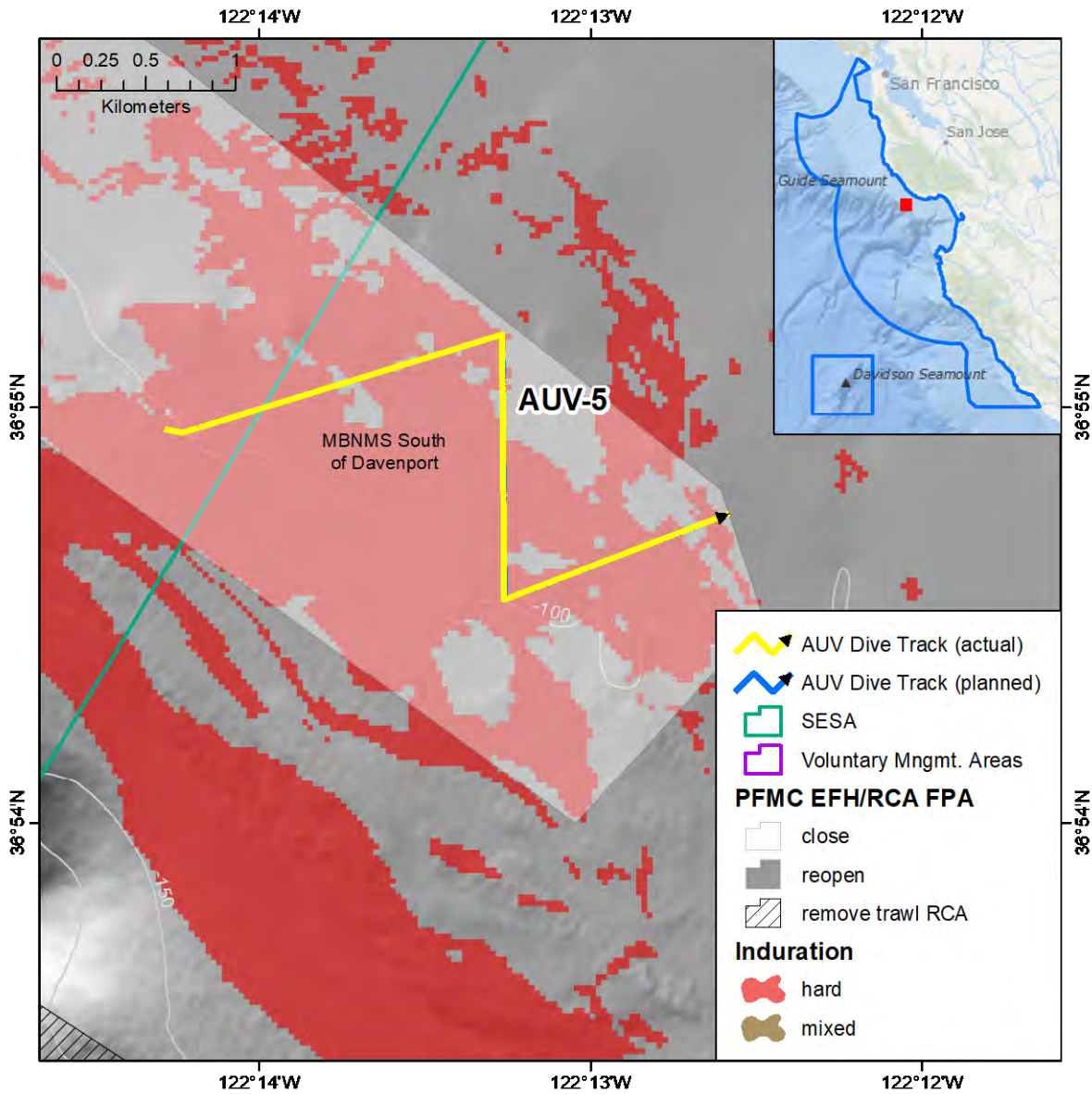


Figure 53. AUV05, Site 2 Davenport Reef Essential Fish Habitat Conservation Area Closure. Locations of planned and actual dive tracks of Autonomous Underwater Vehicle (AUV). Depth Contours are in meters.

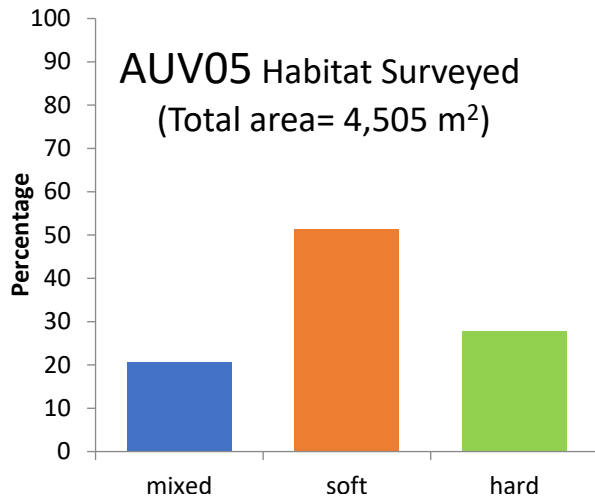
Site Overview

Table 16. Summary site data for Site 4 – AUV05

Contact Information	NOAA NWFSC elizabeth.clarke@noaa.gov
Purpose	Survey fish, deep coral and sponge communities in areas of interest to MBNMS managers
Vessel	NOAA Research Vessel <i>Fulmar</i>
Science Observers	M. Elizabeth Clarke, Erica Fruh, Karen Grimmer, Sophie De Beukelaer, Curt Whitmire
External Video Tapes	None
Internal Video Tapes	None
Digital Still Photos	5933 (Angled, port, and starboard)
Positioning System	Ship: GPS; AUV: USBL
CTD Sensors	Yes
O₂ Sensor	Yes
pH Sensor	No
Specimens collected	No
Maximum Depth	97 meters
Minimum Depth	83 meters
Time arrived at bottom (UTC)	2017/07/14 15:58:02
Time departed bottom (UTC)	2017/07/14 20:18:38
Duration of mission	04:20:36
Authors of report	M. Elizabeth Clarke, Erica Fruh, Karen Grimmer, Sophie De Beukelaer, Curt Whitmire, Abigail Powell

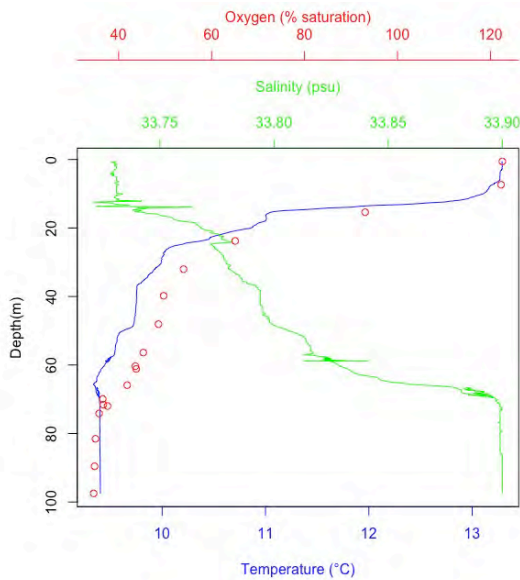
AUV05 was a zig-zag pattern over a fairly flat area between 97 and 83 meters (Figure 53, Table 16). This site is proposed for closure from trawl fishing.

Physical Environment



The habitat at this site was mostly soft (51%) but there were significant amounts of 28 % hard habitat and 21% mixed habitat (Figure 54).

Figure 54. Relative amounts of hard, mixed and soft habitats at AUV05.



At this site the water column was not well mixed and a shallow thermocline was present at 18 meters (Figure 56). Oxygen was over saturated at 122% at the surface and declined to 19% at the bottom (97 m).

Figure 55. Salinity, temperature, and oxygen saturation by depth on AUV05 descent.

Biological Environment

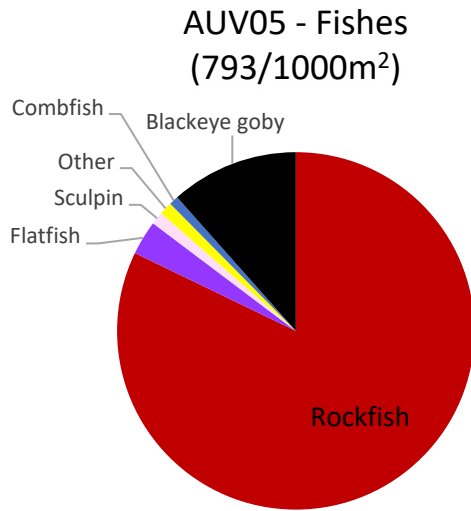


Figure 56. Percentage of fish by group for AUV05. Colors in pie diagram match the colors in the Table 17 below.

