

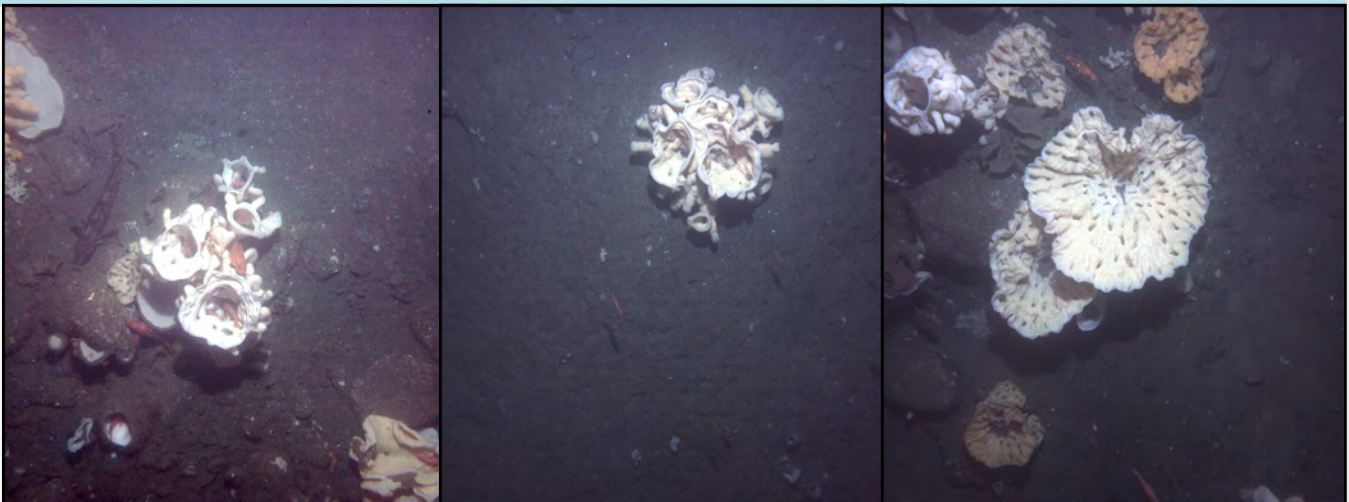
A REPORT TO NOAA DEEP-SEA CORAL RESEARCH AND TECHNOLOGY PROGRAM

A CHARACTERIZATION OF THE SPONGE COMMUNITY IN THE REGION OF GRAYS CANYON, WA FROM A SURVEY USING AN AUTONOMOUS UNDERWATER VEHICLE OCTOBER 2010

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Contact Information	NOAA NWFSC elizabeth.clarke@noaa.gov
Purpose	Survey sponge area in region near Gray's Canyon, WA
Vessel	OSU Vessel Pacific Storm
Science Observers	Elizabeth Clarke, Erica Fruh, Jeremy Taylor, Russell Haner, Chris Murphy
External Video Tapes	None
Internal Video Tapes	None
Digital Still Photos	22561
Positioning System	Ship: GPS; AUV: USBL
CTD Sensors	Yes
O₂ Sensor	No
pH Sensor	No
Specimens collected	No
Report Authors	Elizabeth Clarke, Erica Fruh

INTRODUCTION AND SCIENTIFIC OBJECTIVES

Areas with high concentrations of glass sponges described as “reefs” recently were discovered associated with methane bubble plumes at Grays Canyon on the Washington State margin and a subsequent survey indicated that this is a particularly rich area with large numbers of associated fish and euphausiids (Johnson 2008, 2009). Previously, large concentrations of glass sponges in the northwest Pacific were only known to occur only off British Columbia (e.g. Conway et al. 1991, 2001, 2004, 2005; Cook 2008).

Oceana proposed in May 2009 to the Pacific Fishery Management Council (PFMC) that this newly discovered site receive additional protection under Essential Fish Habitat (EFH) mandates (Oceana 2009). However, the extent of these sponge areas off the Washington Coast had not been identified and the sponge and fish communities had not been quantified. Current EFH Conservation Area boundaries do not include the sponge reef site and many of the previous records of sponges detailed by Oceana are not within current EFH Conservation Area boundaries (Figure 1). The PFMC declined to take action in 2009 citing the need for more information about the area to enable appropriate protections and regulations to be put in place..

The goals of this project are to:

- 1) Examine the extent of the sponge reef identified in 2007 and proposed for protection by Oceana in 2009
- 2) Describe the associated ecosystem to assist in determining this area's role as EFH; and
- 3) Provide the PFMC with additional information to assess any actions that may be needed to protect the Grays Canyon sponge area.

Targeted habitats for this work were soft bottom and moderately rocky habitat offshore of Grays Harbor, WA. The primary survey site was centered at the glass sponge site already identified by Paul Johnson (Johnson 2008, 2009). The SeaBed AUV, *Lucille*, was used to conduct photographic surveys of macro-fauna, including invertebrates and bottom fish in order to determine the species composition and density of sponges and associated fish fauna.



Study Site

The sponge site is located offshore of Grays Harbor, Washington near Grays Canyon (Figure 1.) This site is near the shelf break in an area of low relief in waters between 200 and 140 m deep. Methane seeps have been reported in this area as well as high densities of euphausiids (Johnson 2009). This area is also the site of an active spot prawn fishery. Multibeam surveys were completed by C. Goldfinger (Oregon State University) just prior to the AUV survey and the draft high-resolution maps of backscatter and bathymetry produced from the multibeam survey (Figures 2 and 3) were used to identify dive sites that would be representative of different habitat types in the area. The dive sites selected were located at the original sponge site as well as three sites in the proposed EFH Conservation area proposed by Oceana (Figure 3).

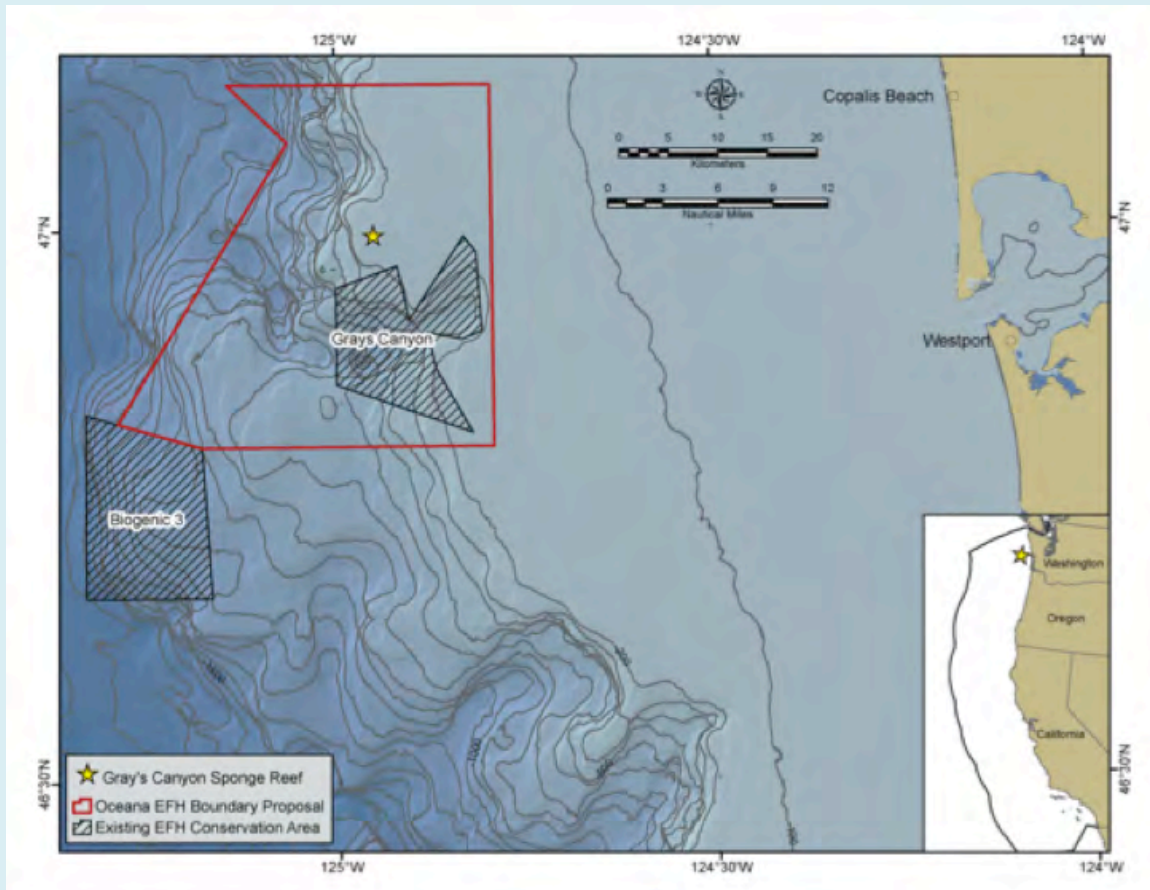


Figure 1. Oceana proposed EFH Boundary showing site of sponge reef and existing EFH Conservation Areas (Oceana 2009).

CHARACTERIZATION OF SPONGE SITE STUDY SITE: GRAYS CANYON

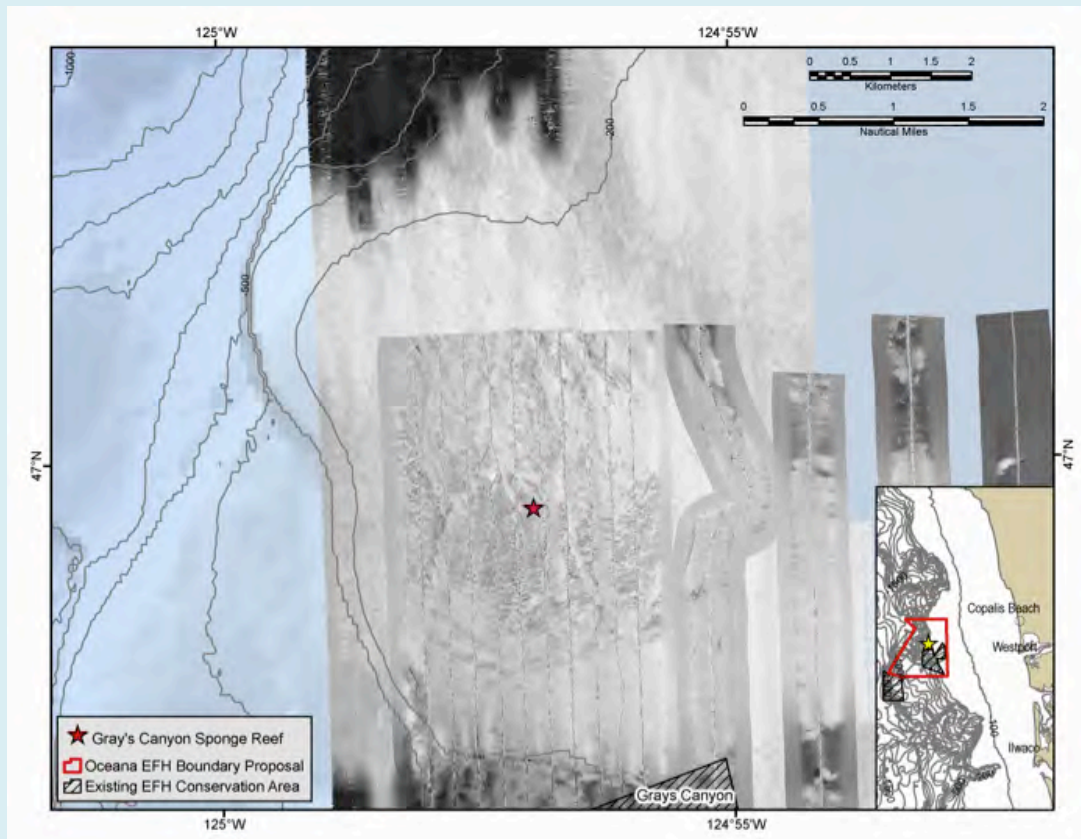


Figure 2. Draft map of backscatter of the area around the sponge site. (provided by C. Goldfinger, Oregon State University)

CHARACTERIZATION OF SPONGE SITE STUDY SITE: GRAYS CANYON

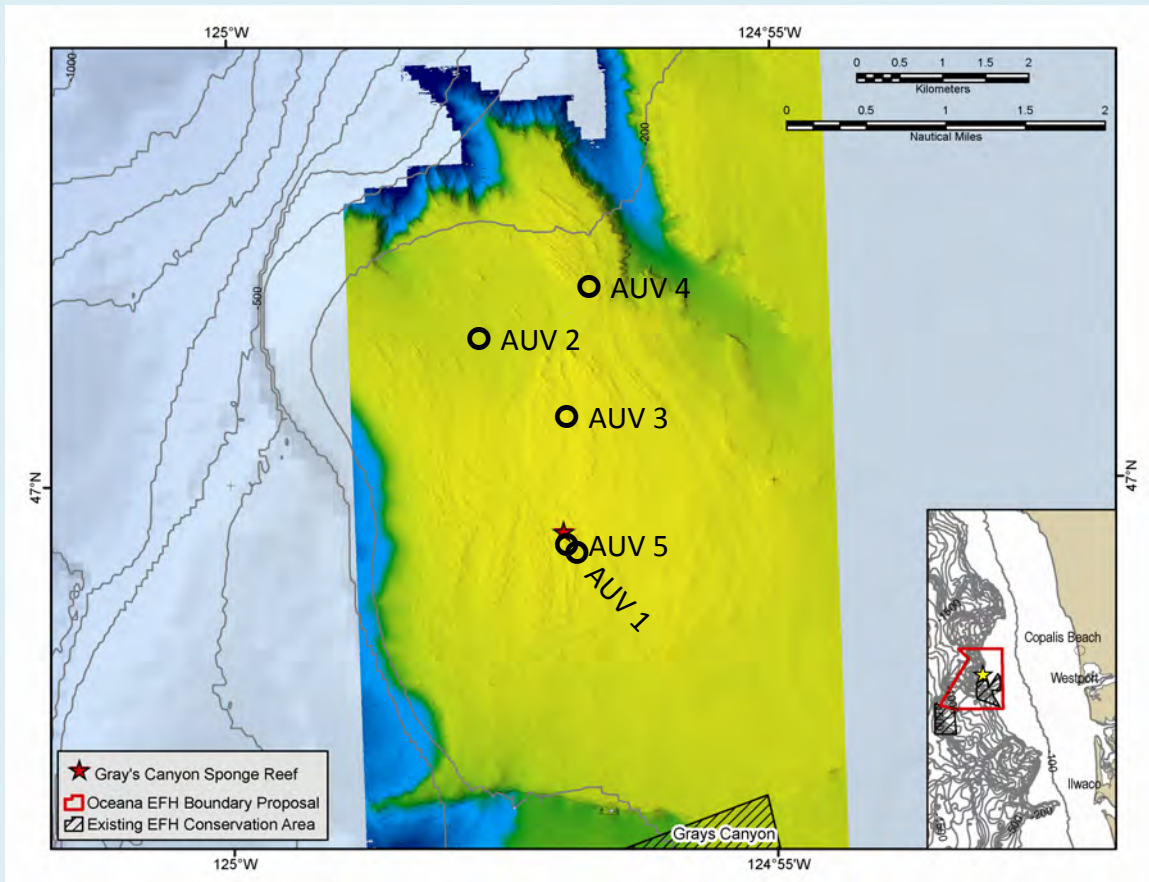
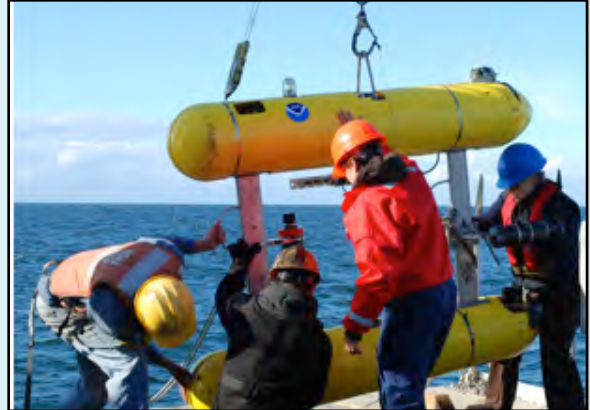


Figure 3. Survey sites on draft map of high resolution bathymetry of the area. (map provided by C. Goldfinger, Oregon State University)

Field Survey Methods



Underwater surveys of sponges, habitats and associated fishes were conducted using the SeaBed type Autonomous Underwater Vehicle (AUV) *Lucille* deployed from Oregon State University's Vessel *Pacific Storm* 20 September - 23 September 2010. 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. Two downward parallel lasers were used to estimate the sizes of organisms in photographs.

The AUV was equipped with two navigational sensors: the RDI 1200 kHz Doppler Velocity Log and the iXSea OCTANS Inertial Navigation. The AUV was tracked using a Link Quest TrackLink 1510 MAH 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 Seabird model 49 FastCat CTD mounted on the AUV. An Imagenex Delta-T profiling sonar was used on dive 005.

Five sites were sampled during 3 days (Figure 3). The AUV was programmed to take photographs once every 4.5 - 5 seconds and to maintain a height of 3 meters from the bottom. Images were down-loaded at the end of each dive and each image was color-corrected.

Post-Dive Analyses

Locations of the AUV during each dive were estimated by using USBL tracking information, the xy coordinates of the vehicle position, and the shipboard GPS coordinates of the start of the dive.

All non-overlapping color-corrected digital photographs from the downward-looking camera were reviewed following the cruise and corals and sponges as well as associated fishes were identified and counted from all images. The area of each image was estimated using the measured distance from the bottom. Since the AUV was programmed to maintain a height of 3 meters from the seabed and did so with little variation (Figure 4) there was limited variability in the size of the field of view of each image.

Sea floor habitats were categorized in each photograph using a two code system. The categories are rock ridge (R, high to low relief), boulder (B diameter > 25.5 cm), cobble (C diameter > 6.5 and < 25.5 cm), pebble (P > 2 and < 6.5 cm), gravel (G > 4 mm and < 2 cm), flat rock (F, continuous, low relief), sand (S, grains distinguishable), and mud (M, noticeable organic particles). The first code signified the habitat type that covered greater than 50% of the area, and second code the habitat type covering between 20% and 50% of the area.

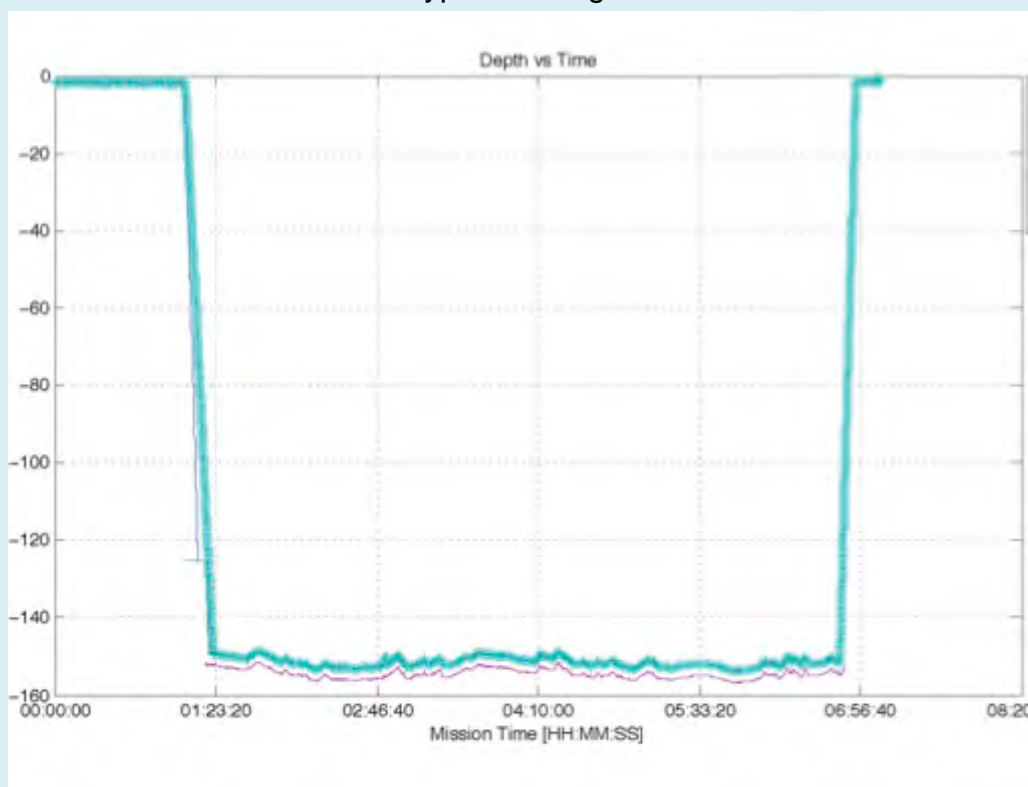


Figure 4. Depth Track of dive AUV 001 showing sea bottom (—) and depth of vehicle (—).

