

**Cruise Report for NOAA's
Monterey Bay National Marine Sanctuary &
Northwest Fisheries Science Center Conduct
Autonomous Underwater Vehicle (AUV) Dive Surveys
July 6 through 19, 2017**

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Introduction:

Monterey Bay National Marine Sanctuary (MBNMS) and National Marine Fisheries Service (NMFS) surveyed seven sites in federal ocean waters aboard the NOAA research vessel *Fulmar* using an autonomous underwater vehicle (AUV) from July 10th to 18th (see map and calendar of events below). The AUV expedition was funded through restoration settlement funds with a focus to collect data on the distribution, abundance, and condition of deep sea coral and sponge communities.

The seven sites surveyed were selected based on areas identified in a 2013 Essential Fish Habitat (EFH) Proposal developed (http://montereybay.noaa.gov/resourcepro/ebmi/130731efh_proposal.pdf) by the Monterey Collaborative which included local trawl fishermen, conservation groups and Monterey Bay National Marine Sanctuary. The overall goal of the proposal was to protect more total area and more sensitive habitats while improving fishing opportunities for the bottom trawl fleet relative to the current array of EFH Conservation Areas.

The images collected during the expedition will be analyzed and provide biological and geological data that can support the Monterey Collaborative's proposal as it moves through the decision process. The Pacific Fishery Management Council (PFMC) is slated to make decisions on west coast wide modifications to groundfish EFH areas in March 2018. Data resulting from analyses of the images taken by the AUV will also provide a better understanding of the Sanctuary's diverse seafloor habitats.

To view the team's mission log go to:

<http://montereybay.noaa.gov/new/2017/170710auv/welcome.html>

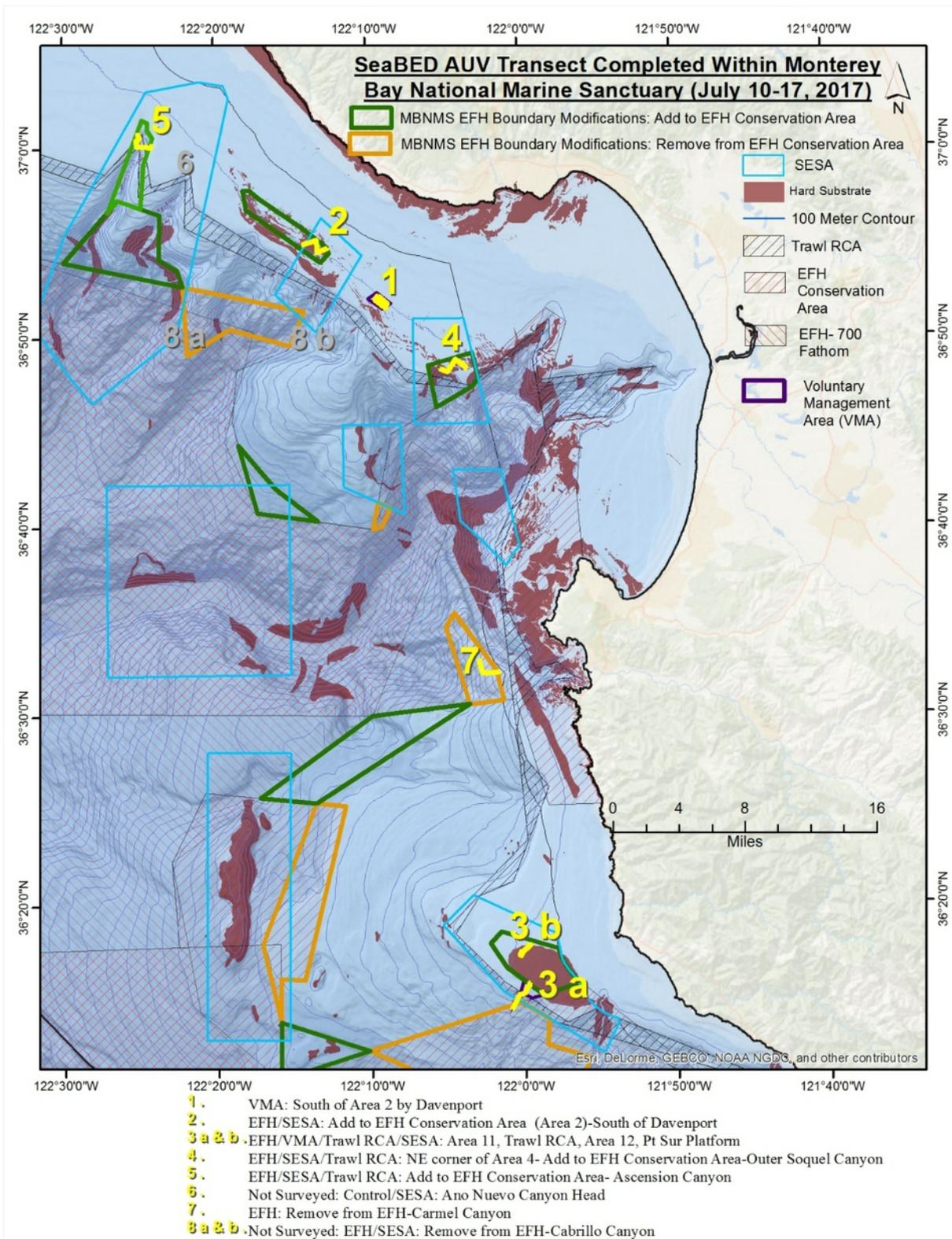


Figure 1. Map of surveyed sites during MBNMS/NMFS AUV mission

Date	7/6 Thu	7/7 Fri	7/8 Sat	7/9 Sun	7/10 Mon	7/11 Tue	7/12 Wed
Operation	Mob	Mob	Mob	Weather	AUV	AUV	AUV
Location					Outer Soquel Canyon	South Davenport Reef	NW- Ascension Canyon
Site #:					4	1	5
Spatial Designation ¹					EFH; SESA	VMA	EFH, SESA
Depth (m)					93-360	90-103	134-383
Dive Length (m)					3782	4988	3556
Date	7/13 Thu	7/14 Fri	7/15 Sat	7/16 Sun	7/17 Mon	7/18 Tue	7/19 Wed
Operation	AUV	AUV	AUV	Weather	AUV	Weather	Demob
Location	Pt. Sur	NW MB	W of Carmel Canyon		Pt. Sur		
Site	3a	2	7		3b		
Spatial Designation ¹	VMA; EFH; SESA	EFH; SESA	EFH		EFH; SESA		
Depth (m)	82-469	83-96	439-670		69-86		
Dive Length (m)	3372	3890	3081		3693		

Table 1: Summary of Sites Information

¹ Spatial designations:

EFH (Essential Fish Habitat)

VMA (Voluntary Management Area)

SESA (Sanctuary Ecologically Significant Area)

Methods:

We used a SeaBED AUV (Figure 2) aboard the *R/V Fulmar* to collect still photography imagery. The SeaBED AUV is owned by the Northwest Fisheries Science Center, is approximately two meters long and weighs nearly two-hundred kilograms. It has two main pressure housings,

a top hull and a bottom hull. The CPU electronics are located in the top hull, the batteries, cameras, and sensors are located in the bottom hull, and all are connected by wet cabling that is routed through vertical struts. With a maximum operational depth range of 2,000 m, SeaBED can be used to survey habitats ranging from shallow coral reefs to deep groundfish environments. This operational depth range may be reduced by other onboard sensor's depth capabilities to a maximum depth of 1,500 m. The AUV has three cameras – one angled camera that shoots oblique photos and two that shoot straight down on port and starboard. The AUV is programmed to fly at an altitude of 3 meters over the seabed and snap images every 8 seconds. For this project we also attached a dissolved oxygen meter to measure any oxygen changes at depth.