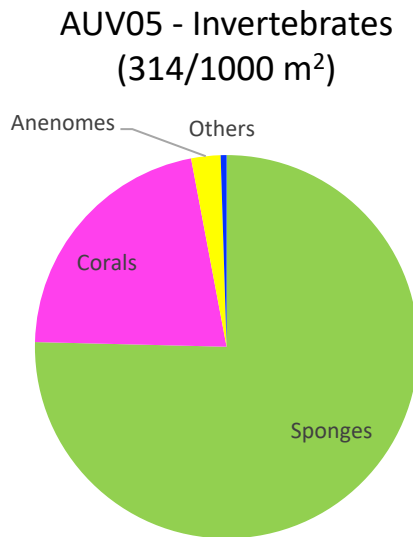


Figure 57. Percentage of invertebrates by group for AUV05. Colors in pie diagram match the colors in the Table 18 below.

Three thousand five hundred and seventy-three fish were counted on this dive. The abundance of fish was estimated to be 793/1000 m² (Figure 56, Table 17). The most abundant fish were small unidentified rockfish and juvenile rockfish. This group combined with 14 species of rockfish comprise 82% of the fish observed. Blackeye goby were very abundant at this site as well and comprised 12% of the total fish (Figure 58).

During this dive invertebrates numbered 1,410 in 18 taxa and their abundance was 314/1000 m² (Figure 57, Table 18). The dominant group quantified were sponges, followed by corals for a total 97% of the invertebrates counted. Brachiopod beds were found in patches (Figure 59) but they were not enumerated.

There was evidence of fishing debris (fishing line primarily) thus obvious that some fishing has occurred here in the past.

Table 17. Fish taxa and abundance AUV05

	Scientific Name	Common Name	Count
	<i>Myxinidae</i>	Unidentified hagfish	3
	Agonidae	Unidentified poachers	13
	Zoarcidae	Unidentified eelpouts	2
	Cottidae	Unidentified sculpins	41
	<i>Citharichthys sordidus</i>	Pacific sanddab	88
	<i>Eopsetta jordani</i>	Petrale sole	7
	<i>Parophrys vetulus</i>	English sole	1
	Pleuronectiformes	Unidentified flatfish	15
	Osteichthyes	Unidentified fishes	13
	<i>Sebastes aurora</i>	Aurora rockfish	1
	<i>Sebastes chlorostictus</i>	Greenspotted rockfish	20
	<i>Sebastes elongatus</i>	Greenstriped rockfish	25
	<i>Sebastes hopkinsi</i>	Squarespot rockfish	234
	<i>Sebastes saxicola</i>	Stripetail rockfish	3
	<i>Sebastes wilsoni/Sebastes emphaeus</i>	Pygmy/Puget Sound rockfish	49
	Unidentified Sebastomus	White spotted rockfishes	86
	<i>Sebastes constellatus</i>	Starry rockfish	24
	<i>Sebastes pinniger</i>	Canary rockfish	1
	<i>Sebastes semicinctus</i>	Halfbanded rockfish	43
	<i>Sebastes paucispinis</i>	Bocaccio	1
	<i>Sebastes rubrivinctus</i>	Flag rockfish	4
	<i>Sebastes umbrosus</i>	Honeycomb rockfish	1
	<i>Sebastes rosaceus</i>	Rosy rockfish	67
	<i>Sebastes spp.</i>	Rockfish unidentified/juvenile rockfish	2377
	<i>Zaniolepis spp.</i>	Combfish	30
	<i>Ophiodon elongatus</i>	Lingcod	6
	<i>Hexagrammus decagrammus</i>	Kelp greenling	1
	<i>Rhinogobiops nicholsii</i>	Blackeye goby	413
	Ophidiidae	Cusk-eel	4

Table 18. Invertebrate taxa and abundance AUV05

	Scientific Name	Common Name	Count
	Porifera	Mound sponge	747
	<i>Poecillastra tenuilaminaris</i>	Fringed shelf sponge	126
	Lyssacine sponge	Glass barrel sponge	18
	Porifera	Branching sponge	6
	Porifera	Vase sponge	9
	Porifera	<i>Polymastia</i> spp.	44
	Porifera	Puff ball sponge	107
	Porifera	Purple sponge #1	5
	Porifera	Unidentified sponge	4
	<i>Pennatula</i> spp.	Sea pen	2
	Pennatulacea	Unidentified sea pens	45
	<i>Swifita pacifica</i>	Red sea fan	3
	Plexauridae	Unidentified sea pens	252
	<i>Halipteris</i> spp.		3
	Anthozoa	Unidentified coral	1
	<i>Metridium farcimen</i>	Giant plumose anemone	35
	<i>Cancer</i> sp.	Unidentified crab	1
	<i>Cancer productus</i>	Red rock crab	2

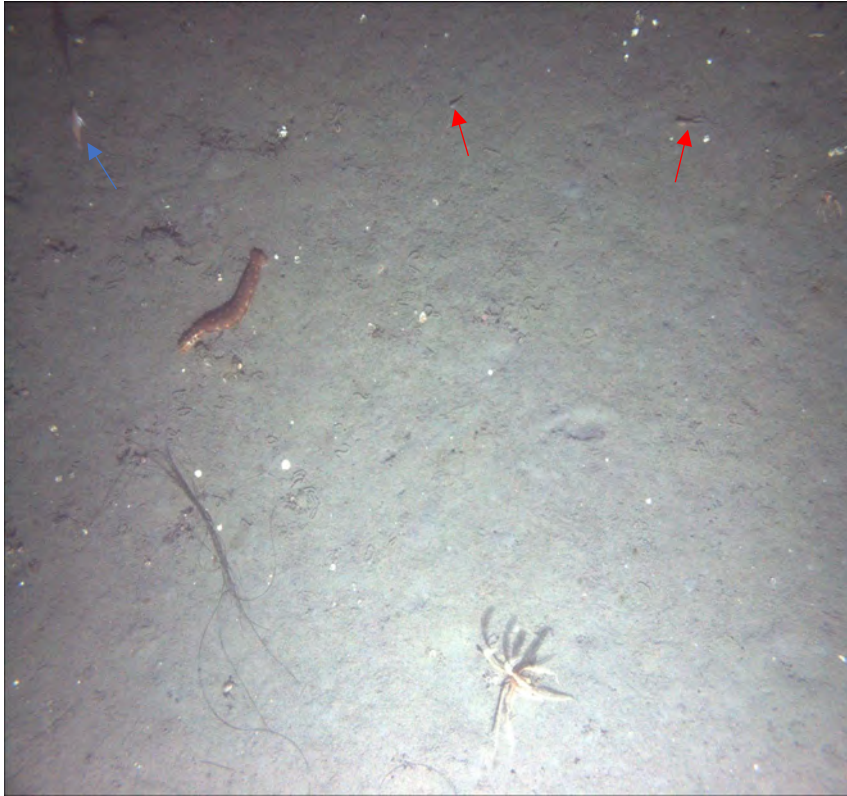


Figure 58. Black eye goby (red arrows), square spot rockfish (blue arrow) along with crinoid and sea cucumber. (image 20170714.200726.05680, latitude: 36.911882, longitude: -122.21147, depth: 91.09 m, substrate: MM)



Figure 59. Beds of brachiopods were found in patches (Image 20170714.184813.03898, latitude: 36.911284, longitude: -122.22104, depth: 92.79 m, substrate: MM)

Marine Debris and Anthropogenic Impacts

There were multiple instances of fishing line, nets, or monofilament observed in the images (Figures 60 and 61). Approximately 4% of the area quantified had remnants of these fishing gears in them. In one image a small pipe was found (Figure 62).