CHARACTERIZATION OF SPONGE SITE STUDY SITE: GRAYS CANYON

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

Corals, sponges, and fishes were identified to the lowest possible taxonomic level from every non-overlapping image collected on each dive. In many cases fauna were grouped into morphological types only.

Physical condition of sponges was noted by indicating if sponges were broken or covered by sediment. Fishes were considered to be associated with sponges if they were less than one body length away from or in direct contact with structure forming sponges. Occurrences of man-made marine debris were noted.

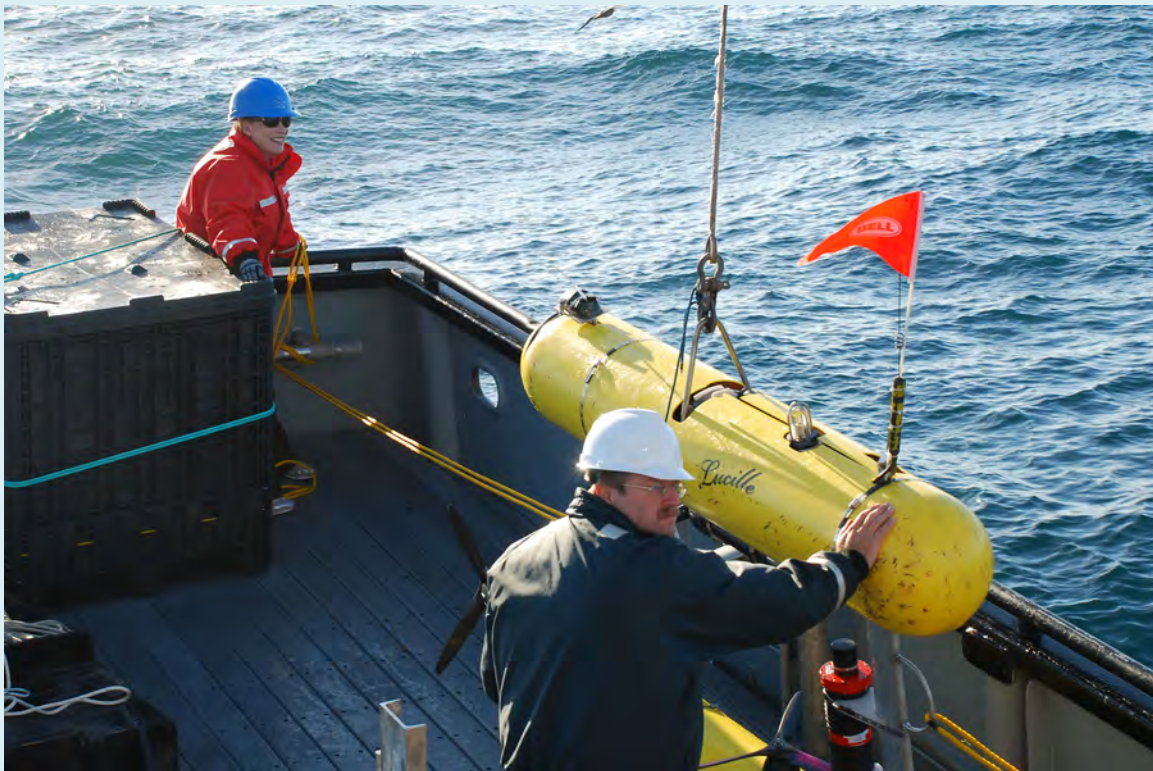


Summary of Dives

A total of 5 dives were completed (Table 1) and a total number of 9722 images from the downward looking camera and 12,828 images from the angled camera were collected. Only the angled camera was functioning on the second dive so no analyses of the data collected from that dive were completed.

Table 1. Summary of Dives

Date	Dive #	Start Time	End Time	Start Lat (N)	Start Long (W)	End Lat (N)	End Long (W)	m ²	min depth (m)	max depth (m)
9/20/10	1	3:26:26	20:26:26	46.996983	-124.946173	46.991584	-124.948975	7830	149	152
9/21/10	2	2:27:14	19:27:14	47.02086	-124.942661	47.027761	-124.943169		152	161
9/22/10	3	8:51:21	9:43:10	47.001235	-124.945081	46.997367	-124.950410	1432	144	152
9/22/10	4	0:51:56	17:51:56	47.023129	-124.942537	47.028545	-124.943453	5491	155	169
9/23/10	5	12:49:38	5:59:38	46.995872	-124.946930	46.995316	-124.947502	2417	148	151



Approximately 17,170 m² of sea floor habitat was classified. A two character code was used to identify the habitat type and the two codes then were aggregated into three habitat categories: sediment/mud, mixed (which included various proportions of rock, boulder, cobble, flat rock and mud), and hard rock (that was primarily a combination of boulder and/or flat rock). Sixty-eight percent of the area surveyed was sediment/mud, 25% mixed and the remainder was hard (Figure 5). There were many instances where it was possible that sediment covered mounds of an unknown consolidated material, however it was not possible to confirm the underlying structure of the mounds from the photographs and therefore in these instances the habitat was only classified as sediment.

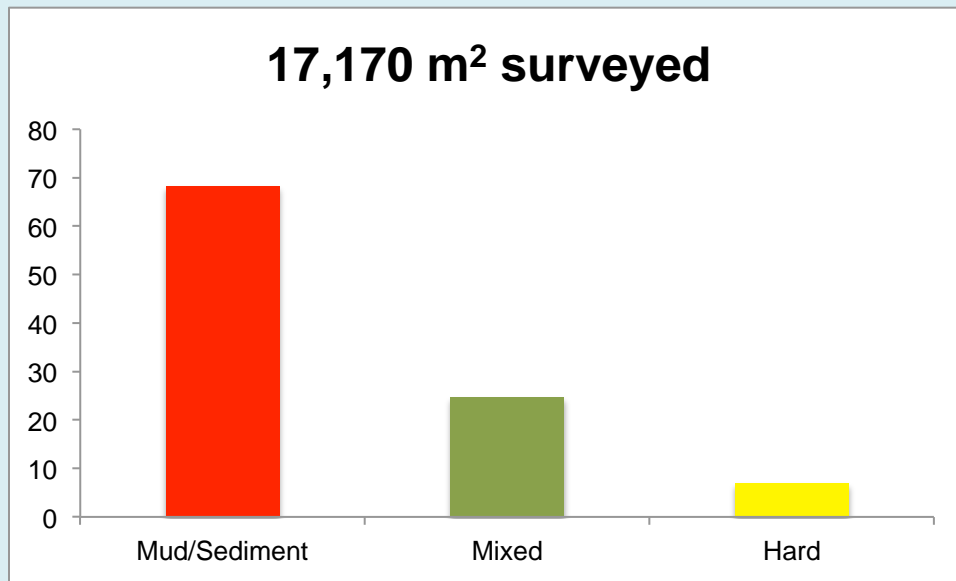
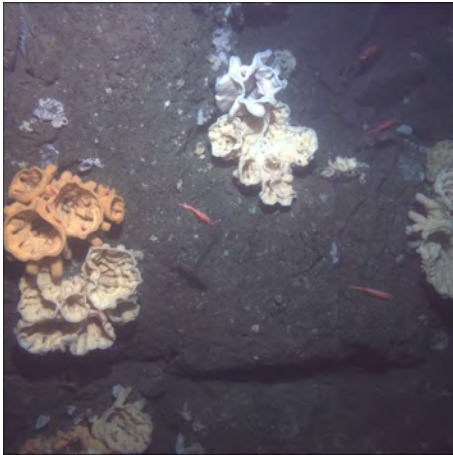
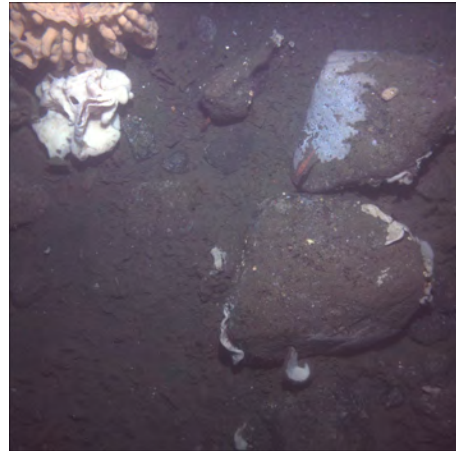


Figure 5. Percentage of habitat categories seen in all dives



Boulder classified as hard



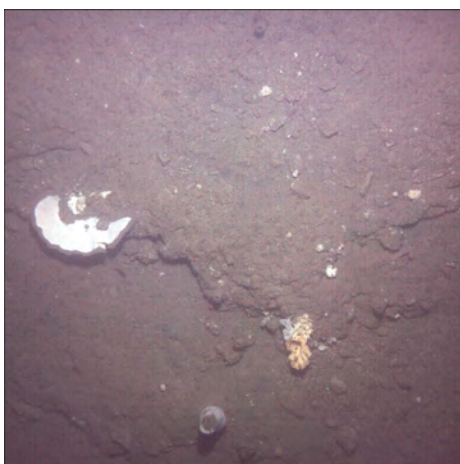
Boulder and sediment classified as mixed



Cobble and sediment classified as mixed



Mud covered seafloor classified as sediment



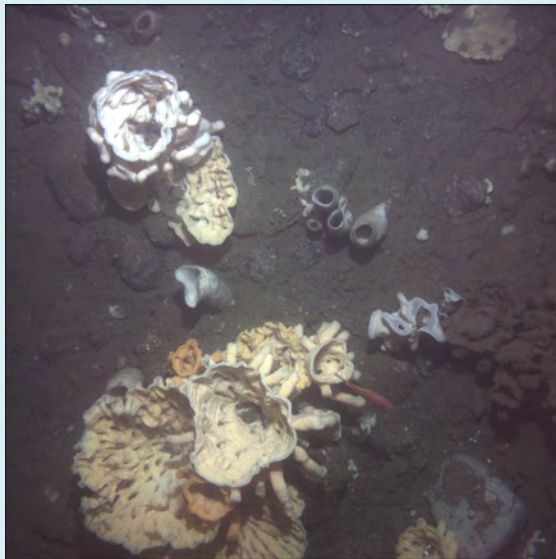
Mud covered mounds with evidence of possible underlying consolidated material and classified as sediment



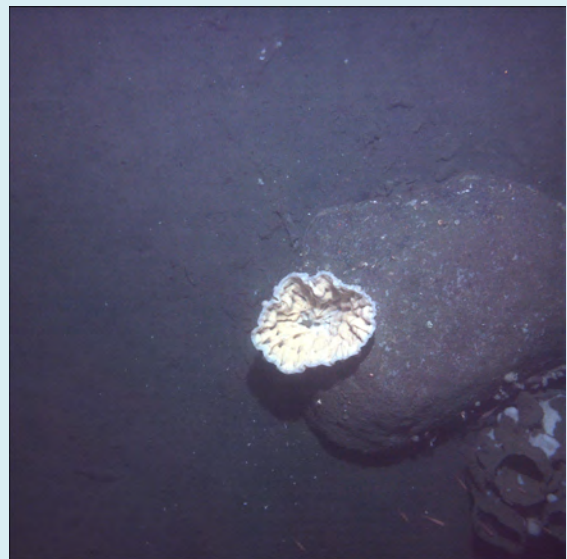
CHARACTERIZATION OF SPONGE SITE STUDY SITE: GRAYS CANYON

Quantitative information was collected for 34 taxa of sponges and fishes. Fish and sponges were identified to the lowest possible taxon and enumerated. A total of 10,634 sponges were enumerated with an overall density 620 per 1,000 m². Ten groups of sponges were identified and the predominant structure forming sponges were the vase sponges *Aphrocallistes* sp. (possibly *A. vastus*) and *Heterochrone calyx*, as well as the fringed demosponge, *Poecillastra* spp. There were many unidentified sponges but they were primarily broken remnants or small encrusting sponges and generally not structure forming.

A total of 3,112 fishes were enumerated for an overall density of 182 per 1,000 m². Many of the sponges had fishes associated with them. Fish were categorized as being associated with sponges when they were within one body length of the structure forming sponges. Twenty-eight percent of the fishes overall were associated with sponges. These fish were predominantly rockfishes.



Heterochrone calyx, *Aphrocallistes* sp.,
Acanthascus spp. and mud covered
sponge and debris

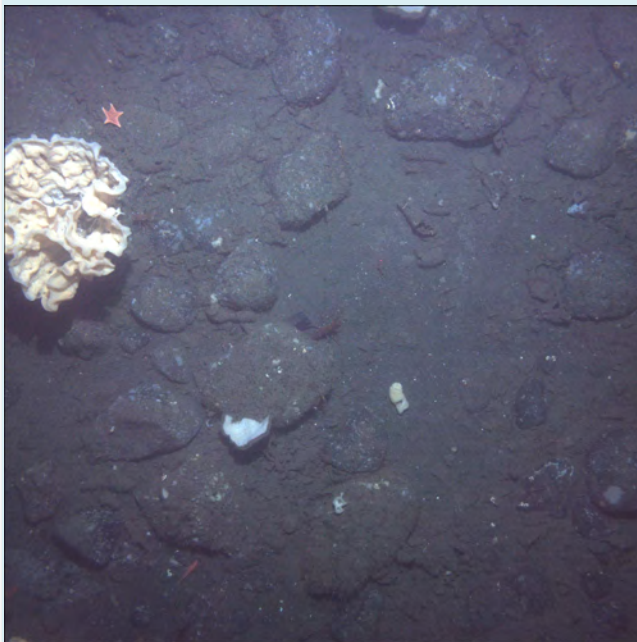


Heterochrone calyx and mud covered
sponge and sponge debris

CHARACTERIZATION OF SPONGE SITE STUDY SITE: GRAYS CANYON

Only three types of corals were encountered and were primarily one unidentified type of small branching coral along with a few sea whips and cup corals.

Below are summaries of the information collected during each of the four quantitative dives. This information includes density of fishes and sponges as well as the habitats identified on each dive. In addition, the salinity and temperature profiles for each dive location are presented.



Heterochone calyx and *Poecillastra* spp.



Small, unidentified branching coral (center right)

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Johnson, H. P. (2009). Washington Sea Grant Progress Report Project R/NP-6 "Glass Sponge Reef Habitat in the Pacific Northwest" for period or the period 2/1/2008 – 1/31/2009. Available at: http://www.wsg.washington.edu/research/ecohealth/ecosystem/glass_sponge.html

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GENERAL LOCATION AND DIVE TRACK

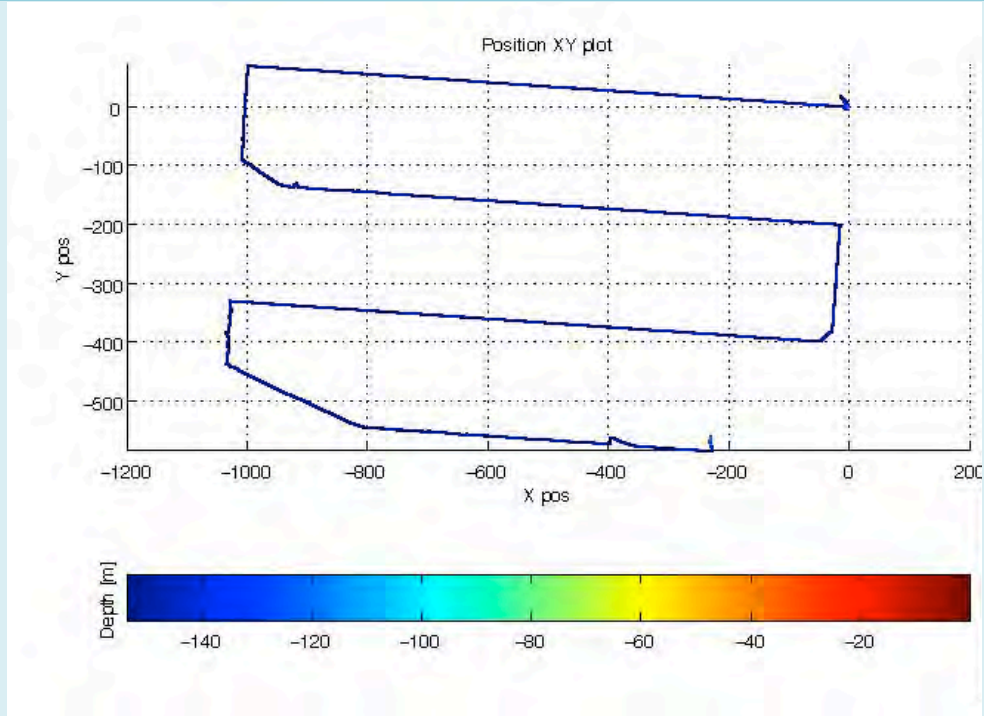


Figure 6. Survey Pattern of during dive AUV 001

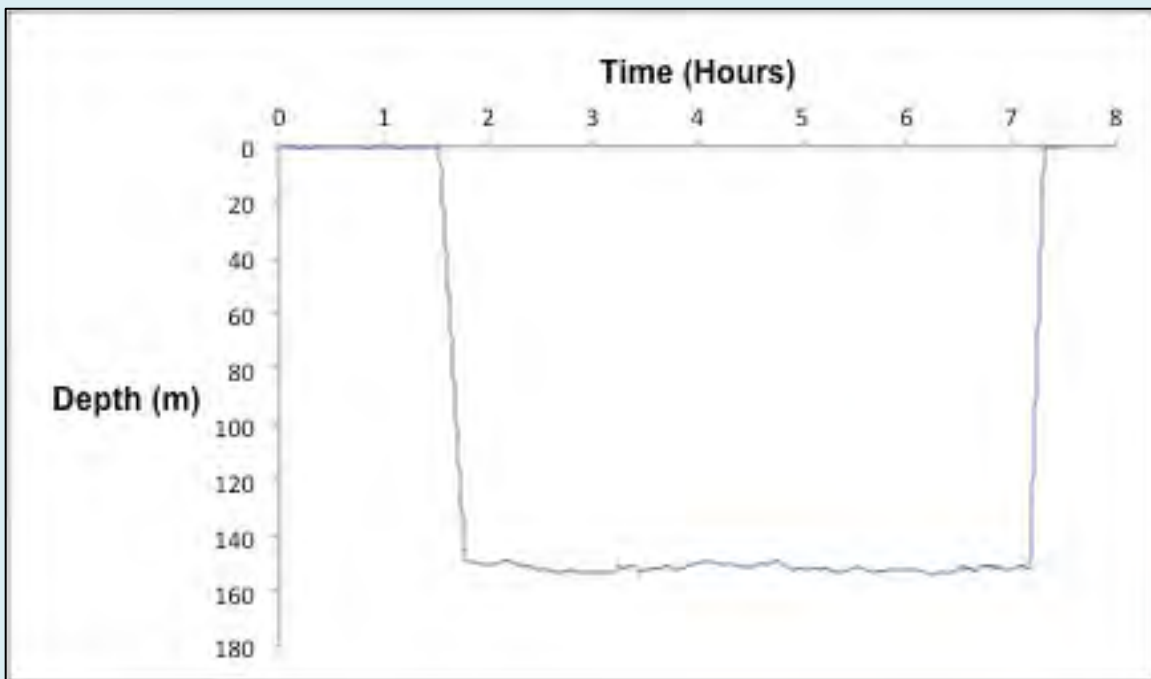


Figure 7. Depth track of AUV during dive AUV 001

STATION OVERVIEW

Contact Information	NOAA NWFSC elizabeth.clarke@noaa.gov
Purpose	Survey sponge area in region near Gray's Canyon, WA
Vessel	OSU Vessel <i>Pacific Storm</i>
Science Observers	Elizabeth Clarke, Erica Fruh, Jeremy Taylor, Russell Haner, Chris Murphy
External Video Tapes	None
Internal Video Tapes	None
Digital Still Photos	7766
Positioning System	Ship: GPS; AUV: USBL
CTD Sensors	Yes
O₂ Sensor	No
pH Sensor	No
Specimens collected	No
Report Authors	Elizabeth Clarke, Erica Fruh

DIVE DATA

Date	20-Sep-10	Starting Latitude (N)	46.996983°
Minimum Bottom Depth (m)	149	Starting Longitude (W)	124.946173°
Maximum Bottom Depth (m)	152	Ending Latitude (N)	46.991584°
Start Time (PDT)	14:59:14	Ending Longitude (W)	124.948975°
End Time (PDT)	20:26:26		

A total of 7,830 m² of bottom was assessed from a sample of digital photographs taken from the AUV *Lucille* deployed from the Oregon State University vessel *Pacific Storm* during Dive 001. The AUV was pre-programmed to conduct a sparse grid survey at a height of 3 meters from the bottom (Figures 6, 7). Photographs were taken every 5.0 seconds from the downward-looking and forward-angled cameras. Photographs taken by the downward-looking camera were used to collect quantitative information about habitat and fauna in the region. Analyses focused on determining the abundance of sponges and fishes as well as their spatial relationship to each other.