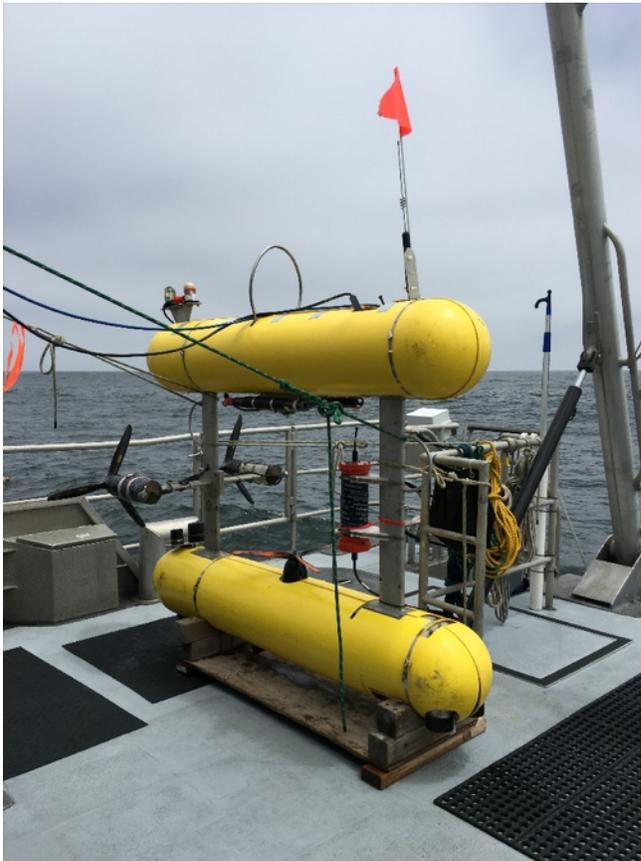


Figure 2. The SeaBED AUV on the back deck of the NOAA Research Vessel Fulmar. The SeaBED AUV is unlike other, more traditional AUV's, in that its twin-hull design provides greatly enhanced stability for low-speed photographic surveys

Survey locations were based on the maximum depth of the AUV (800 m with this navigational package) as well as seafloor topography and features. The study areas are management areas of interest to MBNMS. Some of the areas have previous data and we can compare and see if there are changes in the diversity and abundance of sponges, corals and fish. For example, Ascension Canyon located west of Santa Cruz on the northern edge of the Monterey Bay Submarine Canyon, includes a proposed closure to trawl fishing, and was studied with a NMFS submersible back in 1994 as well as more recently by California State University Monterey Bay (CSUMB). Other areas such as the outer Carmel Canyon have little existing data, so the data will be more of (an initial) characterization of the area.

The AUV transects for each site were designed based on the slope of the seafloor (limit for good images is 45 degrees), depth, and strategically overlapped historical data collections completed by entities such as NMFS or CSUMB.

Daily Cruise Log:**7/6/17 to 7/7/17**

Crew and science party mobilized in Monterey harbor utilizing the fuel dock and crane to load equipment. USCG provided support with a fork lift to load equipment from truck to pier. Science team worked on setting up AUV and other equipment.

7/8/17

Science team continued and completed set up on vessel at Fulmar dock with oversight from MBNMS cruise leader.

7/9/17

Weather day taken due to high winds

7/10/17 - Site 4 at Outer Soquel Canyon

We deployed the vehicle at 8:40am and survey leg began at 9:05am after the AUV maneuvered over to the start point.

The survey at Site 4 transected the Soquel canyon head and then followed the side of the canyon. Ninety-five percent of transect was over hard substrate area (Figure 5). Most of the previous research from CSUMB in this area is within the canyon.

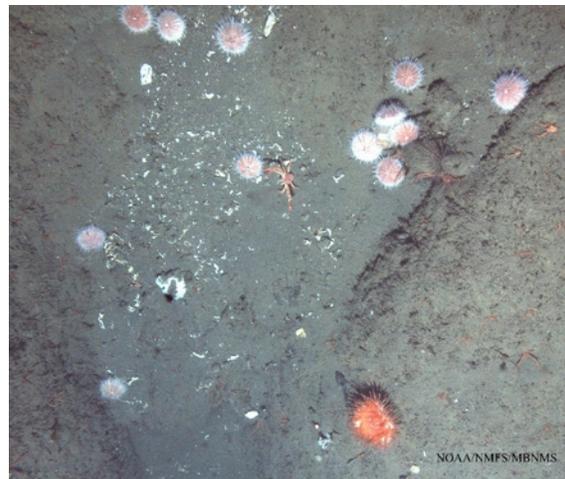


Figure 3. Pink urchins at Site 4.

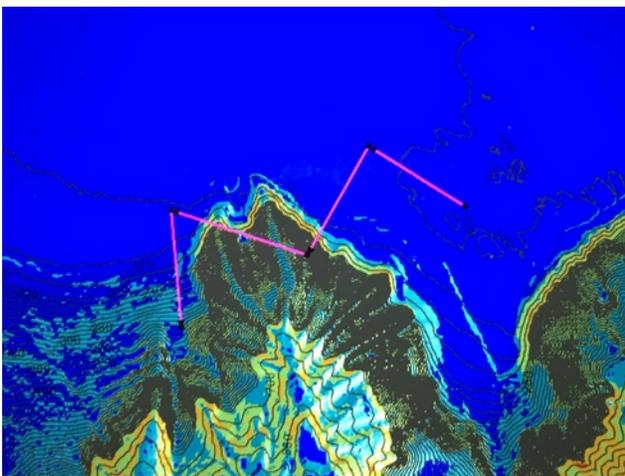


Figure 4. Planned AUV transect at Site 4 (pink lines) over slope map (range of blue to red indicates low to high slope).