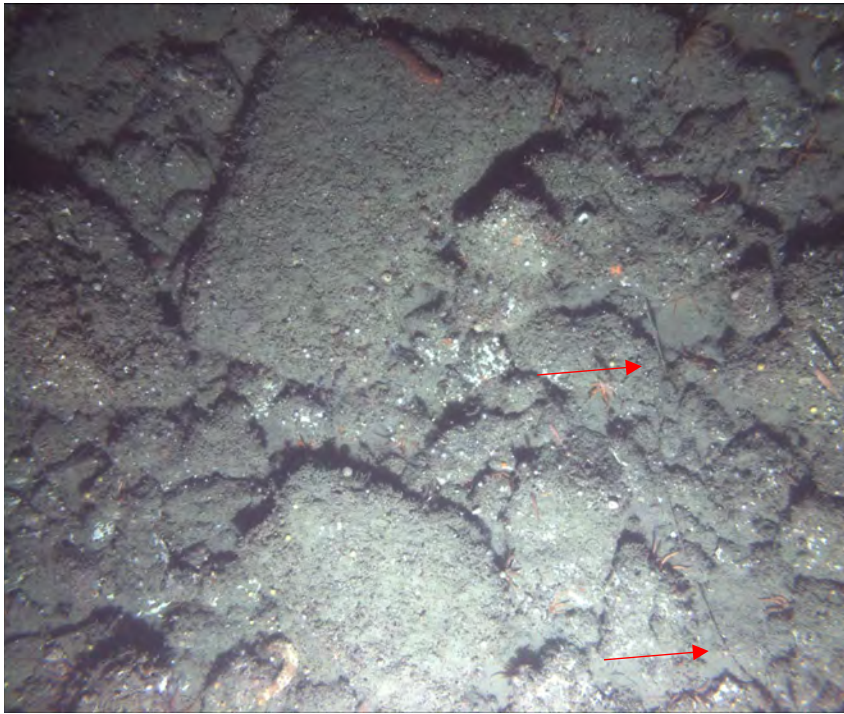


Figure 60. Fishing line (Image 20170714.180652.02968, latitude: 36.916807, longitude: -122.2211, depth: 84.84 m, substrate: BC)



Figure 61. Fishing line (Image 20170714.170059.01486, latitude: 36.917882, longitude: -122.22815, depth: 84.3 m, substrate: CC)

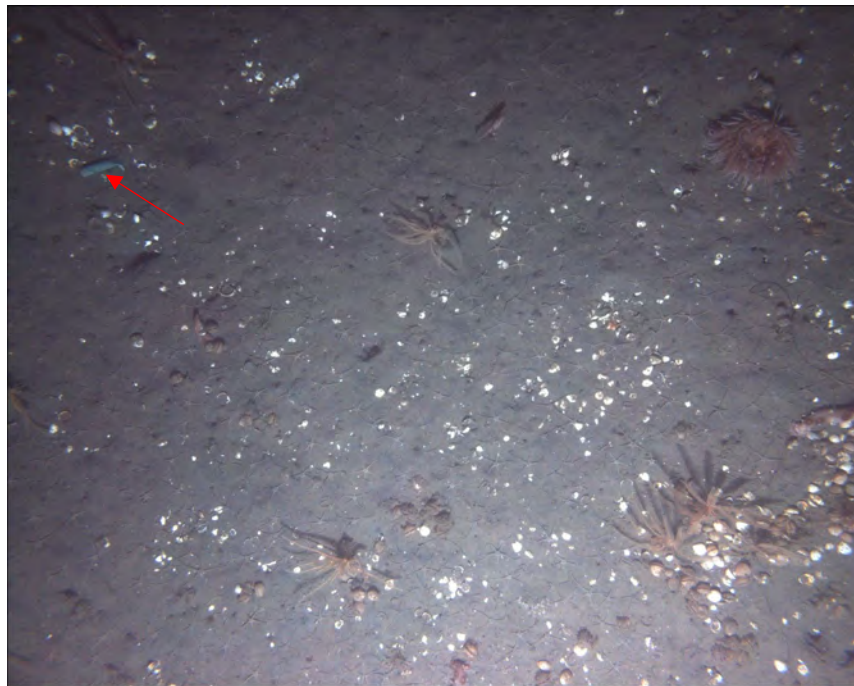
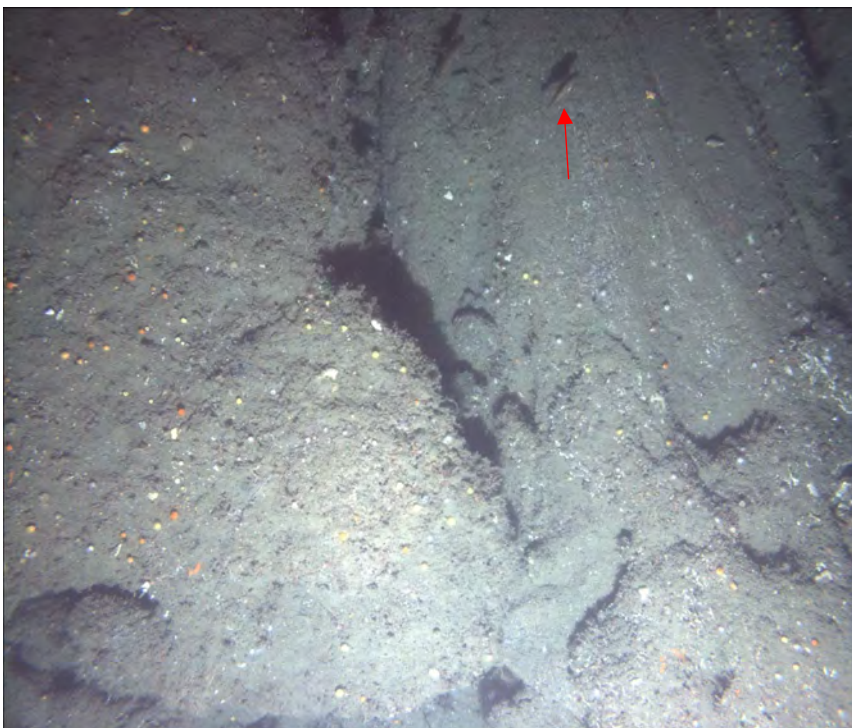


Figure 62. Pipe debris (red arrow) (Image 20170714.194757.05242, latitude: 36.91096, longitude: -122.21447, depth: 92.78 m, substrate: MM)

Image Gallery AUV05



Yellowtail Rockfish (Image 20170714.164931.01228, latitude: 36.917438, longitude: -122.22995, depth: 85.98 m, substrate: BM)



Squarespot rockfish (image 20170714.162603.00700, latitude: 36.916538, longitude: -122.23364, depth: 90.03 m, substrate: RB)