PHYSICAL ENVIRONMENT

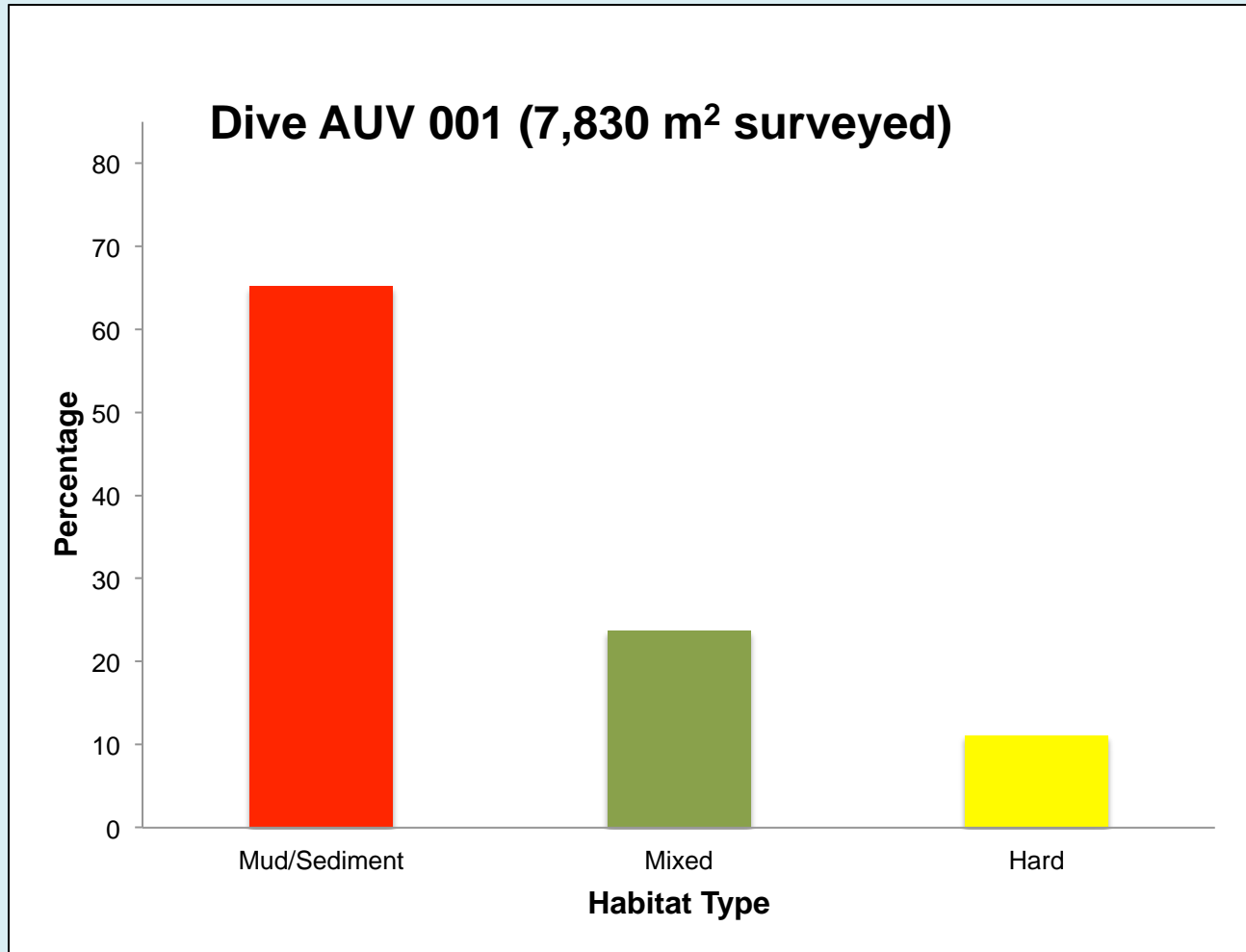


Figure 8. Percentage of three habitat categories in area sampled during dive AUV 001

A two character code was used to identify the habitat type and the two codes then were aggregated into three habitat categories: sediment/mud, mixed (which included various proportions of rock, boulder, cobble, flat rock and mud), and hard rock that was primarily a combination of boulder and/or flat rock. Sixty-five percent of the area surveyed was sediment/mud, 24% mixed and the remainder was categorized as hard (Figure 8). There were many instances where it was possible that sediment covered mounds of an unknown consolidated sediment, however it was not possible to confirm this from the photographs and therefore in these instances the habitat was categorized as sediment.

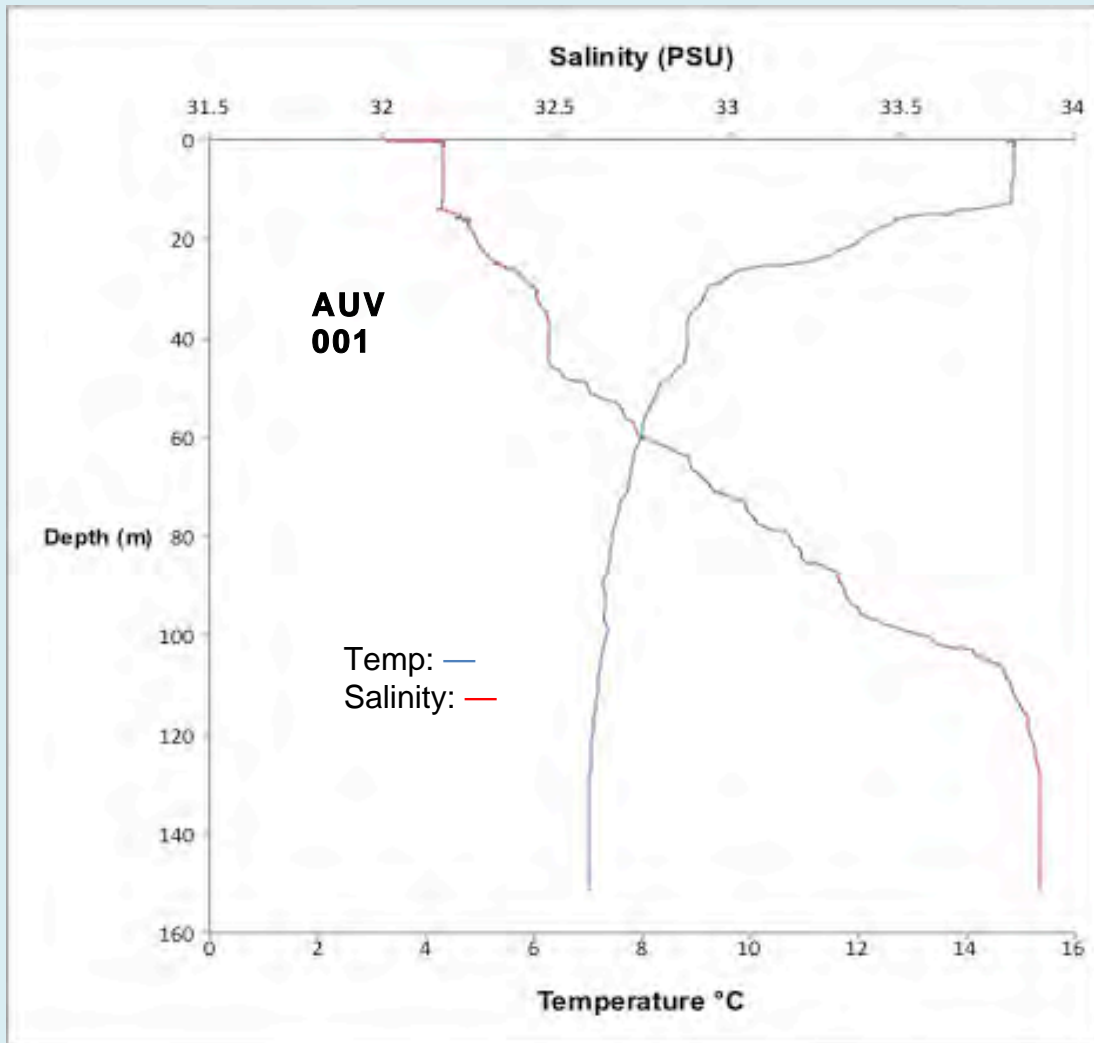


Figure 9. Salinity and temperature during descent of AUV.

The AUV was equipped with an onboard Seabird model 49 FastCat CTD that collected temperature and salinity information during the AUV's descent as well as along the dive track. The temperature varied from 15.28 to 6.95°C during descent and salinity varied from 32.14 to 33.92 (PSU) (Figure 9). The temperature and salinity varied only slightly along the dive track from 6.95 to 6.99 and 33.90 to 33.92 respectively.

BIOLOGICAL ENVIRONMENT: SPONGES AND CORALS

A total of 5,925 sponges from 10 taxonomic and morphometric groups were enumerated from 1821 photos covering 7,830 m² during Dive 001 (Table 2). Photos were collected from the AUV *Lucille* deployed from the Oregon State University vessel *Pacific Storm*. An overall density of 757 sponges per 1,000 m² of seafloor was estimated from analysis of photographs. The identified sponges with the highest densities were the vase sponges *Heterochone calyx* and *Aphrocallistes sp* (16%) followed by ball/mound sponges (10%), the fringed demosponge *Poecillastra spp.* (9%) and the barrel sponges including *Acanthascus spp.* (8%) (Figure 10). Fifty-five percent of the sponges were unidentified were primarily fragments of sponges and small non-structure forming encrusting sponges. Two percent of the sponges were mud covered/dead sponges primarily consisting of vase sponges.

Corals were much less abundant (a total of 220 were enumerated) and primarily were an unidentified small white branching coral and a small number of sea whips and cup corals.

Table 2. Number of sponges enumerated from dive 001

AUV 001	Common Name	Scientific name	Number
	Vase Sponge	<i>Aphrocallistes sp.</i> (possibly <i>A. vastus</i>)	358
	Lobed Vase sponge	<i>Heterochone calyx</i>	579
	Fringed demosponge	<i>Poecillastra spp.</i>	544
	Unidentified barrel sponges	Porifera	406
	Barrel sponge	<i>Acanthascus spp.</i>	40
	Unidentified ball and mound sponges	Porifera	610
	Cloud or lace sponge	<i>Farrea occa</i>	1
	Unidentified demosponge	Porifera	7
	Mud covered/dead sponge	Porifera	112
	Unidentified sponge	Porifera	3268

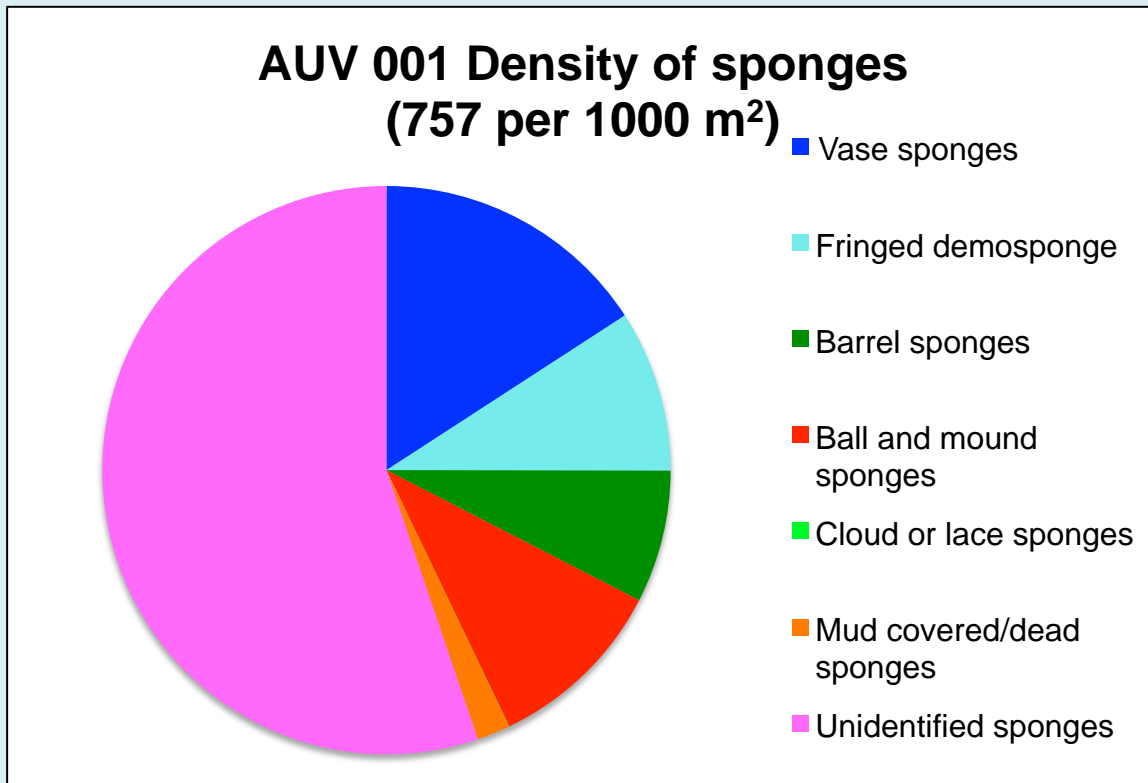


Figure 10. Percentage of sponge density by group. Colors in pie diagram match colors in list of sponge taxa (Table 2).

BIOLOGICAL ENVIRONMENT: FISHES

Twenty-one groups of fishes were identified in Dive 001 (Table 3). 1,568 fishes were enumerated for an overall density of 200 per 1000 m². Rockfish comprised 79% of the total fish density (Figure 11). A group of unidentified rockfish that included juvenile rockfish and a suite of rockfish primarily *S. zacentrus*, *S. wilsoni*, *S. proriger*, *S. diploproa*, or *S. alutus* that in many cases could not be easily distinguished from each other in the photographs were the most abundant, followed by rosethorn rockfish, and greenstriped rockfish. Rosethorn rockfish and other rockfish except greenstriped rockfish were mostly found on mixed or hard habitat associated with sponges. Greenstriped rockfish were found primarily on muddy habitat along with an assemblage of flatfish including Dover sole, slender sole, rex sole, and petrale sole. The flatfish assemblage comprised 2% of the total density of fishes. Other fishes seen included lingcod, ratfish, longnose skate, and unidentified poachers, cottids and eelpouts.

Table 3. Number of fishes enumerated from dive 001

AUV 01	Common name	Common name	Number
Blue	Unidentified rockfish including young of the year	<i>Sebastes</i> spp.	887
	Rosethorn	<i>Sebastes helvomaculatus</i>	217
	Greenstriped	<i>Sebastes elongatus</i>	126
	Pacific Ocean Perch	<i>Sebastes alutus</i>	2
	Yellowtail	<i>Sebastes flavidus</i>	1
	Splitnose	<i>Sebastes diploproa</i>	5
	Redstripe	<i>Sebastes proriger</i>	1
	Rougheye	<i>Sebastes aleutianus</i>	1
	Redbanded	<i>Sebastes babcocki</i>	1
	Green	Rex sole	<i>Glyptocephalus zachirus</i>
Slender sole		<i>Lyopsetta exilis</i>	94
Dover sole		<i>Microstomus pacificus</i>	24
Petrable sole		<i>Eopsetta jordani</i>	4
Unidentified flatfish		Pleuronectiformes	37
Red	Lingcod	<i>Ophiodon elongatus</i>	12
Yellow	Unidentified sculpins	Cottidae	16
	Unidentified poachers	Agonidae	14
Purple	Spotted ratfish	<i>Hydrolagus collieri</i>	3
	Unidentified eel pout	Zoarcidae	1
	Longnose skate	<i>Raja rhina</i>	1
Pink	Unidentified fish		94

Many of the rockfish were associated with the sponges. Fish were categorized as being associated with sponges when they were either touching or were within one body length of the structure forming sponges. Many of the fish were sitting in openings in vase sponges and only partly visible. These fish could not be specifically identified in many cases. Thirty percent of the fishes were associated with structure forming sponges.

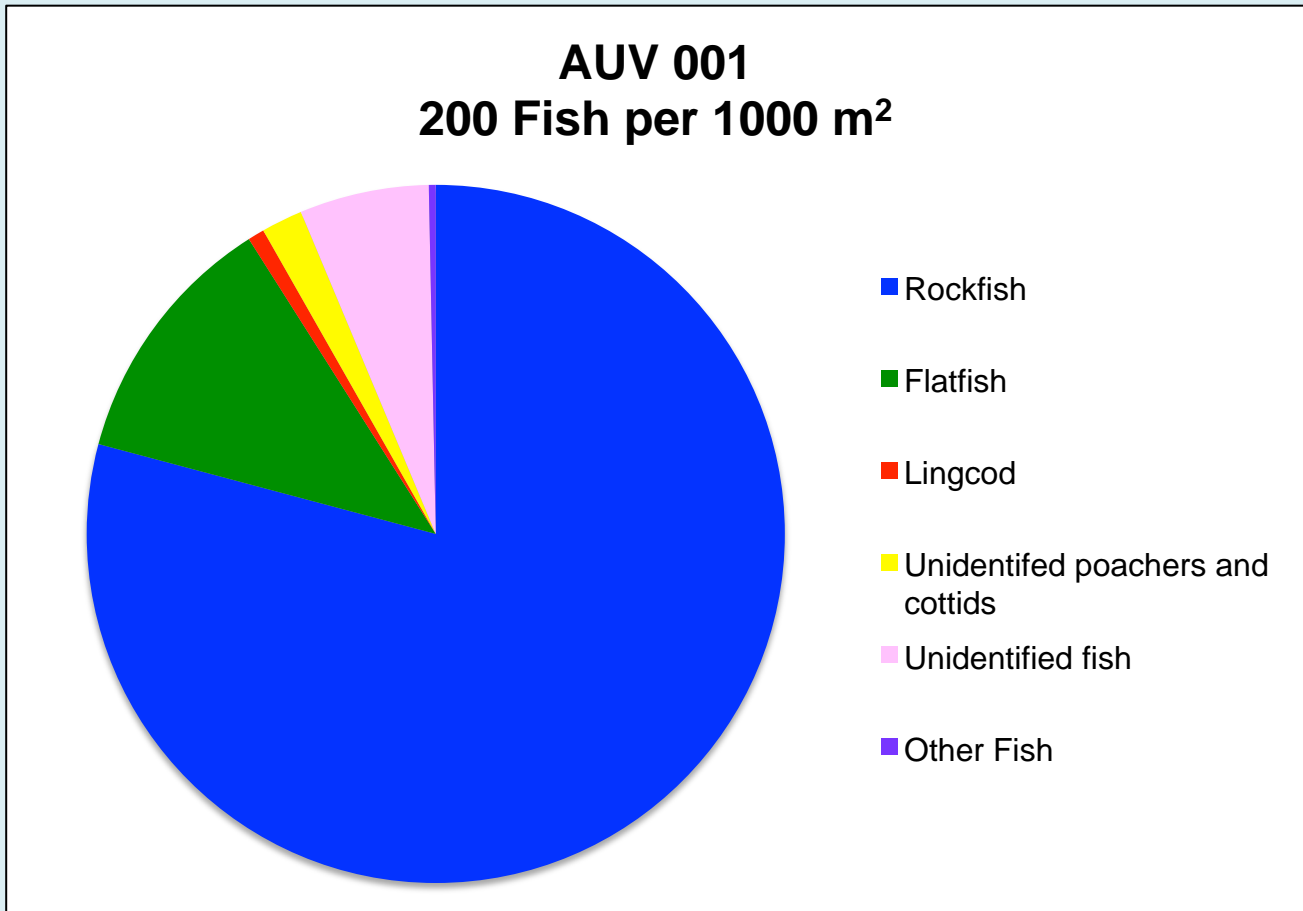


Figure 11. Percentage of fish density by group. Colors in pie diagram match colors in list of fish taxa (Table 3).

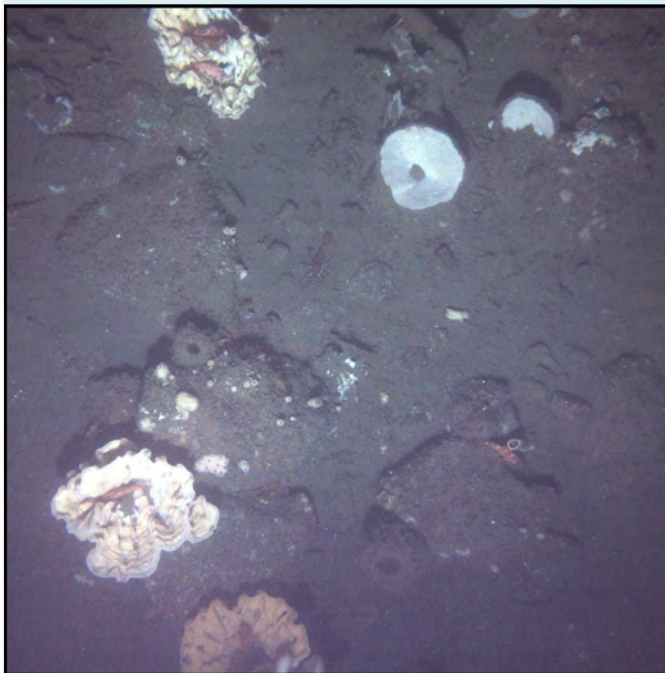
IMAGE GALLERY



Lingcod and barrel sponge



Aphrocallistes sp. with rockfish inside

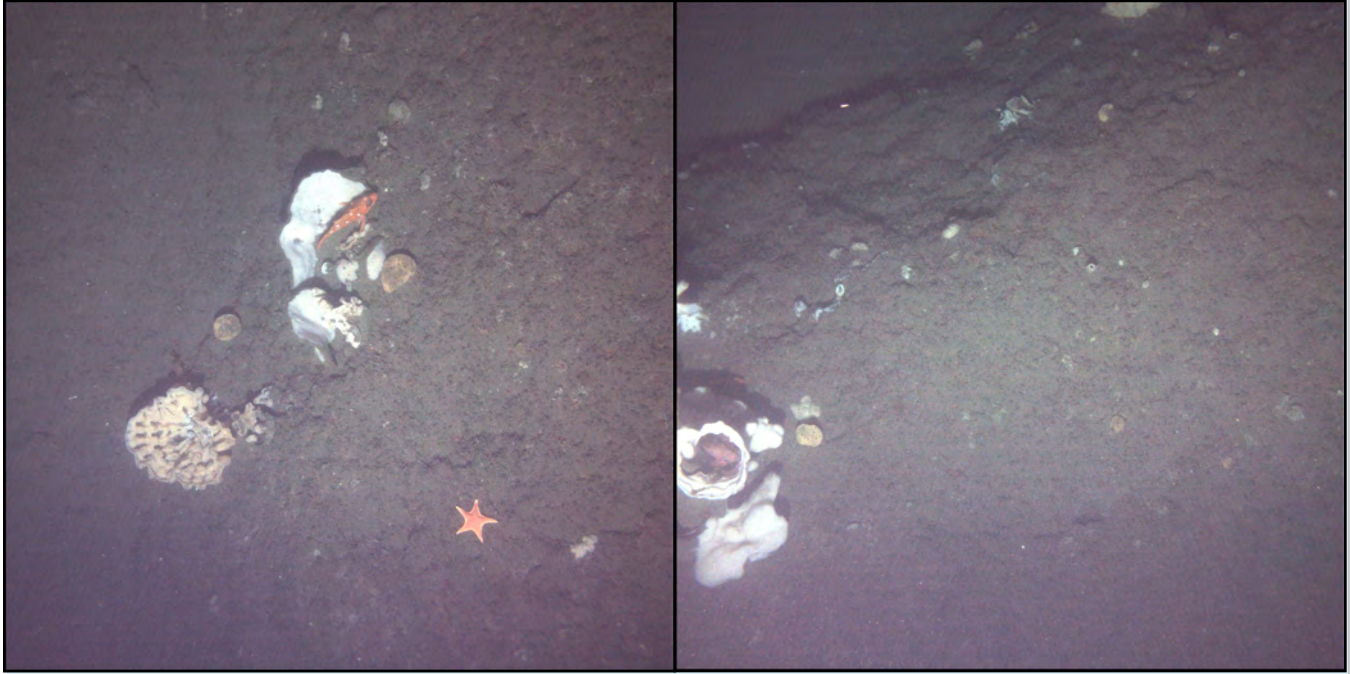


Heterochone calyx, *Poecillastra* sp. and *Sebastes* spp. on mixed habitat.



Rex sole and *Poecillastra* sp. mud

ADDITIONAL COMMENTS



There were many photographs in which sediment covered mounds were visible. Those mounds were possibly formed of layers of consolidated material but this could not be confirmed from photographs so they were categorized as sediment habitat. Note the edges of these mounds in some cases were sharp and had significant numbers of structure forming sponges (as in photographs above).

In a three instances man made marine debris was found and were a pipe, a length of rope or cable and two bottles.

There were significant number of salps in the area and were evident in many photographs.



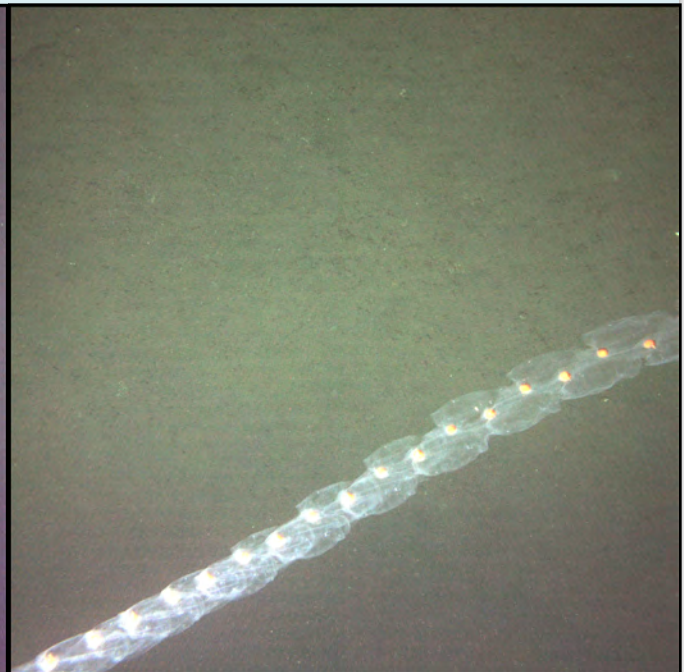
Marine debris: a metal pipe



Marine debris: a length of rope



Marine debris: two bottles



Salps in water column over sediment covered habitat. Salps were commonly seen in during all dives

GENERAL LOCATION AND DIVE TRACK

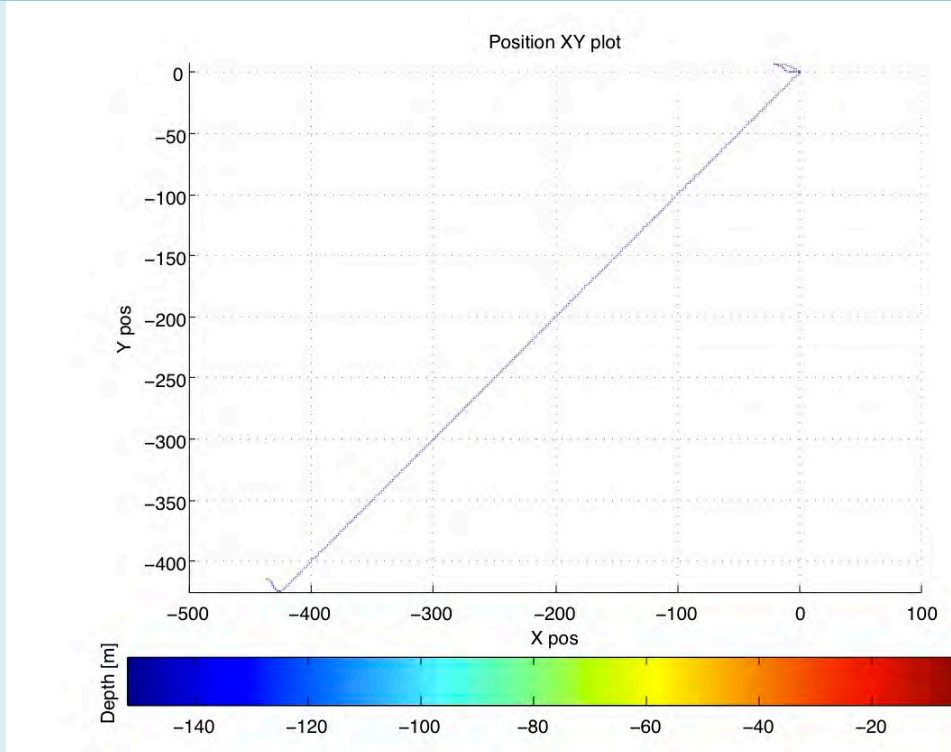


Figure 12. Survey Pattern of during dive AUV 003

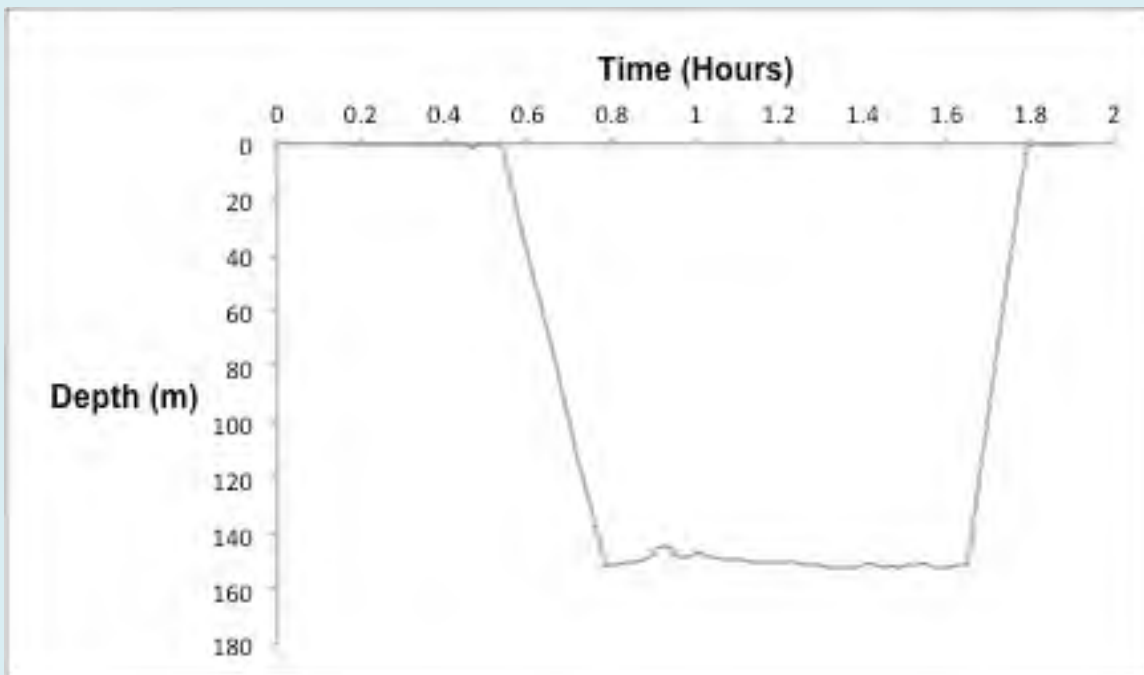


Figure 13. Depth track of AUV during dive AUV 003

STATION OVERVIEW

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CTD Sensors	Yes
O₂ Sensor	No
pH Sensor	No
Specimens collected	No
Report Authors	Elizabeth Clarke, Erica Fruh

DIVE DATA

Date	22-Sep-10	Starting Latitude (N)	47.001235°
Minimum Bottom Depth (m)	144	Starting Longitude (W)	124.94508°
Maximum Bottom Depth (m)	152	Ending Latitude (N)	46.997367°
Start Time (PDT)	8:51:21	Ending Longitude (W)	124.95041°
End Time (PDT)	9:43:10		

A total of 1,432 m² of bottom was assessed from a sample of digital photographs taken from the AUV *Lucille* deployed from the Oregon State University vessel *Pacific Storm* during Dive 003. The AUV was pre-programmed to conduct a single straight line transect toward the southwest from the start point at a height of 3 meters from the bottom (Figures 12, 13). Photographs were taken every 4.5 seconds from the downward-looking and forward-angled cameras. Photographs taken by the downward-looking camera were used to collect quantitative information about habitat and fauna in the region. Analyses focused on determining the abundance of sponges and fishes as well as their spatial relationship to each other.

PHYSICAL ENVIRONMENT

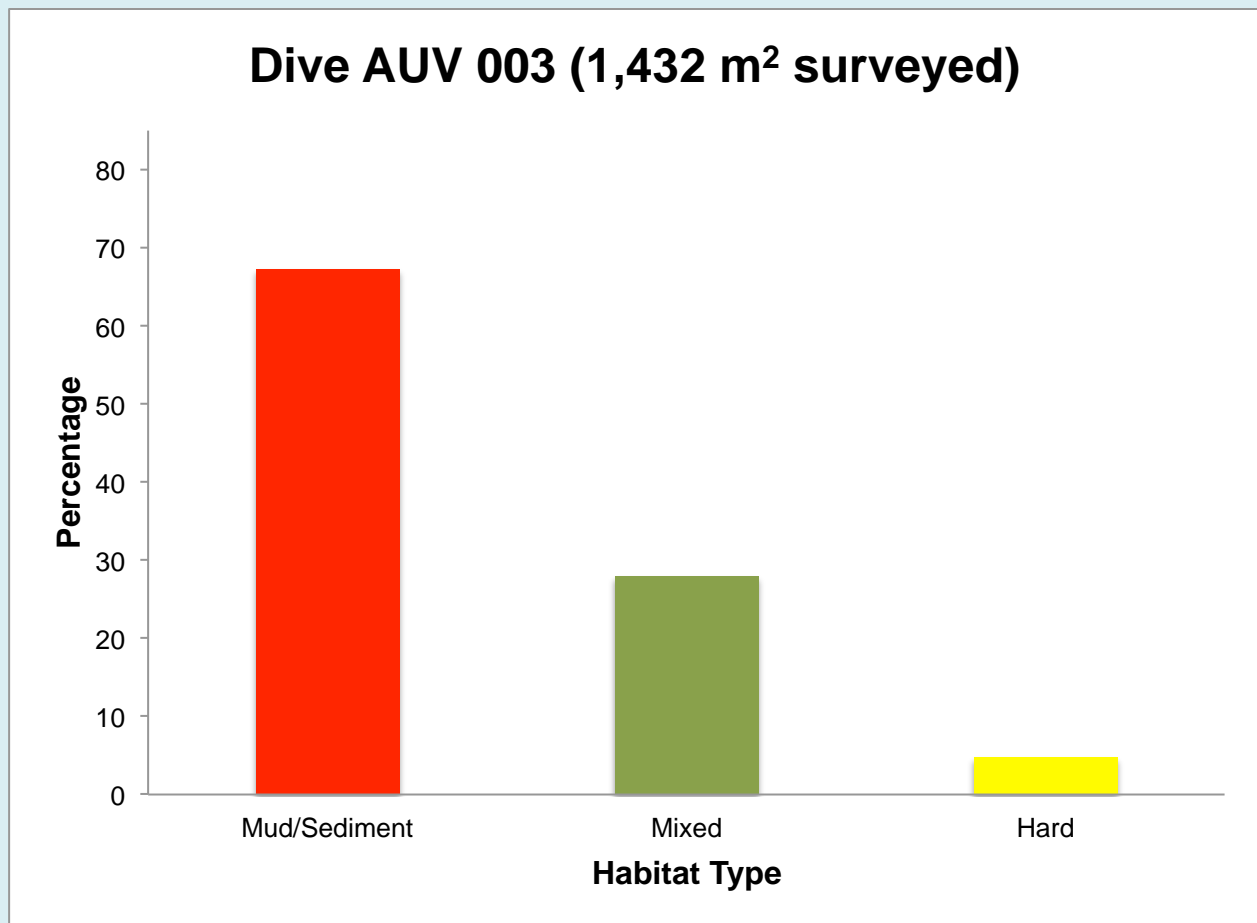


Figure 14. Percentage of habitat categories seen in dive AUV 003

A two character code was used to identify the habitat type and the two codes then were aggregated to identify three habitat categories : sediment/mud, mixed (which included various proportions of rock, boulder, cobble, flat rock and mud), and hard rock that was primarily a combination of boulder and/or flat rock. Sixty-seven percent of the area surveyed was sediment/mud, 28% mixed and the remainder was categorized as hard (Figure 14). There were many instances where it was possible that sediment covered mounds of consolidated material, however it was not possible to confirm this from the photographs and therefore in these instances the habitat was identified as sediment.

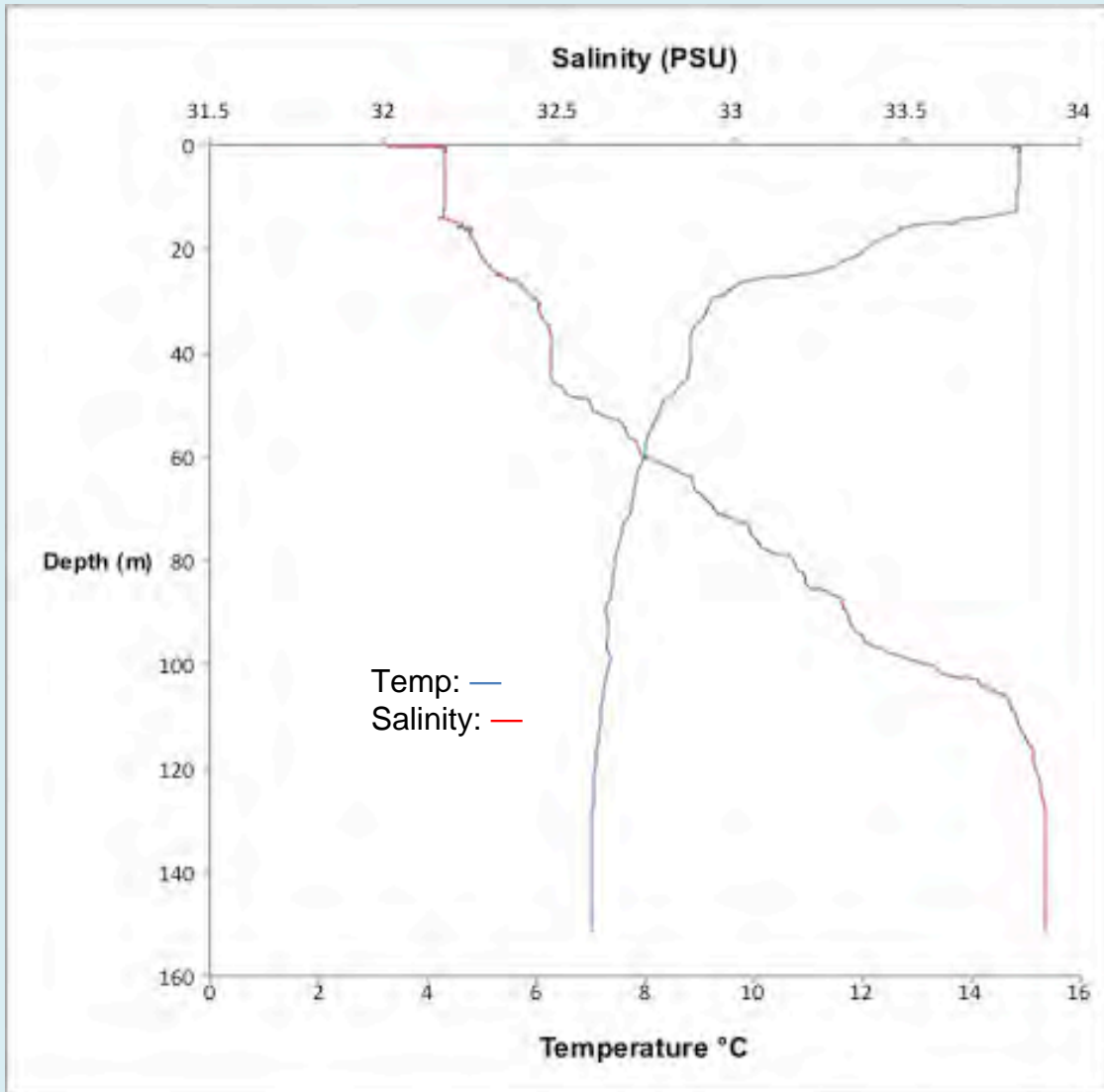


Figure 15. Salinity and temperature during descent of AUV.

The AUV was equipped with an onboard Seabird model 49 FastCat CTD that collected temperature and salinity information during the AUV's descent as well as along the dive track. The temperature varied from 14.78 to 7.01°C during descent and the salinity varied from 32.18 to 33.90 (PSU) (Figure 15.). The temperature and salinity varied only slightly along the dive track from 7.01 to 7.02 and 33.90 to 33.89 respectively.

BIOLOGICAL ENVIRONMENT: SPONGES AND CORALS

A total of 1,416 sponges from 10 taxonomic and morphometric groups were enumerated from 325 photos covering 1,432 m² during Dive 003 collected from the AUV *Lucille* deployed from the Oregon State University vessel *Pacific Storm* (Table 4). An overall density of 990 sponges per 1,000 m² of seafloor was estimated (Figure 16). The sponges with the highest percentage of the total density of sponges identified were the vase sponges *Heterochone calyx* and *Aphrocallistes* sp. (21%) followed by the barrel sponges including *Acanthascus* spp. (17%), and ball and mound sponges (8%). The fringed demosponge *Poecillastra* spp. only comprised 1% of the density on this dive but was abundant at the sites of all other dives. Mud covered/dead sponges comprised 2% of the density. Unidentified sponges, primarily fragments of sponges or non-structure forming small encrusting sponges, represented 49% of the density.