AUV06 – Site 7 – West of Carmel Canyon, EFH Re-Opening

Location and Dive Tracks

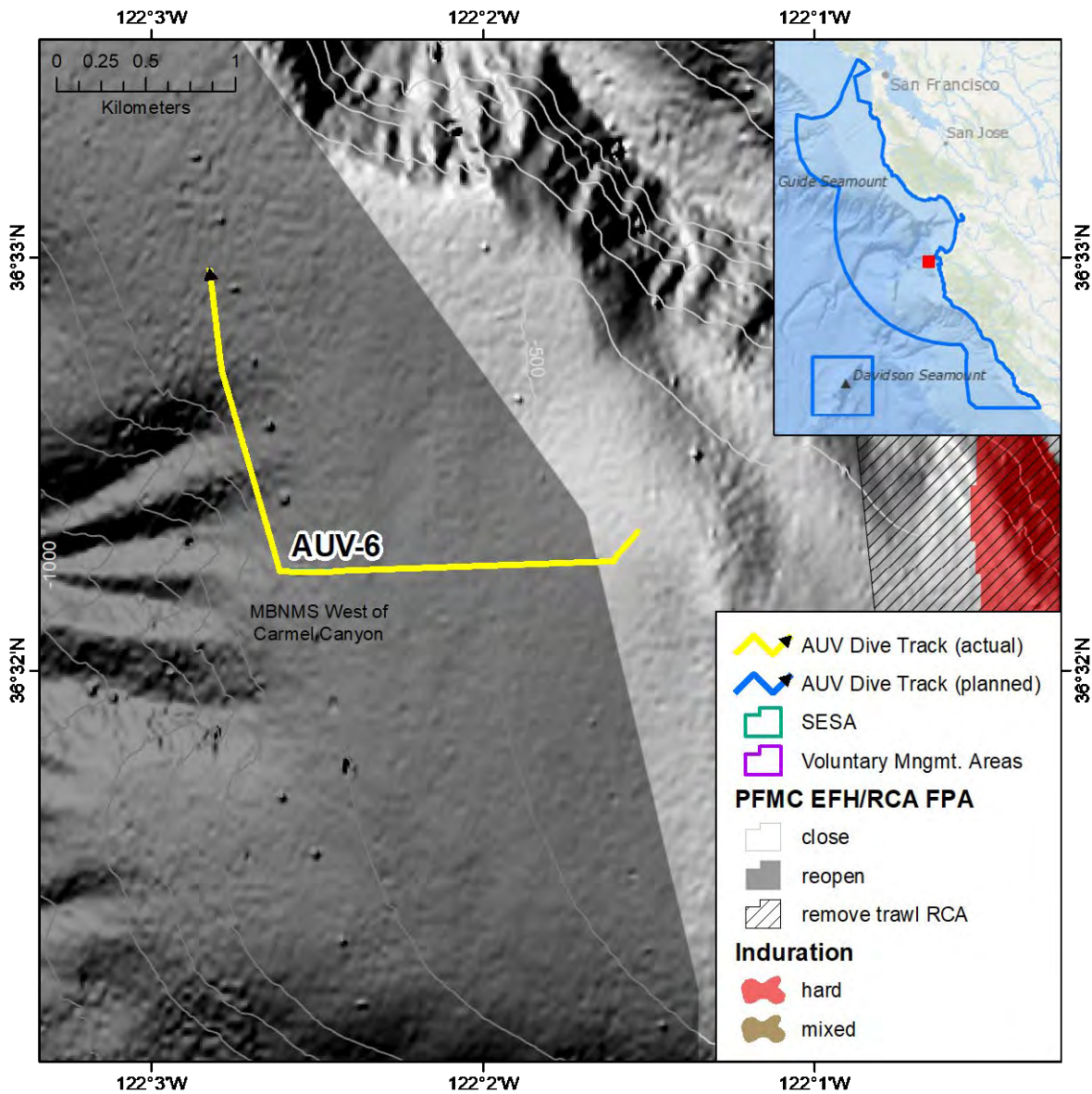


Figure 63. AUV06, Site 7, west of Carmel Canyon, and is a proposed re-opening of a trawl EFH Conservation Area. Locations of planned and actual dive tracks of the autonomous underwater vehicle (AUV). Depth contours are in meters. Until this survey, there has been little survey effort in this area.

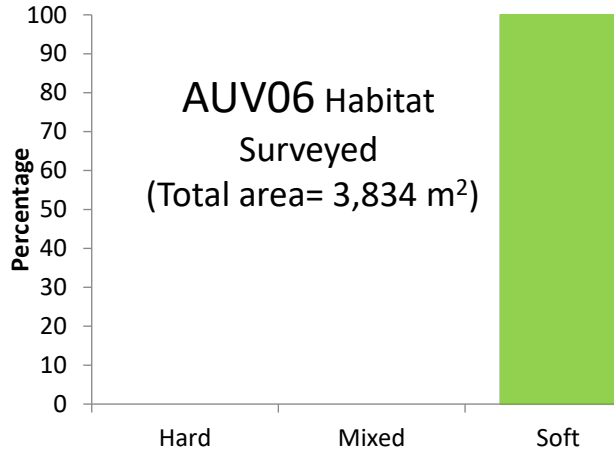
Site Overview

Table 19. Summary site data for Site 7 – AUV06.

Contact Information	NOAA NWFSC elizabeth.clarke@noaa.gov
Purpose	Survey fish, deep coral and sponge communities in areas of interest to MBNMS managers
Vessel	NOAA Research Vessel <i>Fulmar</i>
Science Observers	M. Elizabeth Clarke, Erica Fruh, Karen Grimmer, Sophie De Beukelaer, Curt Whitmire
External Video Tapes	None
Internal Video Tapes	None
Digital Still Photos	4703 (Angled, port, and starboard)
Positioning System	Ship: GPS; AUV: USBL
CTD Sensors	Yes
O₂ Sensor	Yes
pH Sensor	No
Specimens collected	No
Maximum Depth	670 meters
Minimum Depth	440 meters
Time arrived at bottom (UTC)	2017/07/15 15:25:41
Time departed bottom (UTC)	2017/07/15 18:51:27
Duration of mission	02:53:38
Authors of report	M. Elizabeth Clarke, Erica Fruh, Karen Grimmer, Sophie De Beukelaer, Curt Whitmire, Abigail Powll

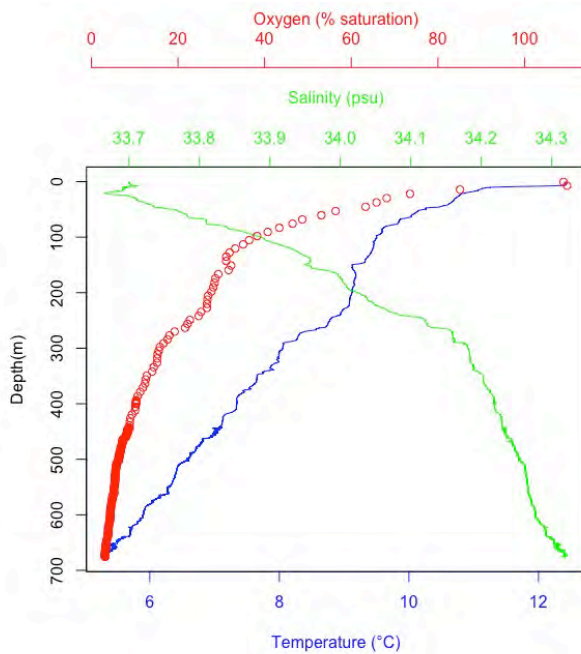
AUV06 transited, in two long legs, over an area with some distinct pock marks in deep water from 440 to 670 meters (Table 19, Figure 65). This area is proposed to be reopened to trawl fishing, as the soft sediment slope habitat provides suitable habitat for some groundfish species and the area is close to Monterey Bay ports for easier access to fishing grounds.

Physical Environment



At Site 7, approximately 3,834 m² of the habitat was categorized. All habitat was categorized as soft (Figure 64).

Figure 64. Relative amounts of hard, mixed and soft habitats at AUV06.



This was the deepest site surveyed. There was no strong thermocline evident at the site. Oxygen was oversaturated (109%) at the surface and declined to 5% at depth (Figure 65). Oxygen at this site dropped quickly starting at around a depth of 150 meters to the bottom.

Figure 65. Salinity, temperature, and oxygen saturation by depth on AUV06 descent.

Biological Environment

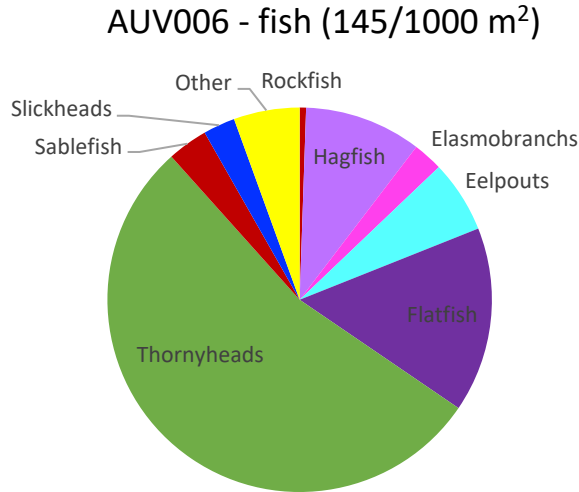


Figure 66. Percentage of fish by group for AUV06. Colors in pie diagram match the colors in the Table 20 below.

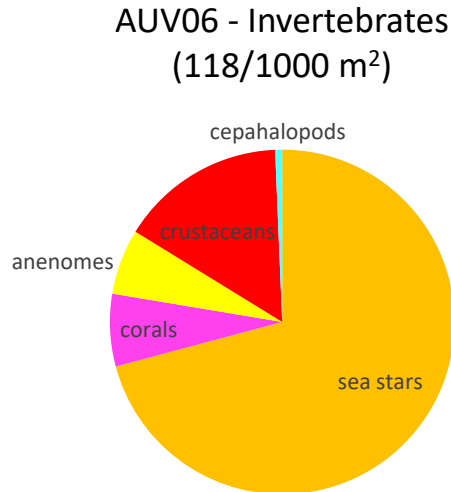


Figure 67. Percentage of invertebrates by group for AUV06. Colors in pie diagram match the colors in the Table 21 below.

The overall abundance of fish was 136/1000 m² (Figure 67, Table 20). Unidentified thornyheads were the most abundant fish at this site (Figure 68). The next most abundant fish were flatfish (primarily dover sole) and sablefish. These three species comprised 77% if the fish observed during this dive.

Brisingids were the most abundant invertebrates, followed by grooved tanner crab and sea pens respectively (Figure 69, Table 21). Sponges were not present.