Corals were not abundant (a total of 41). The most abundant of these was an unidentified small branching coral. There were also small numbers of sea whips and cup corals.

Table 4. Number of sponges enumerated from dive 003

AUV 003	Common name	Scientific name	Number
	Vase Sponge	<i>Aphrocallistes</i> sp. (possibly <i>A. vastus</i>)	88
	Lobed Vase sponge	<i>Heterochone calyx</i>	208
	Fringed demosponge	<i>Poecillastra</i> spp.	18
	Unidentified barrel sponges	Porifera	11
	Barrel sponge	<i>Acanthascus</i> spp.	236
	Unidentified ball and mound sponges	Porifera	111
	Cloud or lace sponge	<i>Farrea occa</i>	5
	Unidentified demosponge	Porifera	8
	Mud covered/dead sponge	Porifera	34
	Unidentified sponge	Porifera	697

AUV 003 Density of sponges (990 per 1000 m²)

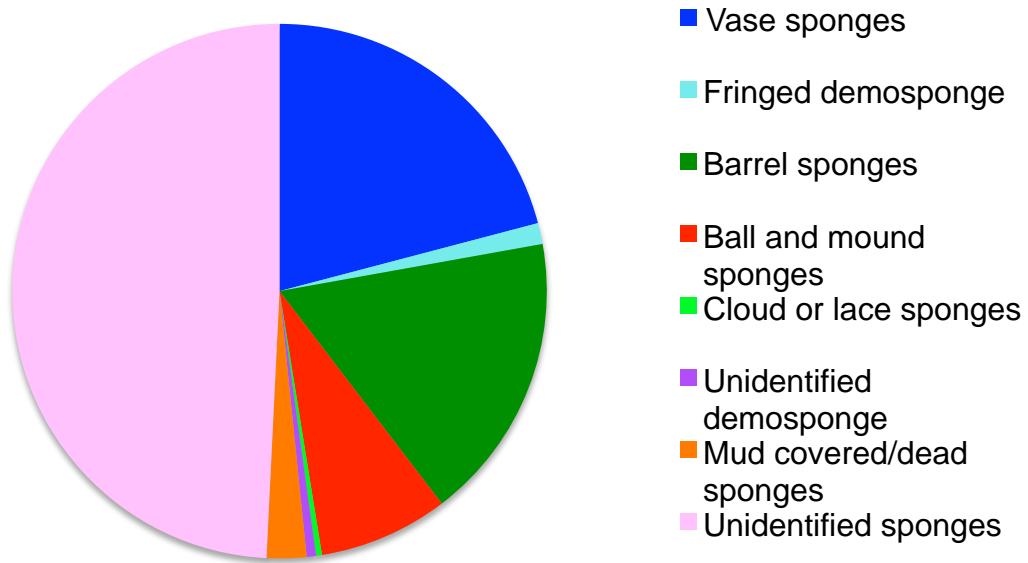


Figure 16. Percentage of total sponge density by group. Colors in pie diagram match colors in list of sponge taxa (Table 4).

BIOLOGICAL ENVIRONMENT: FISHES

Eighteen groups of fishes were identified in Dive 003 (Table 5). 686 fishes were enumerated with an overall density of 463 per 1000 m². Rockfish comprised 92% of the total fish density (Figure 17). A group of unidentified rockfish that included juvenile rockfish and a suite of rockfish primarily *S. zacentrus*, *S. wilsoni*, *S. proriger*, *S. diploproa*, or *S. alutus* that in many cases could not be easily distinguished from each other in the photographs were the most abundant, followed by rosethorn rockfish, greenstriped rockfish and other rockfish including, splitnose, redstripe, roughey and redbanded rockfish. Greenstriped rockfish were found primarily on muddy habitat along with an assemblage of flatfish including Dover sole, slender sole, rex sole, and petrale sole (3% of the total density of fishes). Other fishes seen included lingcod, longnose skate, and unidentified poachers, cottids. Rosethorn rockfish and other rockfish except greenstriped rockfish mostly occurred on mixed or hard habitat.

Table 5. Number of fishes enumerated from dive number 003

AUV 003	Common name	Common name	Number
Blue	Unidentified rockfish including young of the year	<i>Sebastes spp.</i>	485
	Rosethorn	<i>Sebastes helvomaculatus</i>	65
	Greenstriped	<i>Sebastes elongatus</i>	52
	Yellowtail	<i>Sebastes flavidus</i>	3
	Splitnose	<i>Sebastes diploproa</i>	1
	Redstripe	<i>Sebastes proriger</i>	20
	Roughey	<i>Sebastes aleutianus</i>	1
	Redbanded	<i>Sebastes babcocki</i>	1
Green	Rex sole	<i>Glyptocephalus zachirus</i>	3
	Slender sole	<i>Lyopsetta exilis</i>	15
	Dover sole	<i>Microstomus pacificus</i>	3
	Petrale sole	<i>Eopsetta jordani</i>	2
	Unidentified flatfish	Pleuronectiformes	1
Red	Lingcod	<i>Ophiodon elongatus</i>	2
Yellow	Unidentified sculpins	Cottidae	3
	Unidentified poachers	Agonidae	7
Purple	Longnose skate	<i>Raja rhina</i>	2
Pink	Unidentified Fish		20

Many of the rockfish were associated with the sponges. Fish were categorized as being associated with sponges when they were either touching or were within one body length of the structure forming sponges. Many of the fish were sitting in openings in vase sponges and were only partly visible. These fish could not be specifically identified in many cases. Twenty-five percent of fishes were associated with structure forming sponges.

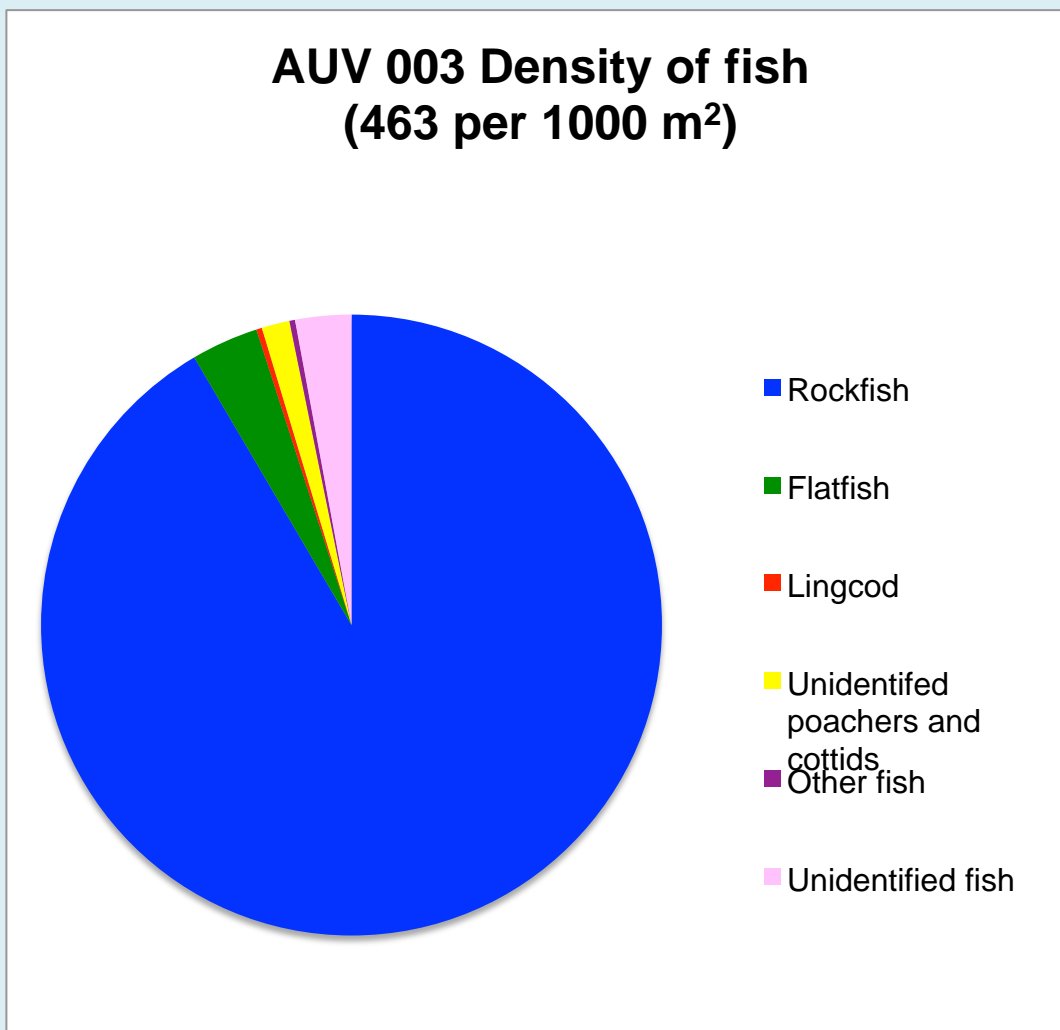
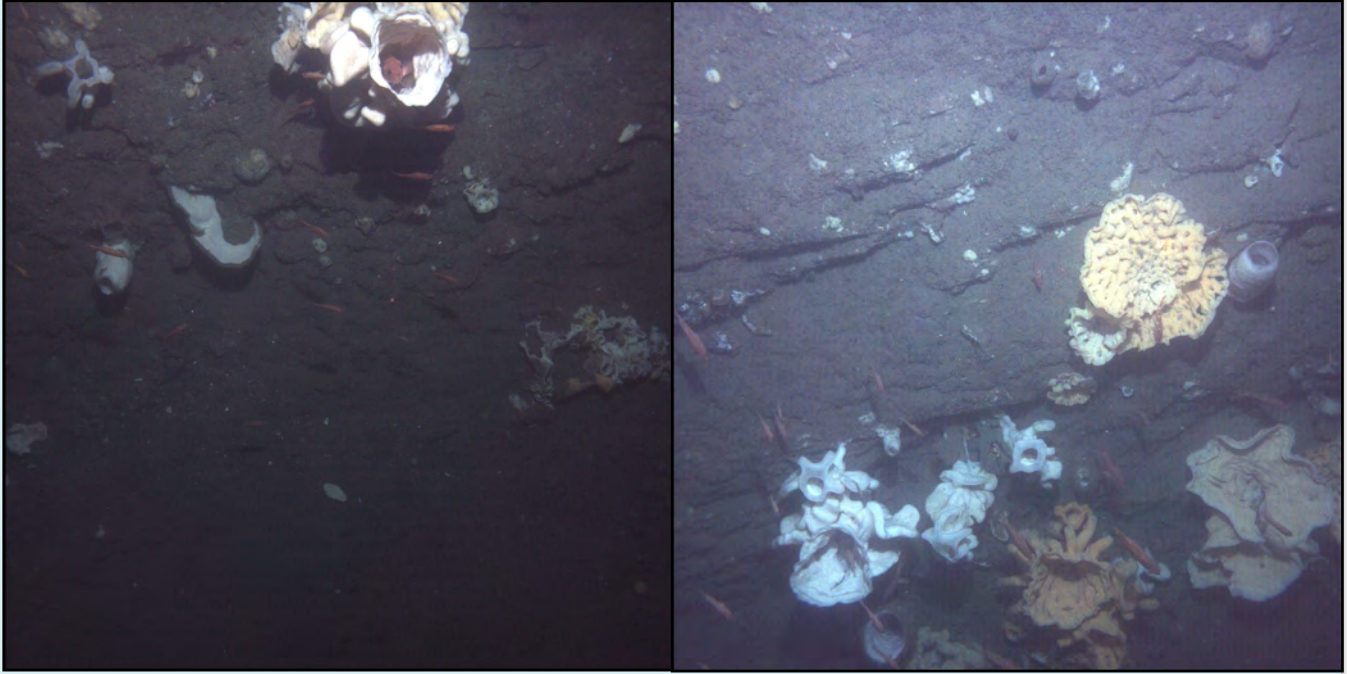


Figure 17. Percentage of fish density by group. Colors in pie diagram match colors in list of fish taxa (Table 5).

IMAGE GALLERY



Sponges along edges of mounds that appear to be composed of layers of consolidated materials



Yellowtail rockfish

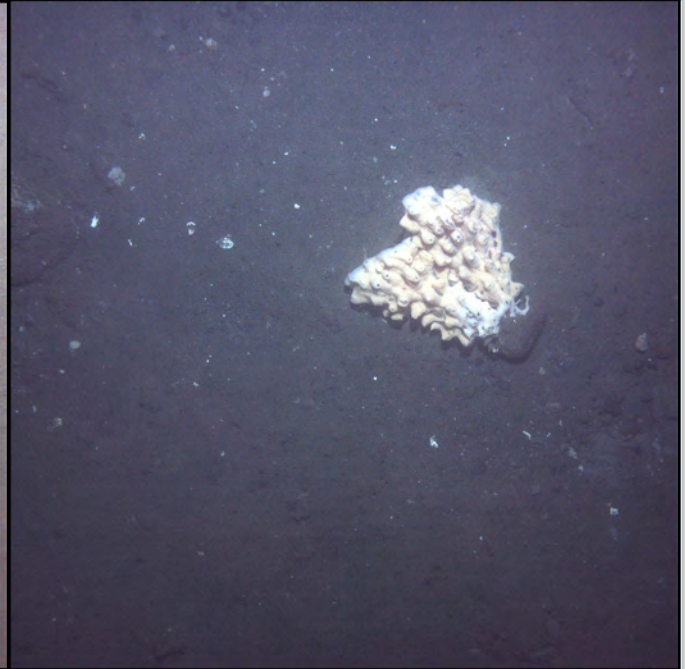


Dover sole and greenstriped rockfish

ADDITIONAL COMMENTS



Slender sole, greenstriped rockfish
and marine debris (brown bottle)



Heterochone calyx tipped on side but still
attached to cobble

On this dive mad-made debris was found twice and in both cases the debris was bottles. Dead and mud covered sponges were evident throughout the dive and in some cases while sponges were in good condition they were tipped over. Again on this dive there were instances where mounds covered by sediments were evident. The edges of these mounds indicated that the mounds could consist of layers of consolidated materials.

GENERAL LOCATION AND DIVE TRACK

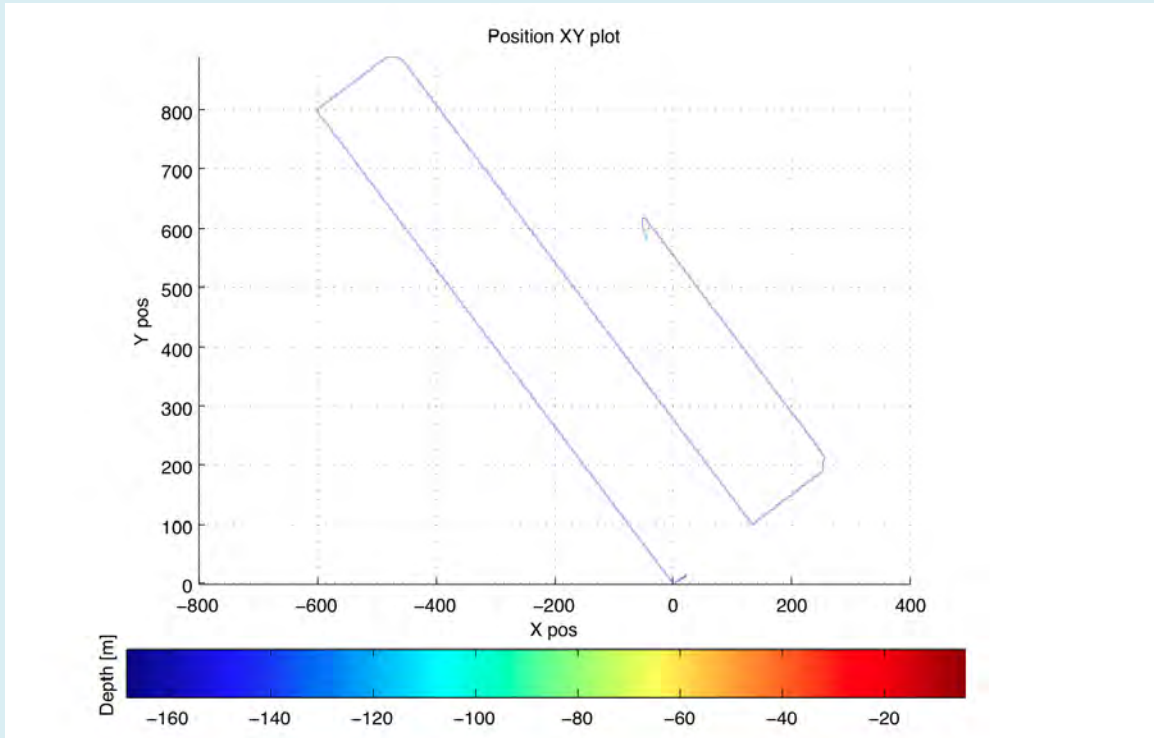


Figure 18. Survey pattern of during dive AUV 004

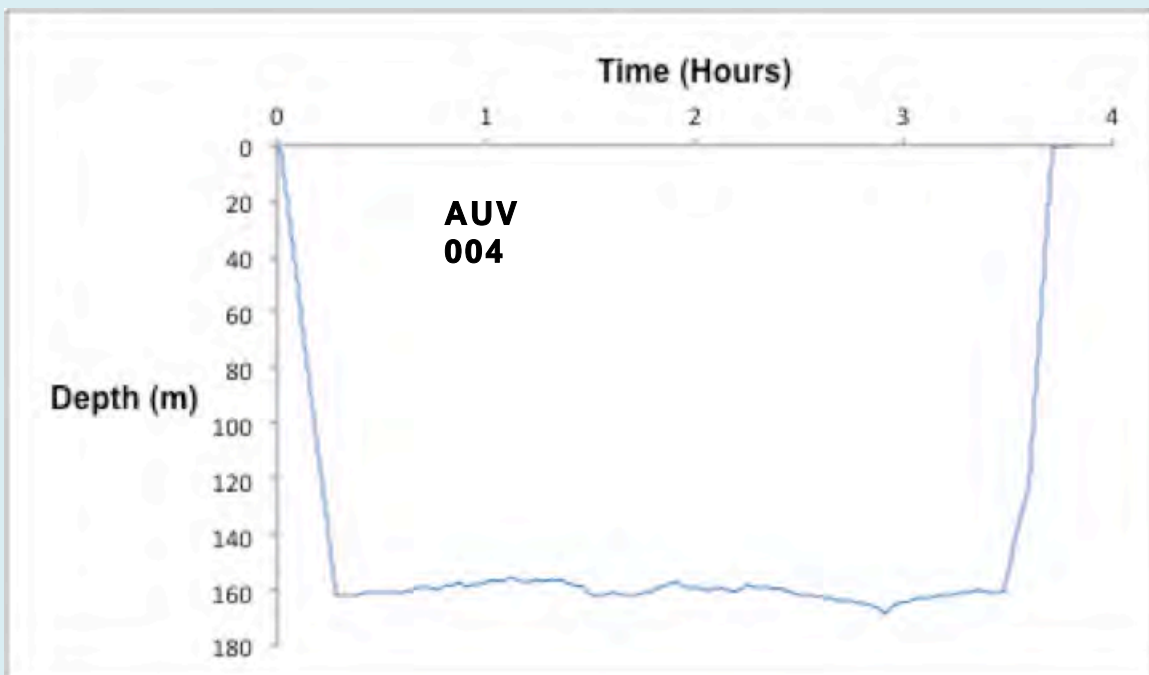


Figure 19. Depth track of AUV during dive AUV 004

STATION OVERVIEW

Contact Information	NOAA NWFSC elizabeth.clarke@noaa.gov
Purpose	Survey sponge area in region near Gray's Canyon, WA
Vessel	OSU Vessel Pacific Storm
Science Observers	Elizabeth Clarke, Erica Fruh, Jeremy Taylor, Russell Haner, Chris Murphy
External Video Tapes	None
Internal Video Tapes	None
Digital Still Photos	5094
Positioning System	Ship: GPS; AUV: USBL
CTD Sensors	Yes
O₂ Sensor	No
pH Sensor	No
Specimens collected	No
Report Authors	Elizabeth Clarke, Erica Fruh

DIVE DATA

Date	22-Sep-10	Starting Latitude (N)	47.023129°
Minimum Bottom Depth (m)	155	Starting Longitude (W)	124.94254°
Maximum Bottom Depth (m)	169	Ending Latitude (N)	47.028545°
Start Time (PDT)	14:40:33	Ending Longitude (W)	124.94345°
End Time (PDT)	17:51:56		

A total of 5,491 m² of bottom was assessed from a sample of digital photographs taken from the AUV *Lucille* deployed from the Oregon State University vessel *Pacific Storm* during Dive 004. The AUV was pre-programmed to conduct a sparse grid survey at a height of 3 meters from the bottom (Figures 18,19). Photographs were taken every 4.5 seconds from the downward-looking and forward-angled cameras. Photographs taken by the downward-looking camera were used to collect quantitative information about habitat and fauna in the region. Analyses focused on determining the abundance of sponges and fishes as well as their spatial relationship to each other.

PHYSICAL ENVIRONMENT

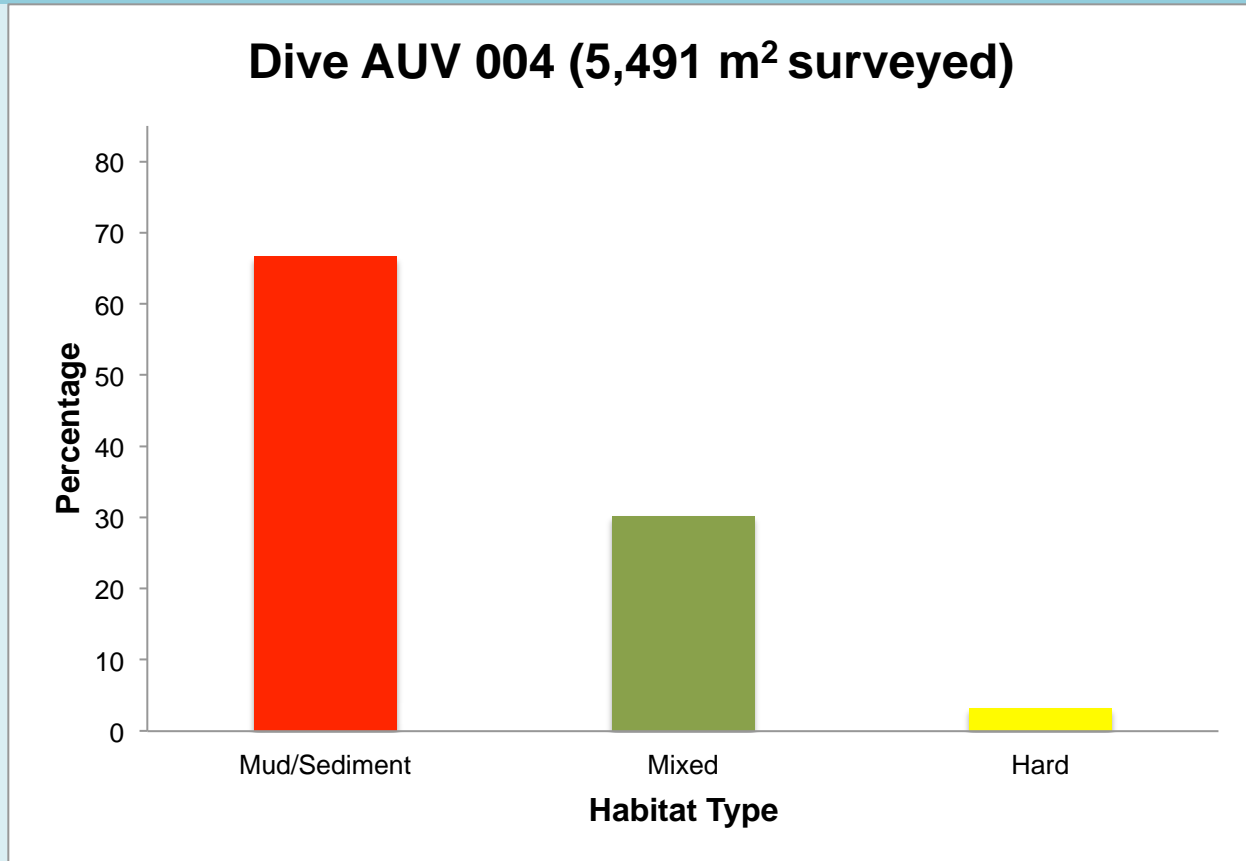


Figure 20. Percentage of habitat categories seen in dive 004

A two character code was used to identify the habitat type and the two codes then were aggregated to identify three habitat categories: sediment/mud, mixed (which included various proportions of rock, boulder, cobble or flat rock and mud), and hard rock that was primarily a combination of boulder and/or flat rock. Sixty-seven percent of the area surveyed was sediment/mud, 30% mixed and the remainder was categorized as hard (Figure 20). There were many instances where it was possible that sediment had covered mounds of consolidated material, however it was not possible to confirm this from the photographs and therefore in these instances the habitat was identified as sediment.

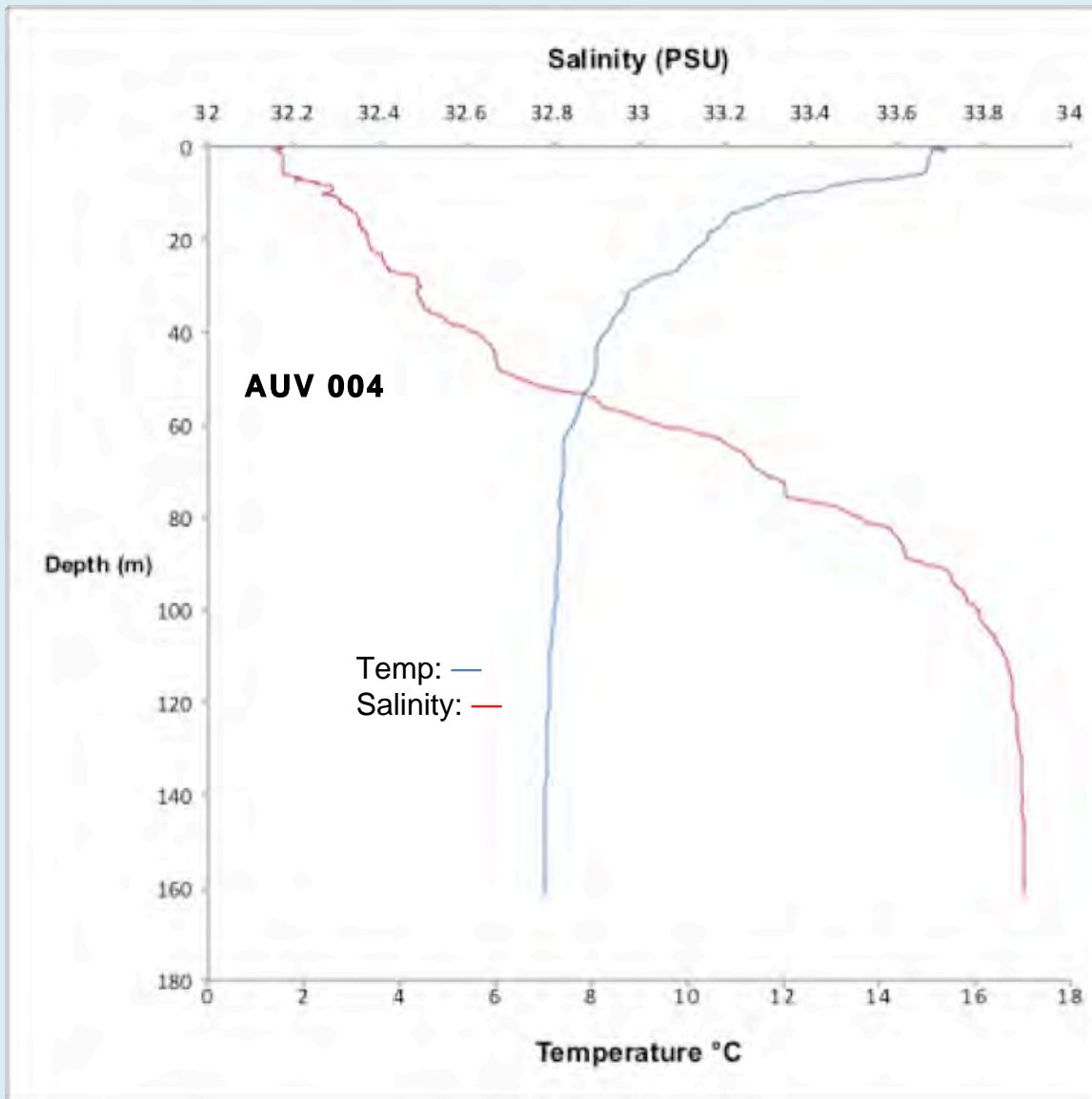


Figure 21 Salinity and temperature during descent of AUV.

The AUV was equipped with an onboard Seabird model 49 FastCat CTD that collected temperature and salinity information during the AUV's descent as well as along the dive track. The temperature varied from 15.84 to 7.02°C during descent and the salinity varied from 32.13 to 33.89 (PSU) (Figure 21). The temperature and salinity varied only slightly along the dive track from 6.99 to 7.02 and 33.89 to 33.90 respectively.

BIOLOGICAL ENVIRONMENT: SPONGES AND CORALS

A total of 2,166 sponges from 10 taxonomic and morphometric groups were enumerated from 1,277 photos covering 5,491 m² during Dive 004 collected from the AUV *Lucille* deployed from the Oregon State University vessel *Pacific Storm* (Table 6). An overall density of 396 sponges per 1,000 m² of seafloor was estimated. The sponges with the highest percentage of the total density of sponges identified were the vase sponges *Heterochone calyx* and *Aphrocallistes* sp. (30%) followed by the fringed demosponge, *Poecillastra* spp. (7%), barrel sponges including *Acanthascus* spp. (7%), mud covered/dead sponges (7%), unidentified demosponges (2%), ball/mound sponges (2%) and cloud sponges (1%) (Figure 22). Unidentified sponges, primarily fragments of sponges or non-structure forming small encrusting sponges, represented 48% of the density.

Corals were much less abundant (a total of 32). The most abundant of these was an unidentified small white branching coral. There also were small numbers of sea whips and cup corals.

Table 6. Number of sponges enumerated from dive 004

AUV 04	Common name	Scientific name	Number
	Vase Sponge	<i>Aphrocallistes</i> sp. (possibly <i>A. vastus</i>)	173
	Lobed Vase sponge	<i>Heterochone calyx</i>	479
	Fringed demosponge	<i>Poecillastra</i> spp.	157
	Unidentified barrel sponges	Porifera	26
	Barrel sponge	<i>Acanthascus</i> spp.	55
	Unidentified ball and mound sponges	Porifera	39
	Cloud or lace sponge	<i>Farrea occa</i>	14
	Unidentified demosponge	Porifera	44
	Mud covered/dead sponge	Porifera	156
	Unidentified sponge	Porifera	1023

AUV 004 Density of sponges (396 per 1000 m²)

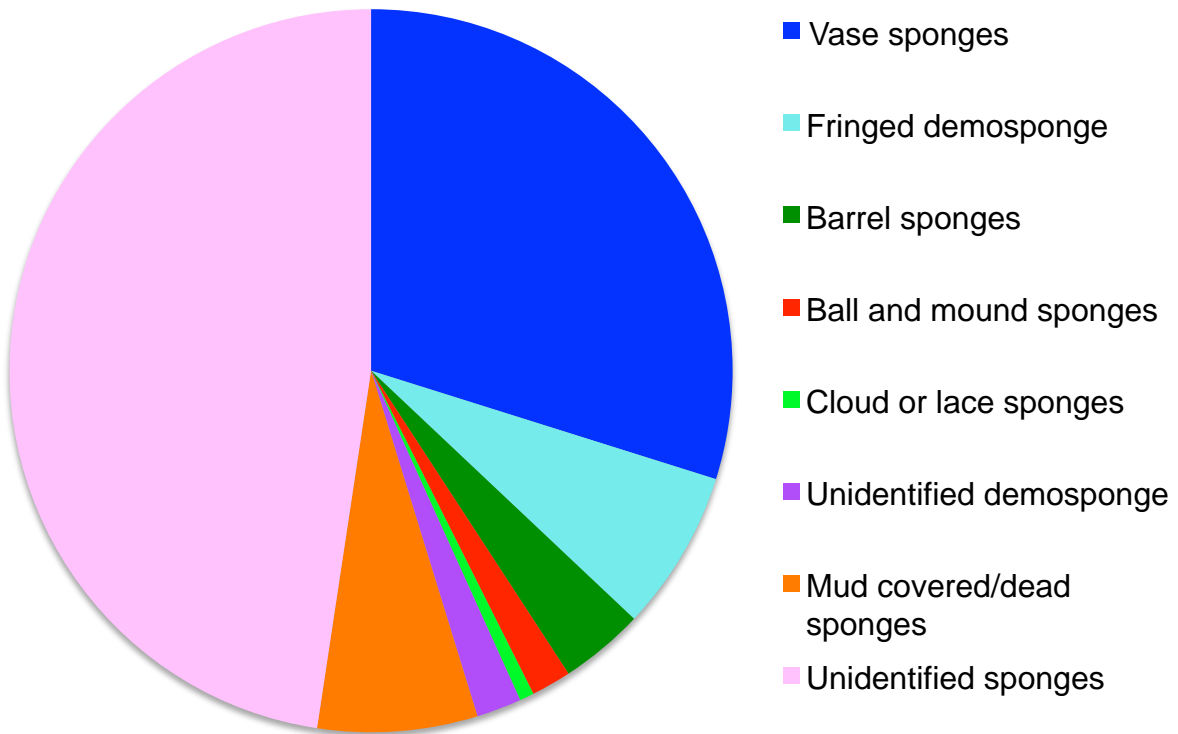


Figure 22. Percentage of sponge density by group. Colors in pie diagram match colors in list of sponge taxa (Table 6).

BIOLOGICAL ENVIRONMENT: FISHES

Nineteen groups of fishes were identified in Dive 004 (Table 7). 548 fishes were enumerated with an overall density of 100 per 1000 m². Rockfishes represented 53% of the total density (Figure 23). A group of unidentified rockfish that included juvenile rockfish and a suite of rockfish primarily *S. zacentrus*, *S. wilsoni*, *S. proriger*, *S. diploproa*, or *S. alutus* that in many cases could not be easily distinguished from each other in the photographs were the most abundant rockfish, followed by greenstriped and rosethorn rockfish. Greenstriped rockfish were found primarily on muddy habitat along with an assemblage of flatfish including Dover sole, slender sole, rex sole, English sole and petrale sole. This assemblage of flatfish was very abundant in this location and comprised 30% of the total density of fishes. Unidentified poachers and cottids were also abundant and comprised 13% of the total density. Other fishes seen included lingcod, longnose skate, and hagfish. Rosethorn rockfish and other rockfish except greenstriped rockfish were mostly found on mixed or hard habitat.

Table 7. Number of fishes enumerated from dive number 004

AUV 04	Common name	Common name	Number
Blue	Unidentified rockfish including young of the year	<i>Sebastes spp.</i>	104
	Rosethorn	<i>Sebastes helvomaculatus</i>	79
	Greenstriped	<i>Sebastes elongatus</i>	98
	Splitnose	<i>Sebastes diploproa</i>	2
	Redstripe	<i>Sebastes proriger</i>	8
	Redbanded	<i>Sebastes babcocki</i>	1
Green	Rex sole	<i>Glyptocephalus zachirus</i>	26
	Slender sole	<i>Lyopsetta exilis</i>	81
	Dover sole	<i>Microstomus pacificus</i>	28
	Petrable sole	<i>Eopsetta jordani</i>	18
	bothid		1
Green	English sole	<i>Parophrys vetulus</i>	1
	Unidentified flatfish	Pleuronectiformes	7
Red	Lingcod	<i>Ophiodon elongatus</i>	3
Yellow	Unidentified sculpins	Cottidae	12
Yellow	Unidentified poachers	Agonidae	61
Purple	Longnose skate	<i>Raja rhina</i>	1
	Pacific Hagfish	<i>Epatatretus stoutii</i>	3
Pink	Unidentified Fish		14

Many of the rockfish were associated with the sponges. Fish were categorized as being associated with sponges when they were either touching structure forming sponges or were within one body length of the structure forming sponges. Many of the fish were sitting in openings of vase sponges and were only partly visible. These fish could not be specifically identified in many cases. Nineteen percent of fishes were associated with sponges.

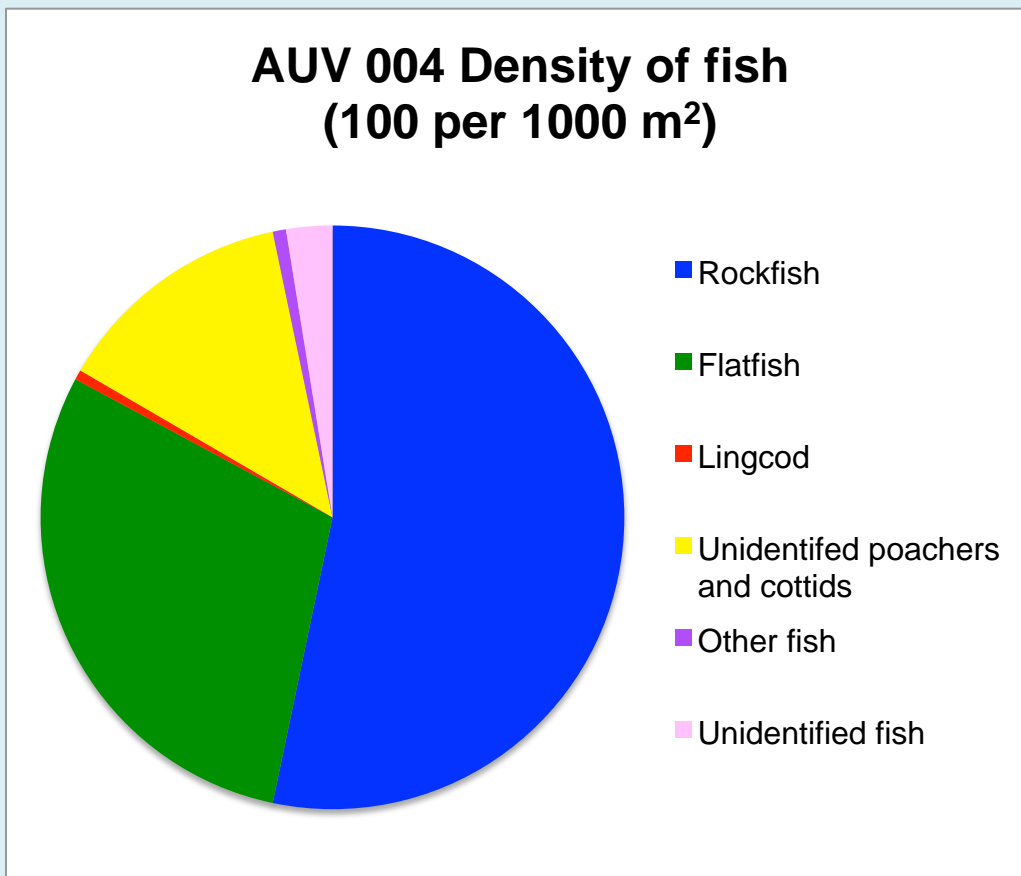
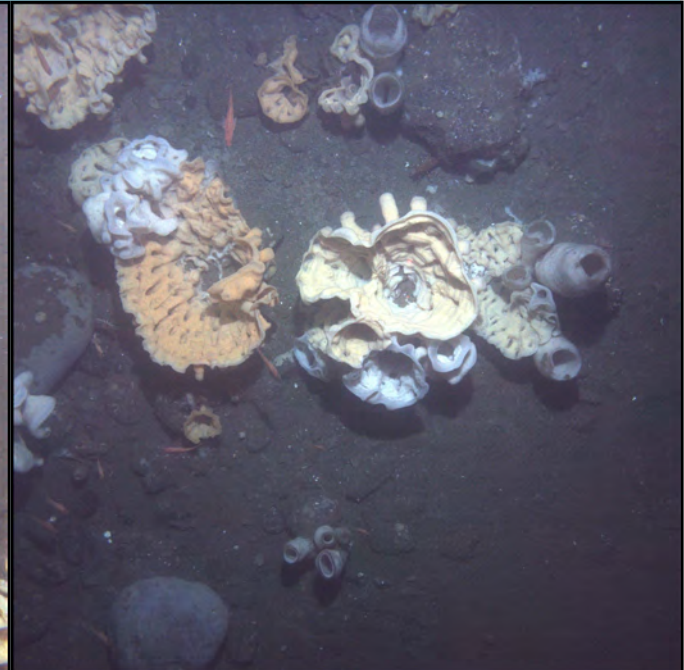


Figure 23. Percentage of fish density by group. Colors in pie diagram match colors in list of fish taxa (Table 7).