Table 20. Fish taxa and abundance AUV06

	Scientific Name	Common Name	Count
	Myxinidae	Unidentified hagfish	55
	<i>Raja rhina</i>	Longnose skate	3
	<i>Bathyraja kincaidii</i>	Sandpaper skate	4
	<i>Parmaturus xaniurus</i>	Filetail catshark	4
	Scyliorhinidae	Unidentified catshark	3
	Zoarcidae	Unidentified eelpouts	28
	<i>Lycodes cortezianus</i>	Bigfin eelpout	6
	<i>Glyptocephalus zachirus</i>	Rex sole	4
	<i>Microstomus pacificus</i>	Dover sole	82
	<i>Embassichthys bathybius</i>	Deepsea sole	1
	Osteichthyes	Unidentified fishes	22
	<i>Sebastes aurora</i>	Aurora rockfish	3
	<i>Sebastolobus</i> spp.	Unidentified thornyhead	301
	<i>Anoplopoma fimbria</i>	Sablefish	19
	<i>Nezumia stelgidolepis</i>	California grenadier	1
	<i>Coryphaenoides acrolepis</i>	Pacific grenadier	1
	<i>Hydrolagus colliei</i>	Spotted ratfish	2
	<i>Careproctus melanurus</i>	Blacktail snailfish	3
	Liparidae	Unidentified snailfish	2
	Alepocephalidae	Unidentified slickhead	15

Table 21. Marine invertebrate taxa and abundance AUV06.

	Scientific Name	Common Name	Count
	Brisengida	Brisingids	323
	<i>Pennatula</i> sp.	Sea pen	10
	Pennatulacea	Unidentified sea pens	21
	<i>Liponema brevicornis</i>	Pom-pom anemone	28
	<i>Cancer</i> sp.	Unidentified crab	1
	<i>Chionoecetes tanneri</i>	Grooved tanner crab	65
	<i>Chorilia longipes</i>	Longnose decorator crab	5
	Decapodiformes	Unidentified squid	3

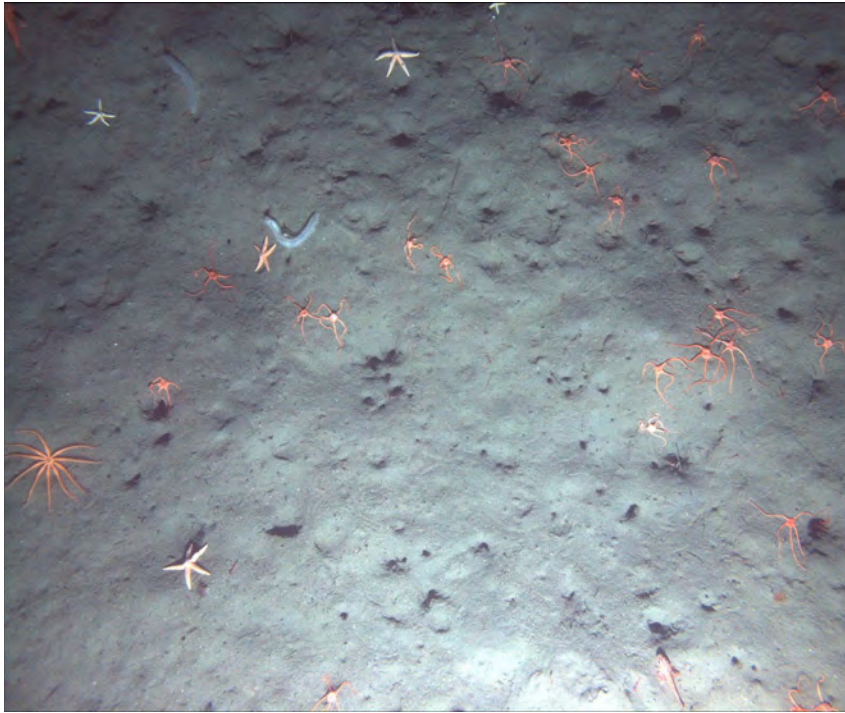


Figure 68. Thornyhead (Image 20170715.165342.02056 , latitude: 36.537373, longitude: -122.03952, depth: 569.62 m, substrate: MM)

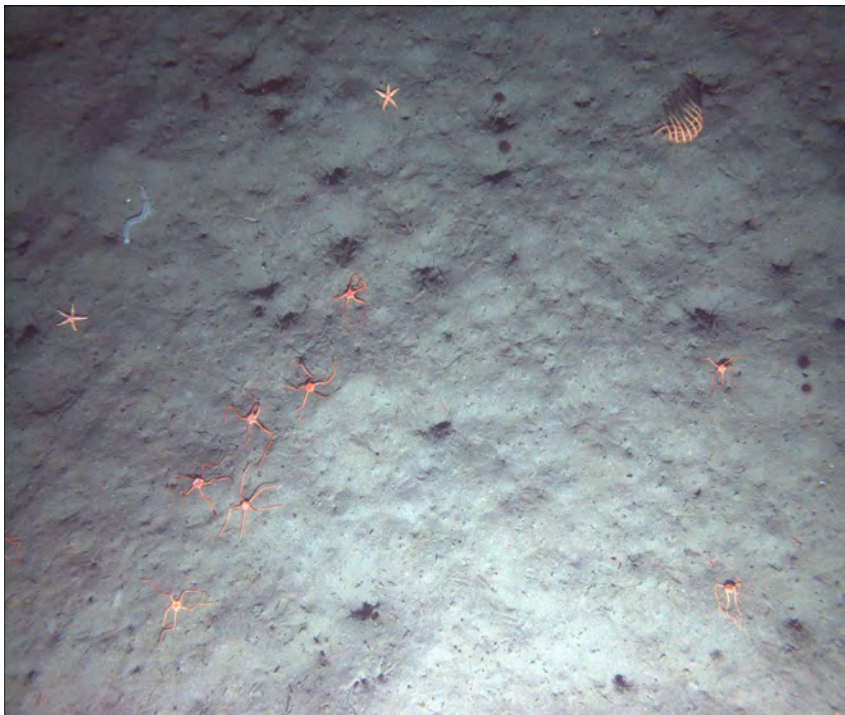


Figure 69. Brisingid (Image 20170715.164142.01786, latitude: 36.537431, longitude: -122.03751, depth: 550.14 m, substrate: MM)

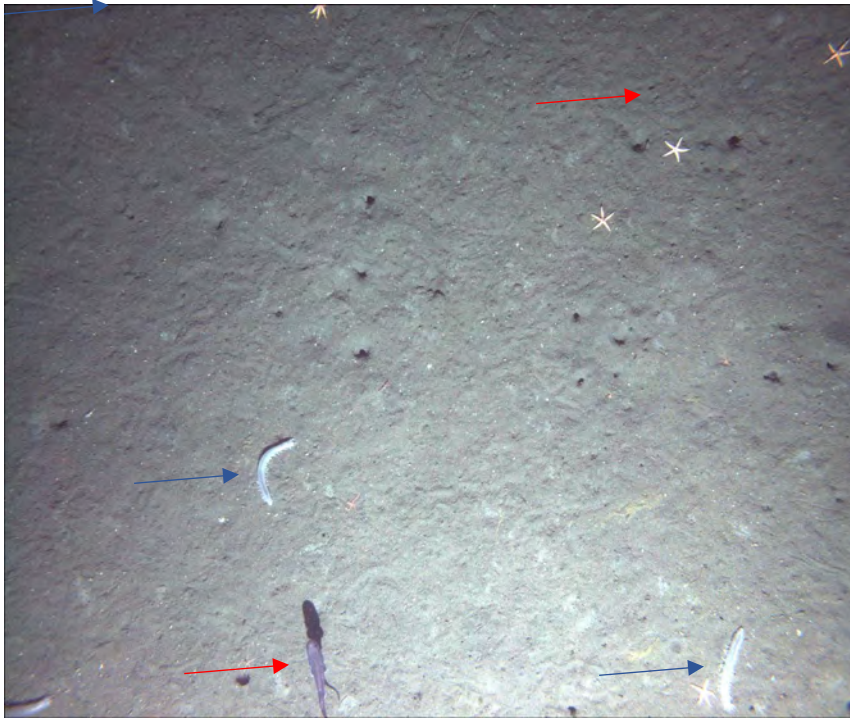
Marine Debris and Anthropogenic Impacts

Only one piece of marine debris was found, a cable floating above the bottom (Figure 65).