IMAGE GALLERY



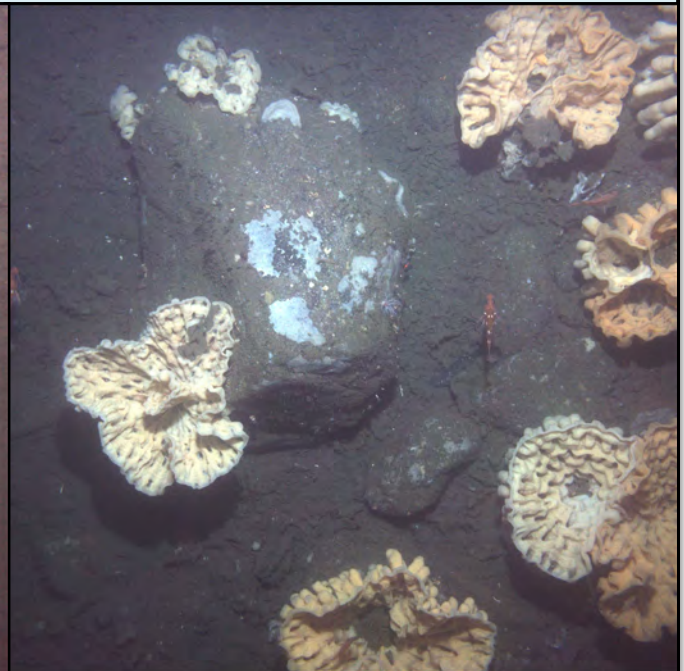
Dover sole, rosethorn rockfish and barrel sponge, *Acanthascus* sp.



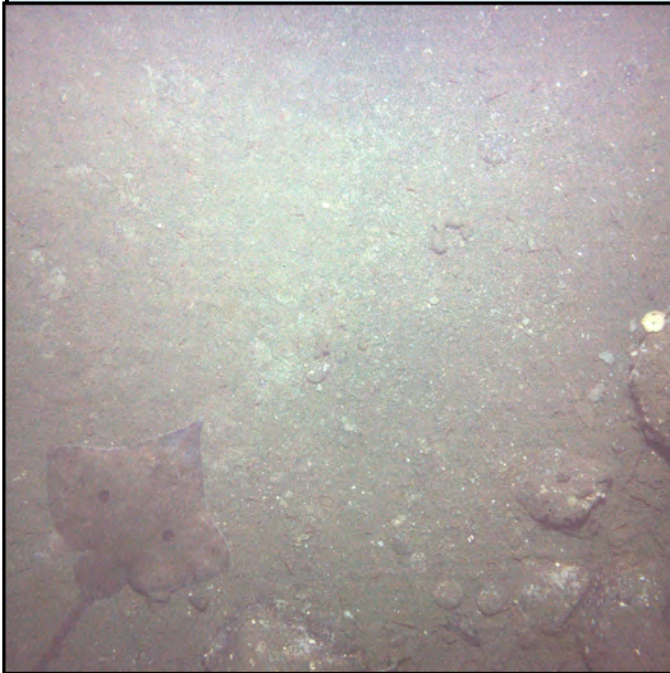
Heterochone calyx, *Acanthascus* sp. and *Sebastes* sp. on mixed habitat with boulders



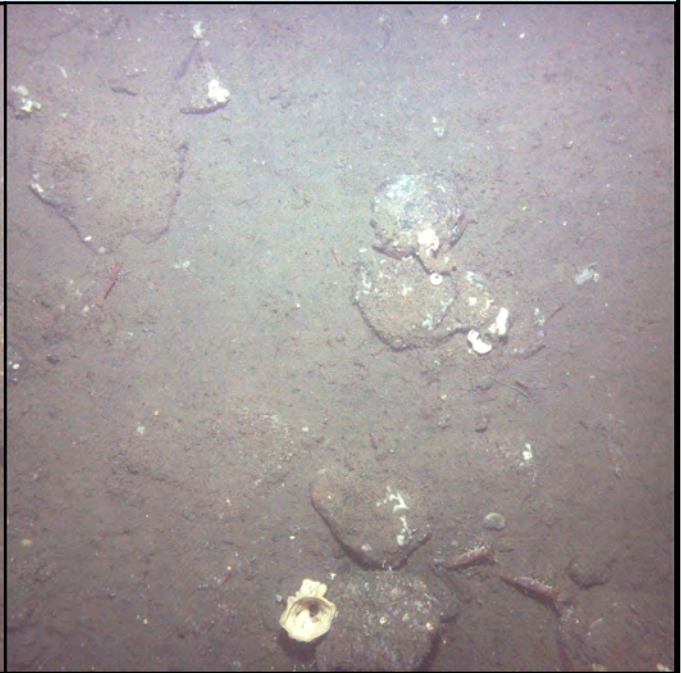
Poecillastra sp. *Heterochone calyx*, and barrel sponge, *Acanthascus* sp. on edge of a mound that appears to be comprised of consolidated material covered in sediment



Heterochone calyx and rosethorn rockfish



Longnose skate on mixed habitat



Spot prawn and *Heterochone calyx*

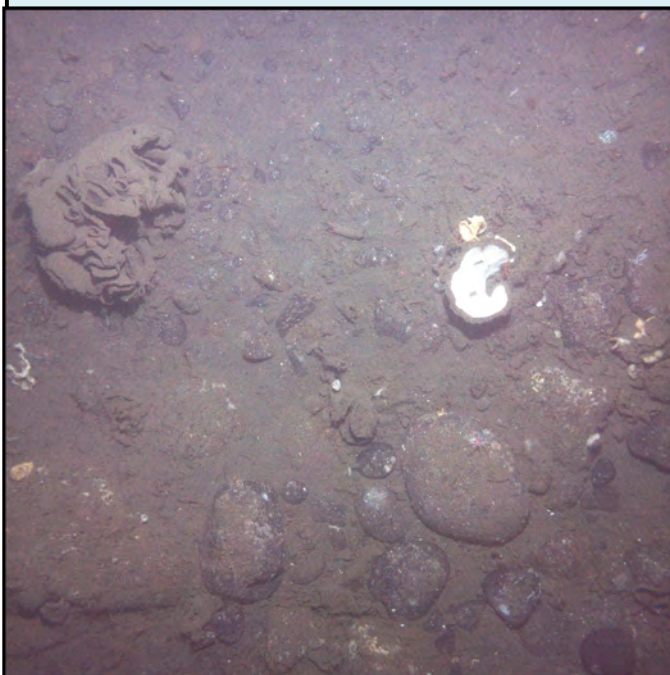
ADDITIONAL COMMENTS



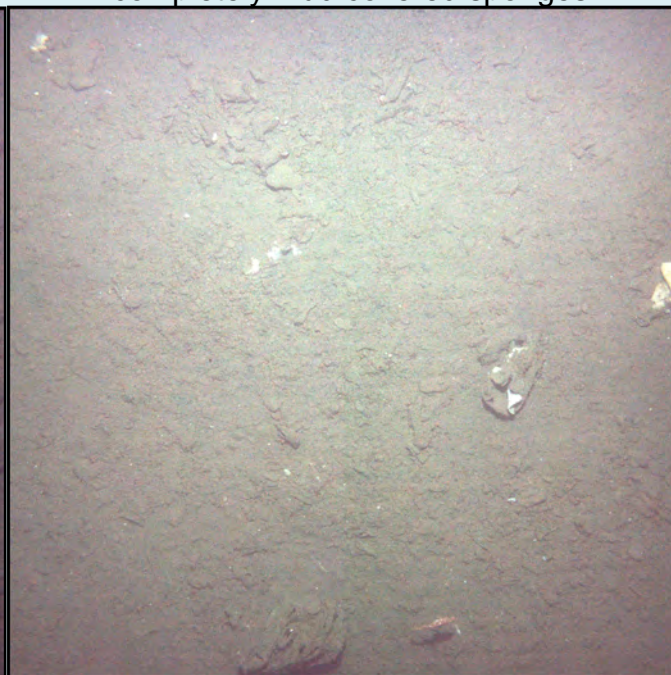
Live *Heterochone calyx* and mud covered sponges



Live *Heterochone calyx*, and *Poecillastra* sp. along with partially mud covered and completely mud covered sponges



Live *Poecillastra* sp., mud covered sponge and fragments of mud covered sponges



Mud covered sponges and fragments of mud covered sponges

There was a high density of mud covered, broken sponges on this dive. In some cases these mud covered sponges were near live sponges and in other photographs an entire area was predominantly covered with mud covered sponges and mud covered sponge fragments. This dive also had the highest density of flatfish and unidentified poachers and cottids. Many of these were associated with areas where there were also broken mud covered sponges. There was only one instance when man-made debris was found. This debris was a small amount of monofilament line.

GENERAL LOCATION AND DIVE TRACK

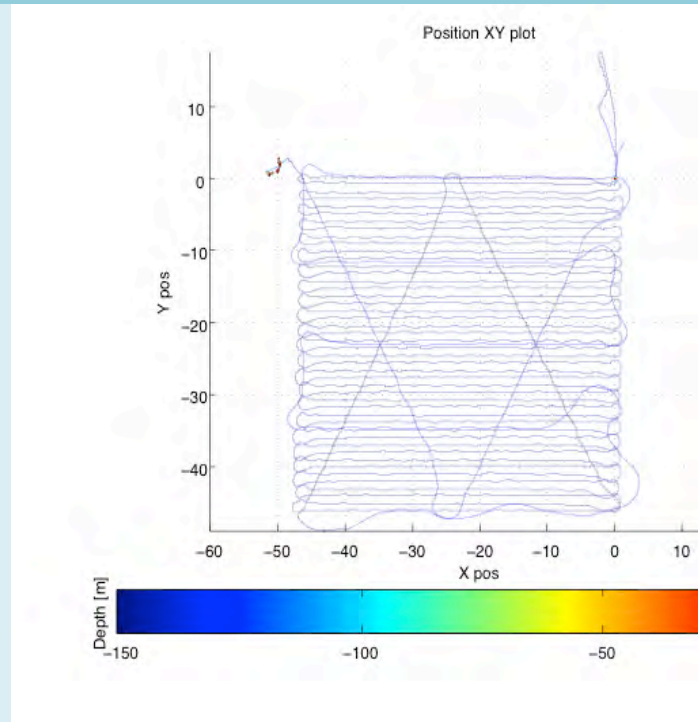


Figure 24. Survey pattern of dive AUV 005

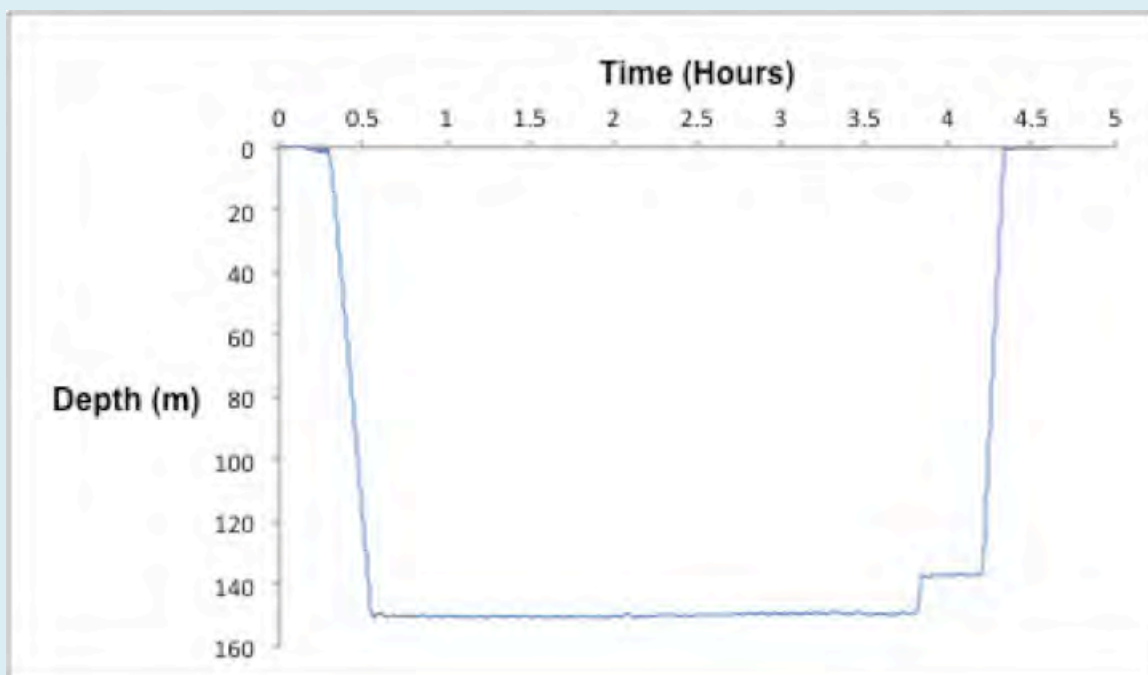


Figure 25. Depth track of AUV during dive AUV 005

STATION OVERVIEW

Contact Information	NOAA NWFSC elizabeth.clarke@noaa.gov
Purpose	Survey sponge area in region near Gray's Canyon, WA
Vessel	OSU Vessel Pacific Storm
Science Observers	Elizabeth Clarke, Erica Fruh, Jeremy Taylor, Russell Haner, Chris Murphy
External Video Tapes	None
Internal Video Tapes	None
Digital Still Photos	5204
Positioning System	Ship: GPS; AUV: USBL
CTD Sensors	Yes
O₂ Sensor	No
pH Sensor	No
Specimens collected	No
Report Authors	Elizabeth Clarke, Erica Fruh

A total of 2,417 m² of bottom was assessed from a sample of digital photographs taken from the AUV *Lucille* deployed from the Oregon State University vessel *Pacific Storm* during Dive 004. The AUV was pre-programmed to conduct a tight grid survey at a height of 3 meters from the bottom (Figures 24, 25) with cameras.. Photographs were taken every 5.0 seconds from the downward-looking and forward-angled cameras. After completing the photographic survey, the AUV was programmed to turn off cameras and rise to 20 meters above the bottom and use the onboard Imagenex Delta-T profiling sonar to conduct a five line survey of the same sampling area. Photographs taken by the downward-looking camera on alternate (non-overlapping) horizontal transects were used to collect quantitative information about habitat and fauna in the region. Analyses focused on determining the abundance of sponges and fishes as well as their spatial relationship to each other.

DIVE DATA

Date	23-Sep-10	Starting Latitude (N)	46.995872°
Minimum Bottom Depth (m)	148	Starting Longitude (W)	124.942693°
Maximum Bottom Depth (m)	151	Ending Latitude (N)	46.995316°
Start Time (PDT)	14:34:01	Ending Longitude (W)	124.94750°
End Time (PDT)	17:59:38		

PHYSICAL ENVIRONMENT

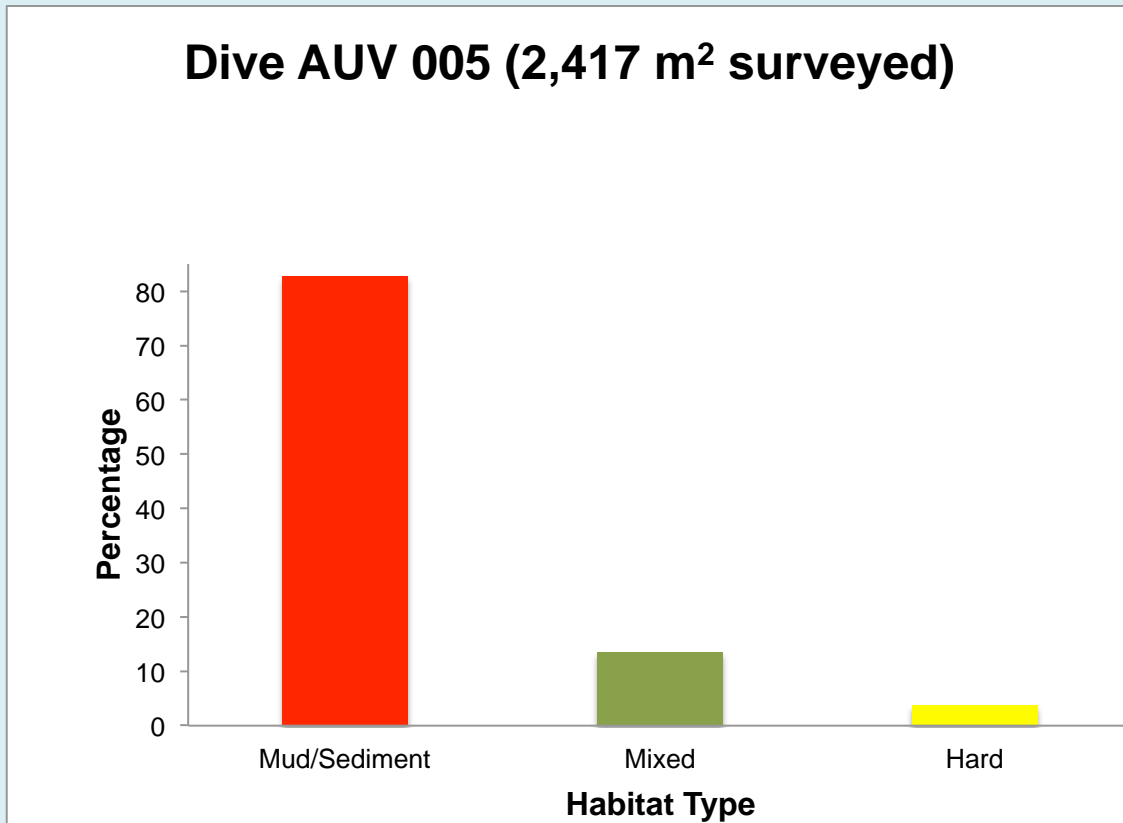


Figure 26. Percentage of habitat types seen in dive 005

A two character code was used to identify the habitat type and the two codes were aggregated to identify three habitat types: sediment/mud, mixed (which included various proportions of rock, boulder, cobble or flat rock) and mud, and hard rock that was primarily a combination of boulder and/or flat rock. Eighty-three percent of the area surveyed was sediment/mud, 14% mixed and the remainder was categorized as hard (Figure 26). There were many instances where it was possible that sediment had covered hard rock, however it was not possible to confirm this from the photographs and therefore in these instances the habitat was identified as sediment.

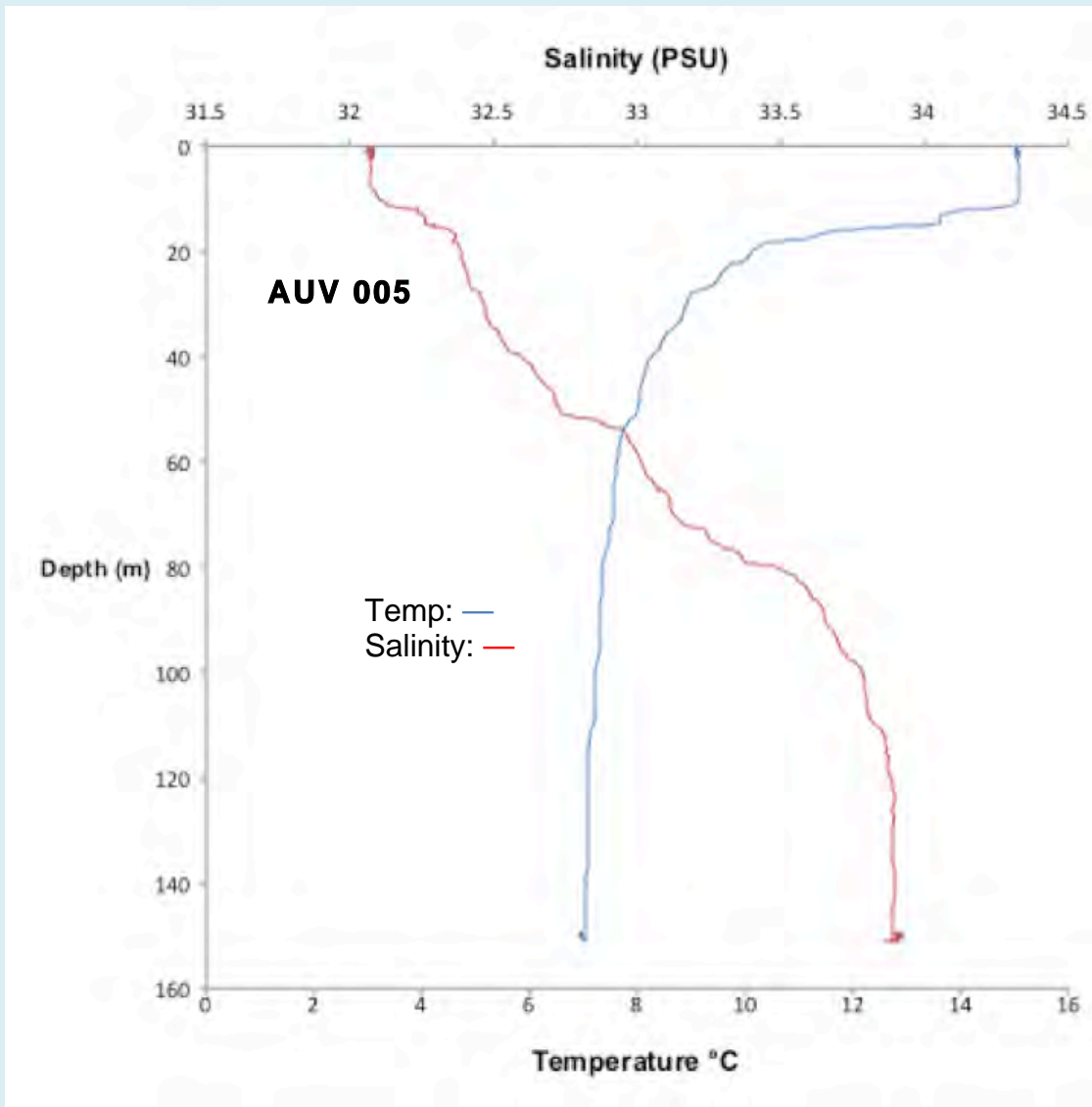


Figure 27. Salinity and temperature during descent of AUV.

The AUV was equipped with an onboard Seabird model 49 FastCat CTD that collected temperature and salinity information during the AUV's descent as well as along the dive track. The temperature varied from 14.90 to 7.03°C during descent and the salinity varied from 32.07 to 33.89 (PSU) (Figure 27). The temperature and salinity varied along the dive track from 6.96 to 7.01 and 32.14 to 33.93 respectively.

BIOLOGICAL ENVIRONMENT: SPONGES AND CORALS

A total of 1,127 sponges from 9 taxonomic and morphometric groups were enumerated from 615 photos covering 2417 m² during Dive 005 collected from the AUV *Lucille* deployed from the Oregon State University vessel *Pacific Storm* (Table 8). An overall density of 466 sponges per 1,000 m² of seafloor was estimated. The sponges with the highest percentage of the total density of sponges identified were the vase sponges *Aphrocallistes* sp and *Heterochone calyx* (30%) followed by the barrel sponges including *Acanthascus* spp. (19%), the fringed demosponge, *Poecillastra* spp. (11%), mud covered/dead sponges (4%), ball/mound sponges (2%) and cloud sponges (2%) (Figure 28). Unidentified sponges, primarily fragments of sponges or non-structure forming sponges small encrusting sponges, represented 31% of the density.

Corals were much less abundant (a total of 19). The most abundant of these was an unidentified small branching coral. There also were small numbers of sea whips and cup corals.

Table 8. Number of sponges enumerated from dive 005

AUV 05	Common name	Scientific name	Number
	Vase Sponge	<i>Aphrocallistes</i> sp. (possibly <i>A. vastus</i>)	215
	Lobed Vase sponge	<i>Heterochone calyx</i>	122
	Fringed demosponge	<i>Poecillastra</i> spp.	123
	Unidentified barrel sponges	Porifera	57
	Barrel sponge	<i>Acanthascus</i> spp.	152
	Unidentified ball and mound sponges	Porifera	28
	Cloud or lace sponge	<i>Farrea occa</i>	28
	Mud covered/dead sponge	Porifera	50
	Unidentified sponge	Porifera	352

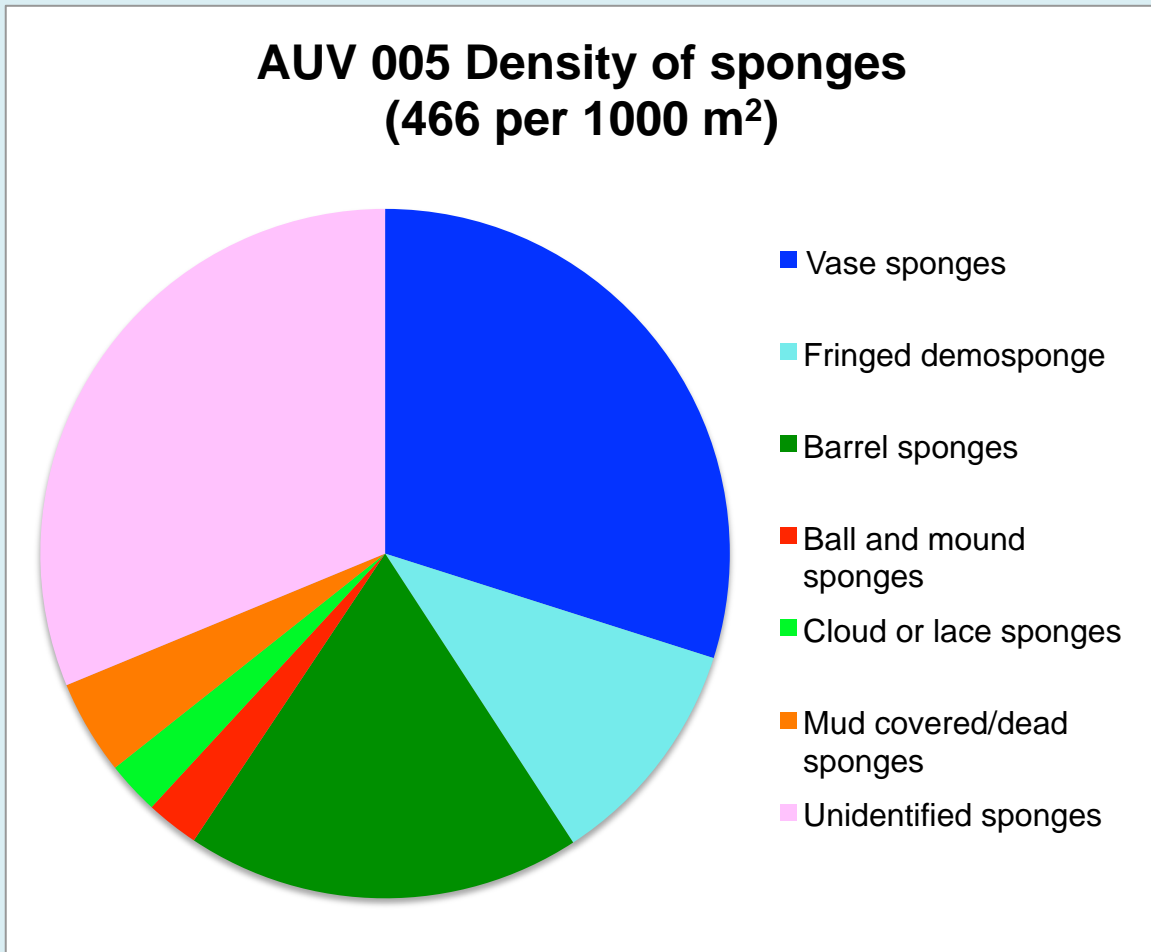


Figure 28. Percentage of sponge density by group. Colors in pie diagram match colors in list of sponge taxa (Table 8).

BIOLOGICAL ENVIRONMENT: FISHES

Seventeen groups of fishes were identified in Dive 005 (Table 9). 310 fishes were enumerated with an overall density of 128 per 1000 m². Rockfish represented 82% of the total fish density (Figure 29). A group of unidentified rockfish that included juvenile rockfish and a suite of rockfish primarily *S. zacentrus*, *S. wilsoni*, *S. proriger*, *S. diploproa*, or *S. alutus* that in many cases could not be easily distinguished from each other in the photographs were the most abundant rockfish followed by rosethorn rockfish, and greenstriped rockfish and other rockfish including splitnose, redstripe, redbanded and rougheye rockfish. Greenstriped rockfish were found primarily on muddy habitat along with an assemblage of flatfish including Dover sole, slender sole, and rex sole that represented 8% of the total density of fishes. Other fishes seen included lingcod, longnose skate, hagfish and unidentified poachers, cottids. Rosethorn rockfish and other rockfish except greenstriped rockfish were mostly found on mixed or hard habitat associated with sponges.

Table 9. Number of fishes enumerated from dive number 005

AUV 05	Common name	Common name	
Blue	Unidentified rockfish including young of the year	<i>Sebastes spp.</i>	141
	Rosethorn	<i>Sebastes helvomaculatus</i>	45
	Greenstriped	<i>Sebastes elongatus</i>	53
	Splitnose	<i>Sebastes diploproa</i>	11
	Redstripe	<i>Sebastes proriger</i>	1
	Rougheye	<i>Sebastes aleutianus</i>	1
	Redbanded	<i>Sebastes babcocki</i>	1
Green	Rex sole	<i>Glyptocephalus zachirus</i>	9
	Slender sole	<i>Lyopsetta exilis</i>	6
	Dover sole	<i>Microstomus pacificus</i>	9
Red	Lingcod	<i>Ophiodon elongatus</i>	11
Yellow	Unidentified sculpins	Cottidae	13
	Unidentified poachers	Agonidae	2
Purple	Spotted ratfish	<i>Hydrolagus collieri</i>	1
	Longnose skate	<i>Raja rhina</i>	2
	Pacific Hagfish	<i>Epatatretus stoutii</i>	2
Pink	Unidentified Fish		2

Many of the rockfish were associated with the sponges. Fish were categorized as being associated with sponges when they were either touching or were within one body length of the structure forming sponges. Many of the fish were sitting within openings of vase sponges and only partly visible. These fish could not be specifically identified in many cases. Sixty-six percent of fishes were associated with sponges. There was a higher number of fishes associated with structure forming sponges than at any other location sampled.

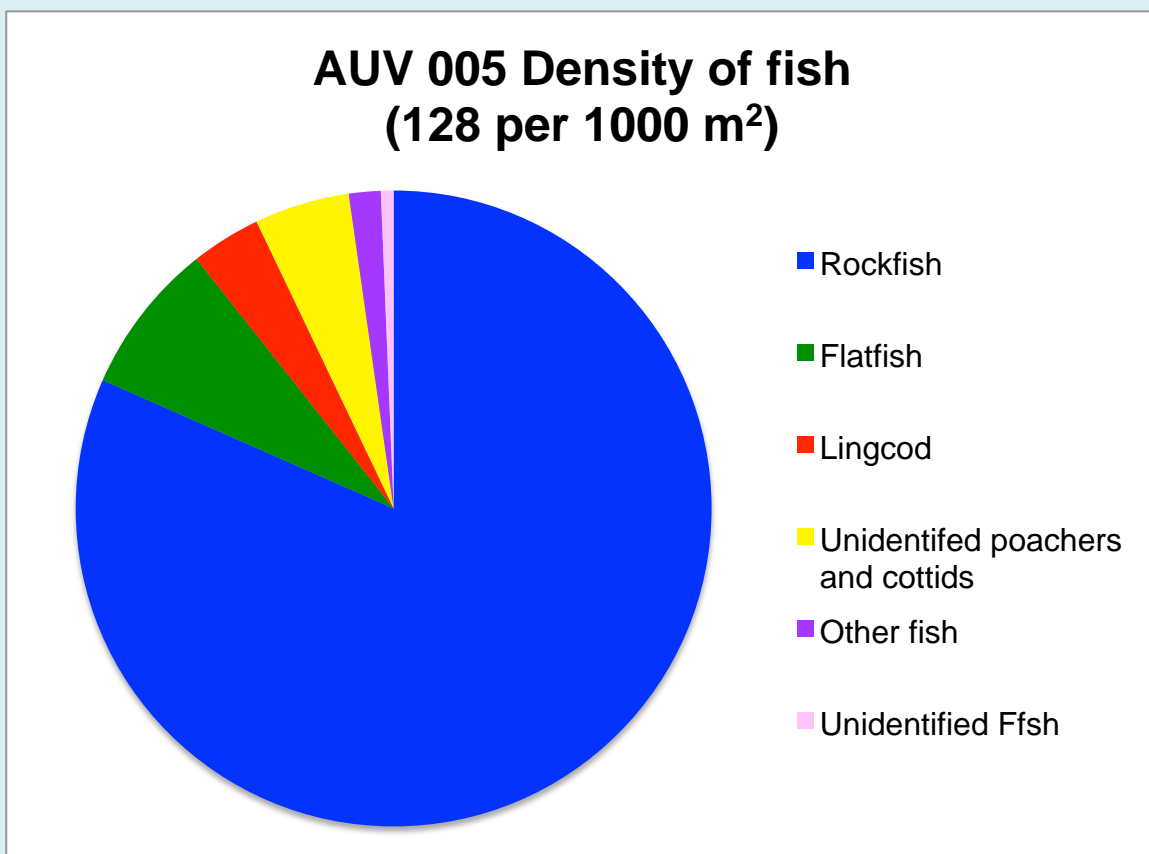
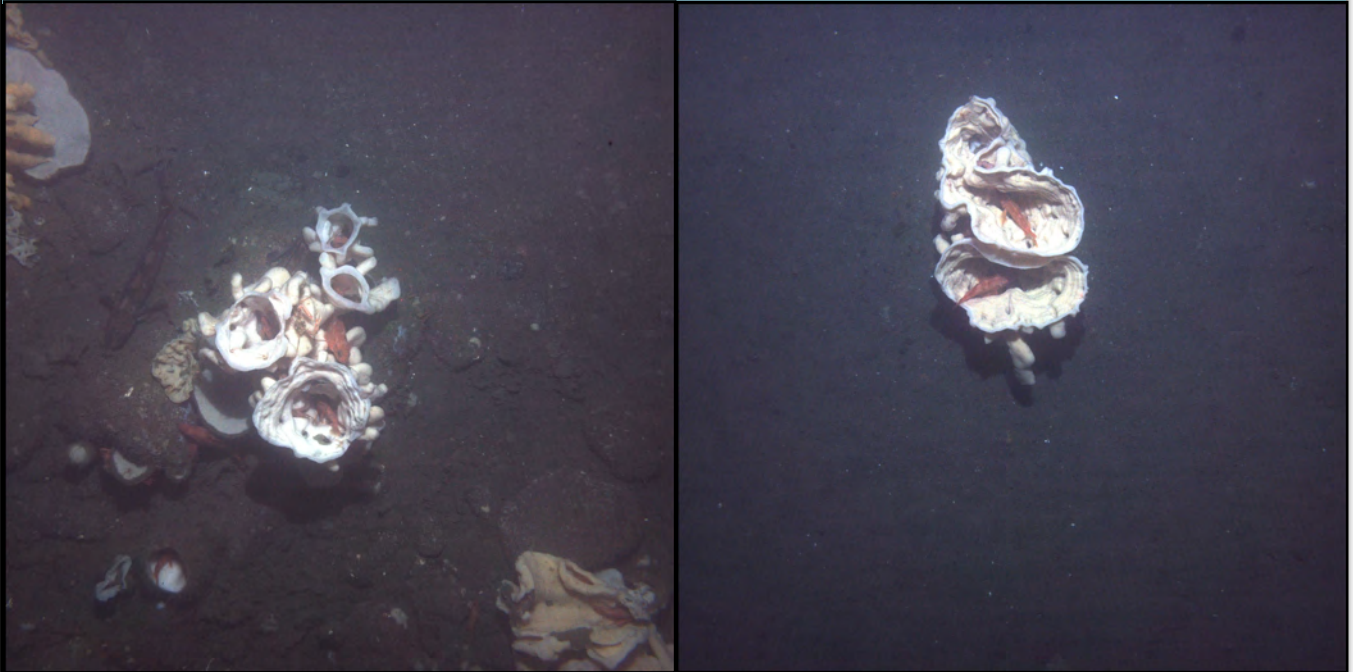
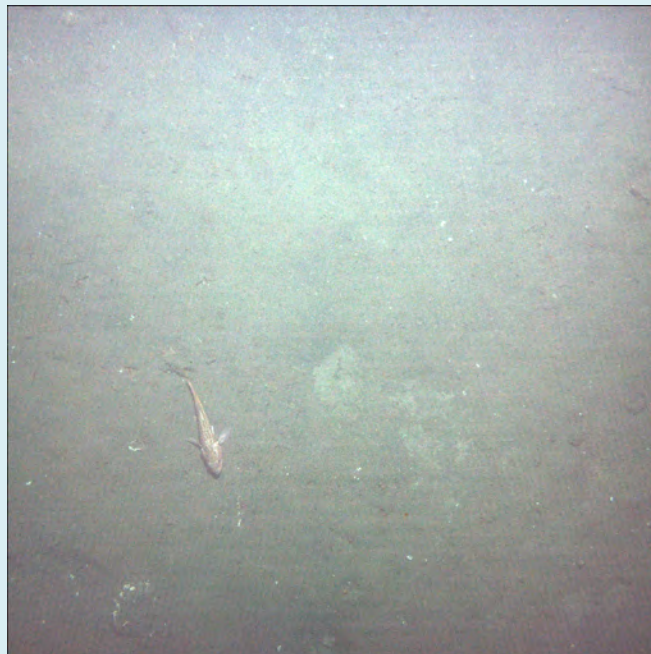


Figure 29. Percentage of fish density by group. Colors in pie diagram match colors in list of fish taxa (Table 9).

IMAGE GALLERY

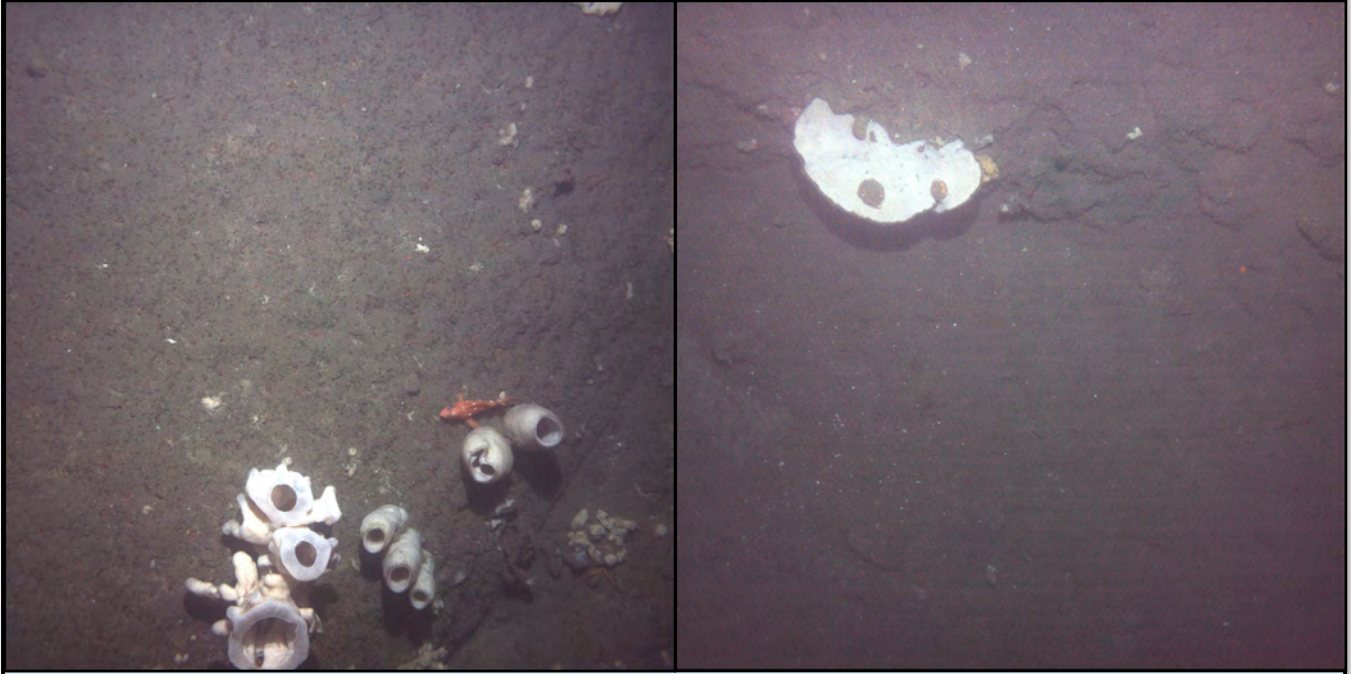


Sebastes spp. in structure forming sponges



Greenstriped rockfish on mud habitat

ADDITIONAL COMMENTS



Sponges on sediment that may cover mounds of consolidated material

This dive was a high density sampling grid of the area in the vicinity of the reported sponge reef (Johnson 2008, 2009). Although the species composition of fishes was similar to those at other dives, the highest number of fishes associated with sponges was at this site. No man-made debris was identified.

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Figure 10. Percentage of sponge density by group. Colors in pie diagram match colors in list of sponge taxa (Table 2).

Figure 11. Percentage of fish density by group. Colors in pie diagram match colors in list of fish taxa (Table 3).

Figure 12. Survey Pattern of during dive AUV 003

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Figure 16. Percentage of sponge density by group. Colors in pie diagram match colors in list of sponge taxa (Table 4).

Figure 17. Percentage of fish density by group. Colors in pie diagram match colors in list of fish taxa (Table 5).

Figure 18. Survey pattern of during dive AUV 004

Figure 19. Depth track of AUV during dive AUV 004

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Figure 22. Percentage of sponge density by group. Colors in pie diagram match colors in list of sponge taxa (Table 6).

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Figure 24. Survey pattern of dive AUV 005

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