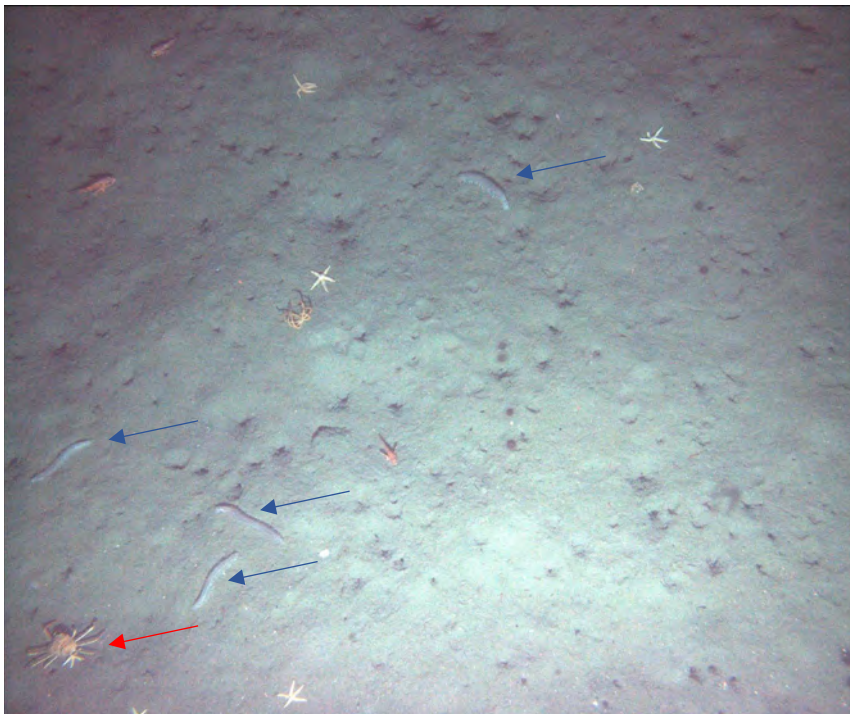


Figure 70. Cable or line (Image 20170715.153501.00286, latitude: 36.538003, longitude: -122.02658, depth: 445.95 m, substrate: MM)

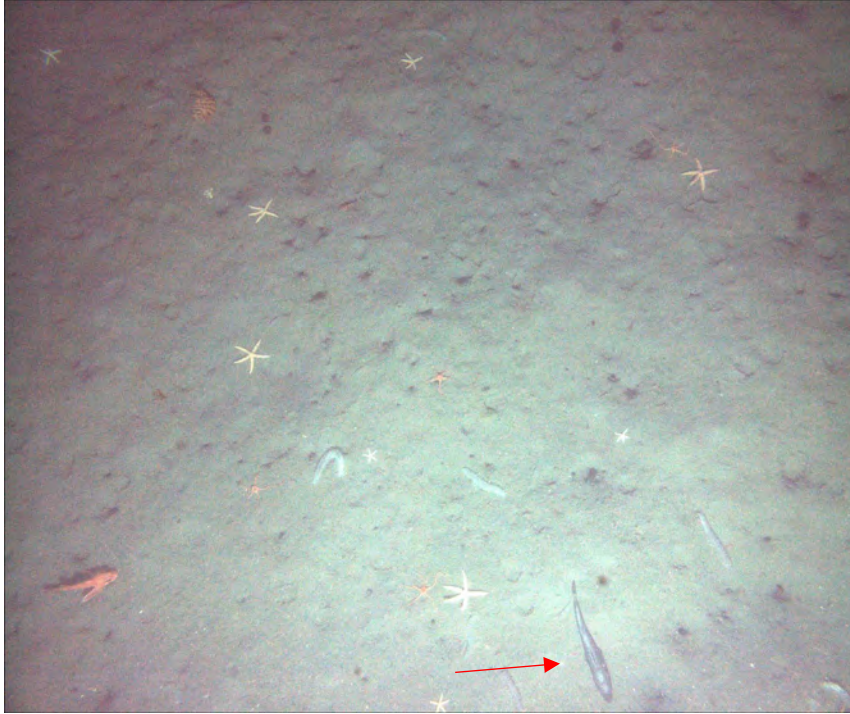
Image gallery AUV06



Filetail catshark (red arrow) and sea cucumbers (blue arrows) (Image 20170715.161014.01078, latitude: 36.537581, longitude: -122.03225, depth: 495.49 m, substrate: MM)



Grooved tanner crab (red arrow) and sea cucumbers (blue arrows) (Image 20170715.171729.02590, latitude: 36.537336, longitude: -122.04348, depth: 646.61 m, substrate: MM)



Sablefish (Image 20170715.170545.02326, latitude: 36.537316, longitude: -122.04153, depth: 605.34, substrate: MM)

Dive 7 – Site 3b – Point Sur Platform, EFH Closure

Location and Dive Tracks

Figure 71. Dive 7, Site 3b, Point Sur platform and proposed added closure for EFH Conservation Area. Locations of planned and actual dive tracks of the autonomous underwater vehicle (AUV). Depth contours are in meters.

Site Overview

Table 22. Summary site data for Site 3b – AUV07

Contact Information	NOAA NWFSC elizabeth.clarke@noaa.gov
Purpose	Survey fish, deep coral and sponge communities in areas of interest to MBNMS managers
Vessel	NOS Vessel R/V <i>Fulmar</i>
Science Observers	M. Elizabeth Clarke, Erica Fruh, Karen Grimmer, Sophie De Beukelaer, Curt Whitmire
External Video Tapes	None
Internal Video Tapes	None
Digital Still Photos	4282 (Angled, port, and starboard)
Positioning System	Ship: GPS; AUV: USBL
CTD Sensors	Yes
O₂ Sensor	Yes
pH Sensor	No
Specimens collected	No
Report Authors	Elizabeth Clarke, Erica Fruh, Melanie Johnson, Curt Whitmire, Abigail Powell
Maximum Depth	86 meters
Minimum Depth	64 meters
Time arrived at bottom (UTC)	2017/07/17 15:49:28
Time departed bottom (UTC)	2017/07/17 18:43:06
Duration of mission	02:53:38
Authors of report	M. Elizabeth Clarke, Erica Fruh, Karen Grimmer, Sophie De Beukelaer, Curt Whitmire, Abigail Powell

AUV07 was originally planned as a dive containing three long legs across the Point Sur platform. The AUV only completed three-quarters the first leg (Table 22, Figure 71). The AUV zig-zagged back and forth in a rocky area but became repeatedly stuck on obstructions and rocks and the dive was aborted. Review of the photos found the AUV was navigating across some very large fractured outcrops that look to be massive granite slabs.

Physical Environment

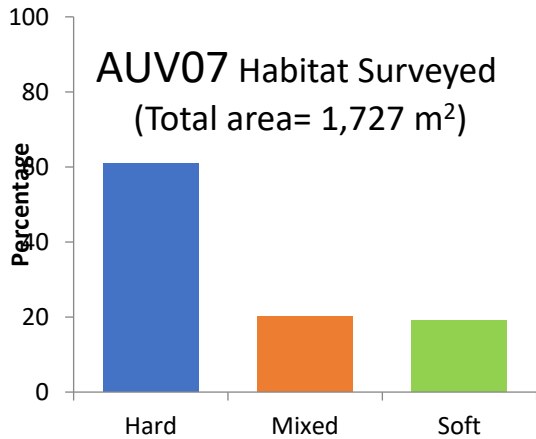


Figure 72. Relative amounts of hard, mixed and soft habitats at AUV07.

At Site 3b, 1,727 m² were surveyed. (Figure 72). This was the only site where the habitat was primarily hard (61%). Mixed and soft habitat represented 20% and 19% respectively.

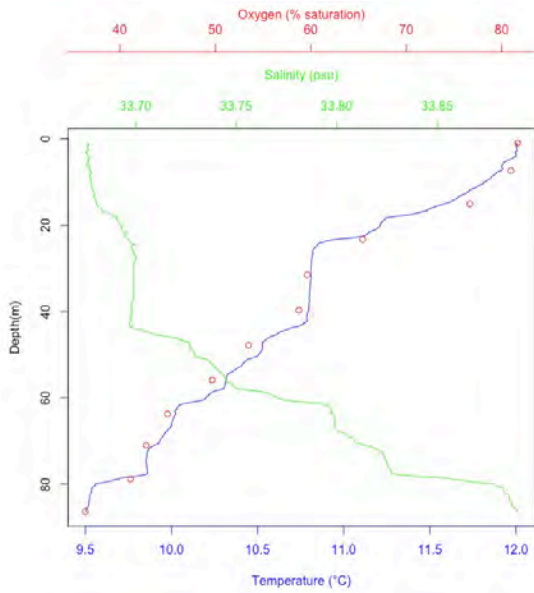


Figure 73. Salinity, temperature, and oxygen saturation by depth on AUV07 descent

A moderate thermocline was present approximately at 24 meters. Oxygen at the surface was 81% saturated and declined during the descent to 35% at depth (Figure 73). During the dive, oxygen saturation ranged from 35% to 39%.

Biological Environment

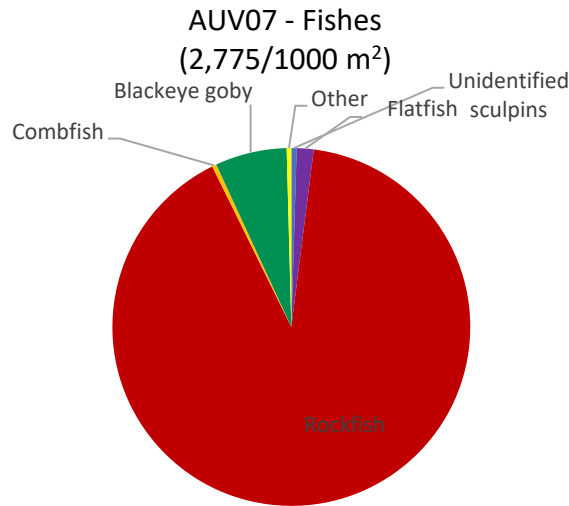


Figure 74. Percentage of fish by group for AUV07. Colors in pie diagram match the colors in the Table 23 below

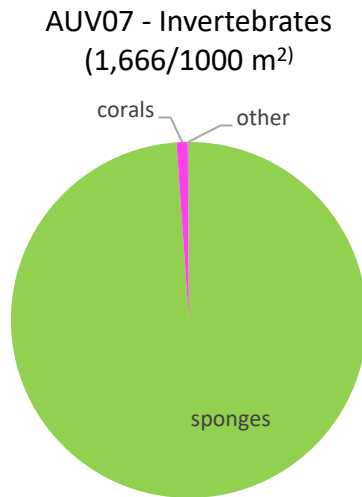


Figure 75. Percentage of invertebrates by group for AUV07. Colors in pie diagram match the colors in the Table 24 below.

Overall fish density was 2,775/1000m². The most abundant fish taxon was small unidentified rockfish and juveniles (Figure 74, Table 23). Rosy rockfish and blackeye goby were also very abundant.

Sponges were the most abundant invertebrate (Figure 75). These sponges were dominated by small unidentified mound sponges, lyssacine sponges, and *Poecillastra tenuilaminaris*. *Swiftia pacifica*, *Stylaster sp.* and sea pens were the most common corals

Table 23. Fish taxa and abundance AUV07

	Scientific Name	Common Name	Count
	Agonidae	Unidentified poachers	2
	Cottidae	Unidentified sculpins	23
	<i>Citharichthys sordidus</i>	Pacific sanddab	73
	Osteichthyes	Unidentified fishes	16
	<i>Sebastes levis</i>	Cowcod rockfish	1
	<i>Sebastes aurora</i>	Aurora rockfish	1
	<i>Sebastes chlorostictus</i>	Greenspotted rockfish	1
	<i>Sebastes hopkinsi</i>	Squarespot rockfish	75
	<i>Sebastes saxicola</i>	Stripetail rockfish	1
	<i>Sebastes caurinis</i>	Copper rockfish	1
	<i>Sebastes wilsoni/Sebastes emphaeus</i>	Pygmy/Puget Sound rockfish	22
	Unidentified Sebastomus	White spotted rockfishes	41
	<i>Sebastes miniatus</i>	Vermillion rockfish	3
	<i>Sebastes constellatus</i>	Starry rockfish	26
	<i>Sebastes ruberrimus</i>	Yelloweye rockfish	2
	<i>Sebastes paucispinis</i>	Bocaccio	1
	<i>Sebastes rubrivinctus</i>	Flag rockfish	1
	<i>Sebastes rosaceus</i>	Rosy rockfish	111
	<i>Sebastes spp.</i>	Rockfish unidentified/juvenile rockfish	4056
	<i>Zaniolepis spp.</i>	Combfish	19
	<i>Ophiodon elongatus</i>	Lingcod	5
	<i>Rhinogobiops nicholsii</i>	Blackeye goby	310
	Ophidiidae	Cusk-eel	1
	<i>Oxylebius pictus</i>	Painted greenling	3

Table 24. Invertebrate taxa and abundance AUV07

	Scientific Name	Common Name	Count
	Porifera	Mound sponge	2395
	<i>Staurocalyptus</i> spp.	Picasso sponge	2
	<i>Poecillastra tenuilaminaris</i>	Shelf sponge	112
	Lyssacine sponge	Glass barrel sponge	199
	Porifera	Branching sponge	2
	Porifera	Vase sponge	10
	Porifera	Foliose sponge	16
	<i>Polymastia</i> spp.	Papillae sponge	30
	Porifera	Pipe organ sponge	2
	Porifera	Puff ball sponge	37
	Porifera	Red death star sponge #1	6
	Porifera	Unidentified sponge	35
	<i>Ptilosarcus gurneyi</i>	Fleshy/orange sea pen	2
	Pennatulacea	Unidentified sea pens	12
	<i>Swifita pacifica</i>	Red sea fan	2
	<i>Stylaster</i> sp.	Lace coral	12
	<i>Clavularia</i> sp.	Star polyps	1
	<i>Cancer</i> sp.	Unidentified crab	1
	<i>Enteroctopus dofleini</i>	Giant Pacific octopus	1
	Unidentified invertebrates		1

Marine Debris and Anthropogenic Impacts

In two instances, heavy rope or cable was seen stretched across boulders (Figures 76 and 77).

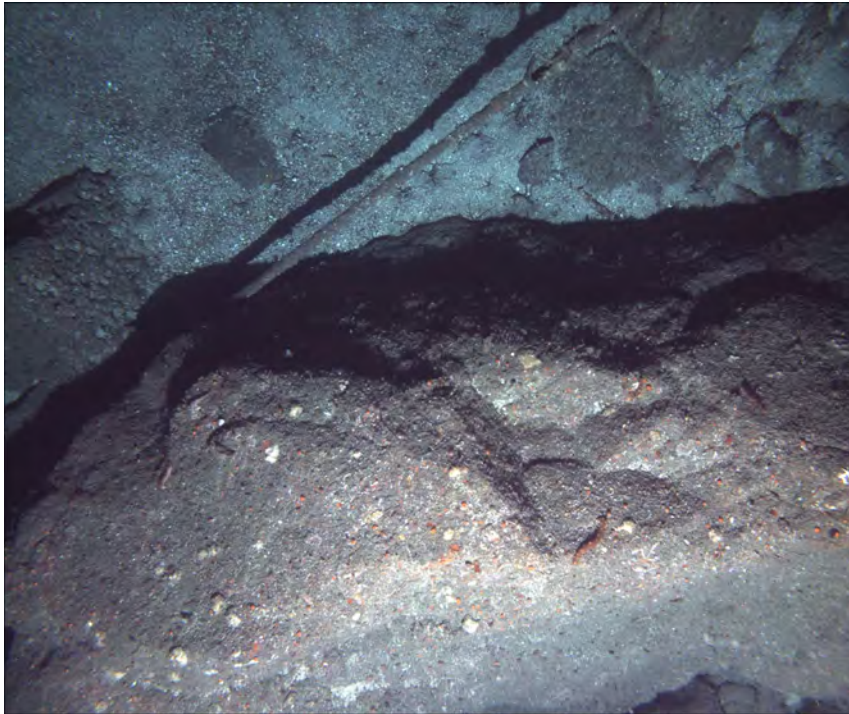
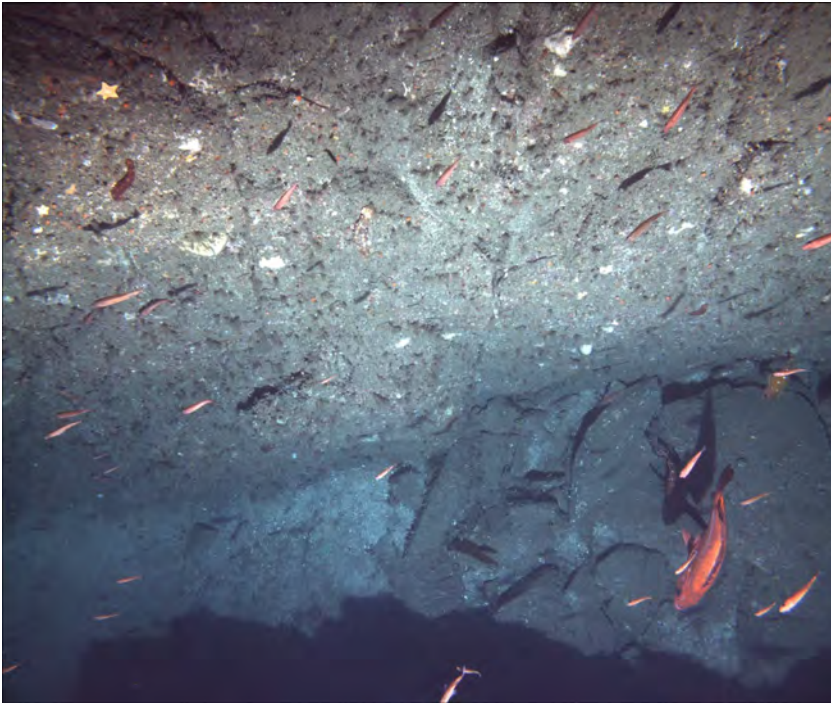


Figure 76. Cable (Image 20170717.171737.02050, latitude: 36.291246, longitude: -122.0029, depth: 74.77 m, substrate: BB)



Figure 77. Cable (Image 20170717.175306.02848, latitude: 36.29085, longitude: -122.00346, depth: 74.88 m, substrate: BB)

Image gallery AUV07



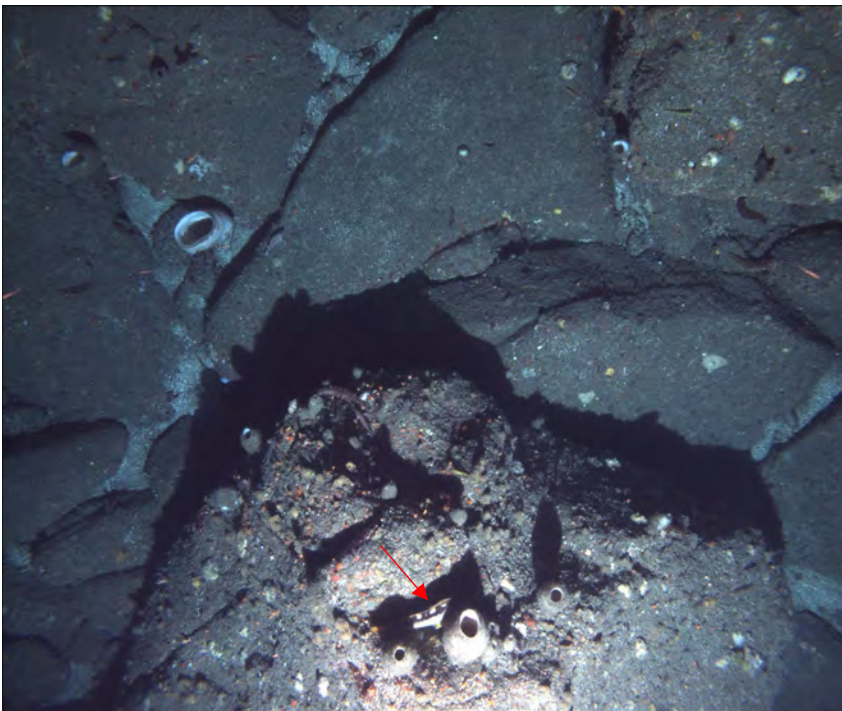
Vermillion rockfish and school of small rockfish (Image 20170717.161440.00634, latitude: 36.29678, longitude: -121.9952, depth: 80.81 m, substrate: RB)



Pacific sanddab (Image 0170717.155616.00220, latitude: 36.297346, longitude: -121.99509, depth: 84.87 m, substrate: SM)



Lingcod (Image 20170717.172137.02140, latitude: 36.290891, longitude:-122.0034, depth: 76.33 m, substrate: BB)



Yellowtail rockfish next to barrel sponges (Image 20170717.172329.02182, latitude: 36.290725, longitude: -122.00362, depth: 74.9m, substrate:BB)

Summary

Some of the dives transited over areas that are either slated for potential opening to fishing or areas that were proposed for opening after years of protection from some fishing. We must know the populations and distributions of key components of the biota before we can take effective action to manage fisheries as well as protect the species that in some cases provide biogenic habitat for many of these commercially fished species. These data will provide a source of baseline information as new management areas are put into place. Protected areas put into place for management purposes must be carefully monitored if the effectiveness of new management measures are to be assessed. (Grorud-Colvert et al. 2014).

These data herein will provide a source of baseline information as these new management measures are put into place so that their effectiveness can be assessed. We particularly focused on assessing the distribution and abundance of fish and two important components of the ecosystem, corals and sponges. We focused on corals and sponges because of their potential sensitivity to impact by bottom contact fishing gear particularly in areas with active fisheries. These are structurally delicate species and can be damaged or crushed by fishing activity (Yoklavich et al. 2018).

Over 15,718 individual fish were enumerated from the seven dives. The dives transited over a variety of habitats. The diversity and composition varied with the habitats. In general the more heterogeneous the habitats the more diverse the community. In addition, the habitat preferences of some species were obvious. Thornyheads dominated the fish community at site 7 where there was no hard or mixed habitat. Whereas, *Sebastes* spp. dominated the fish community in site 3b where the primary habitat was hard. The habitat at site 1 was primarily mud but the area did have some hard and mixed bottom that supported some OFS such as cowcod and yelloweye and a large number of juveniles moving in schools near the rocks.

Heterogeneity of the habitat does not seem to be the only driver of fish diversity. We calculated fish diversity and evenness for each of the sites Table 25. It was highest at sites 4 and 5 (Table 25) where habitat was primarily soft but with some small amounts of mixed habitat (Table 26). Diversity was lowest at sites 3b and 1 where the habitat included significant amounts of each type of habitat.

Outer Soquel Canyon, site 4, had very little hard or mixed habitat despite significant information indication that there should be hard habitat in the area. It is possible that in this region rock in many sections is covered by a veneer of sediment. More validation of habitat in this area is needed in order to categorize the habitat correctly.

Our goal was to focus our efforts on fish, corals, and sponge. Sponges and corals were quantified at all sites. At some sites sponges were very abundant. The highest numbers of sponges were found on the Point Sur Platform, site 3b. Mound sponges were the most abundant and not the larger biogenic sponges that dominate at sponges gardens found off Washington State (Powell et al. 2018). Sponges, predominatly mound sponges were also abundant at site 3a.

Some of the larger sponge species were sediment covered, indicating they were dead or dying. Crushed sponges were not evident, and these sediment covered sponges retained their form so they are unlikely to be damaged by direct contact with fishing gear. Corals were never the most abundant taxa at any site and there were very few octocorals seen at any site. At one site the most dominant invertebrate was spot prawns. This species has been enumerated at all sites because of its importance as a commercial fishery in the region.

There was a strong thermocline (indicating limited mixing through the entire water column) at only two of the sites, 3a and 2. At the rest of the sites there was no strong thermocline indicating mixing throughout the water column was likely significant. At most of the sites oxygen saturation levels closely followed the patterns seen in the water temperature profiles. Lower oxygen is seen at higher temperature throughout the water column. However, the two deepest sites (3a and 7) had the lowest bottom oxygen saturations. It is not clear if this is a short-term or seasonal pattern but either time frame could impact non-mobile organisms such as sponges and corals. No sponges were found at site 7: however, many healthy sponges were found at site 3a.

Table 25. Species richness and diversity for fish taxa for each AUV dive.

AUV Dive	Site Name	Richness	Count	Shannon Index of Diversity	Species Evenness
AUV01	4: Outer Soquel Canyon	23	951	2.298	0.733
AUV02	1: Davenport Reef	30	3326	1.169	0.344
AUV03	5: Ascension Canyon	21	605	2.224	0.73
AUV04	3a: South of Pt Sur Platform	37	1909	1.925	0.533
AUV05	2: Davenport Reef	29	3573	1.387	0.412
AUV06	7: West of Carmel Canyon	20	559	1.674	0.559
AUV07	3b: Pt Sur Platform	24	4795	0.732	0.232

Table 26. Percent Habitat by dive.

AUV Dive	Site Name	Percent Hard	Percent Mixed	Percent Soft
AUV01	4: Outer Soquel Canyon	0.5	2.5	97
AUV02	1: Davenport Reef	9	17	74
AUV03	5: Ascension Canyon	0	1	99
AUV04	3a: South of Pt Sur Platform	40	7	53
AUV05	2: Davenport Reef	28	21	51
AUV06	7: West of Carmel Canyon	0	0	100
AUV07	3b: Pt Sur Platform	61	21	19

References

¹ Monterey Bay National Marine Sanctuary. July 31, 2013, Collaborative Groundfish Essential Fish Habitat Proposal: Protecting Groundfish Essential Fish Habitat While Balancing Fishing Opportunities in Monterey Bay National Marine Sanctuary, South of Año Nuevo

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