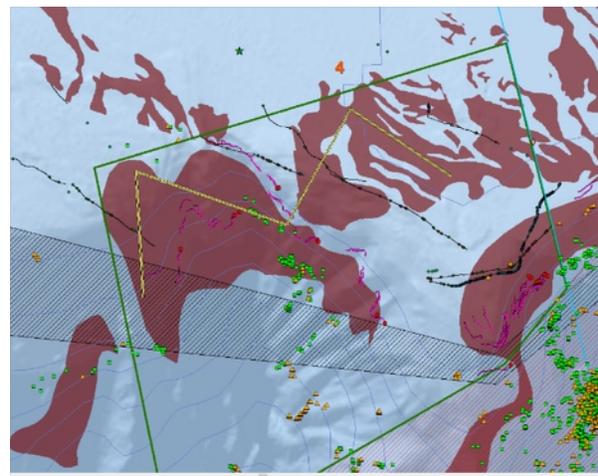


Figure 5. Planned AUV transect (yellow line) over map with hard substrate (brown areas), past research (various colored dots), and management areas (proposed EFH Conservation Area addition and Trawl Rockfish Conservation Area).

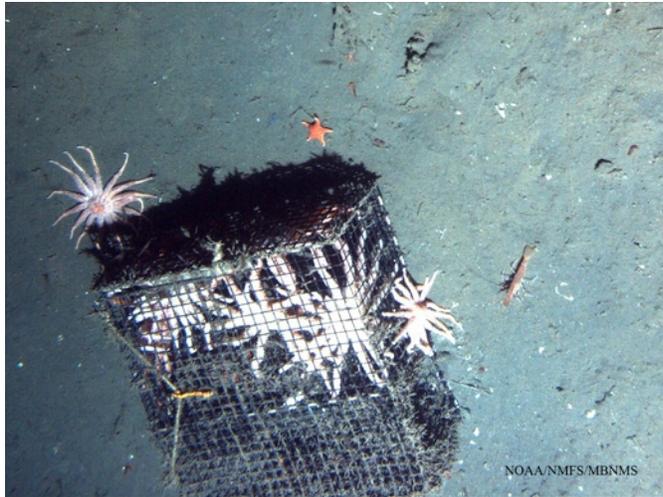


Figure 6. Spot prawn trap with sun stars sitting on soft bottom habitat at Site 4.

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.

7/11/17 - Site 1 at Davenport Reef VMA

Survey Site #1 is offshore of Davenport in federal waters, which was selected by fishermen and the Monterey Collaborative group as a proposed voluntary management area (VMA).



Figure 7. A starry skate, feathery crinoids and a couple of rockfish hang out south of Davenport Reef in 100 meter depth rocky habitat that will be voluntarily avoided in the future by the trawl fishery.

We deployed vehicle at 8:40am and survey leg began at 8:55am after the AUV maneuvered to the start point of the sparse grid which connected seven 500 meter long transects over the area of interest. In addition to seeing a number of humpbacks and Pacific white sided dolphins on the topside, the AUV took some nice images of the rocky and soft bottom habitats (Figure 7). This area has many large boulders and some large fish species including lingcod, flag and a cowcod rockfish. A number of molas were swimming along at the surface.

There were no mechanical issues with the gear, and all operations went smoothly.



Figure 8. A large nudibranch (pleurobranchia) (top left of image), sits on the soft bottom at Site 5.

7/12/17 - Site 5 at Ascension Canyon

We transited aboard the R/V Fulmar to Site #5 at Ascension Canyon, which is slated as a proposed EFH conservation area closure. We deployed vehicle at 9:20am and survey leg began at 9:45am after the AUV maneuvered to the area of interest along the lower part of the canyon wall at approximately 280 meters depth (Figure 10). 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.

The images in the canyon included species such as pleurobranchia (Figure 8), lingcod, spot prawns, squat lobsters and rockfish. There were some images of fresh trawl tracks (Figure 9), and we assume



Figure 10. A fish sits next to a trawl track near Ascension Canyon head.

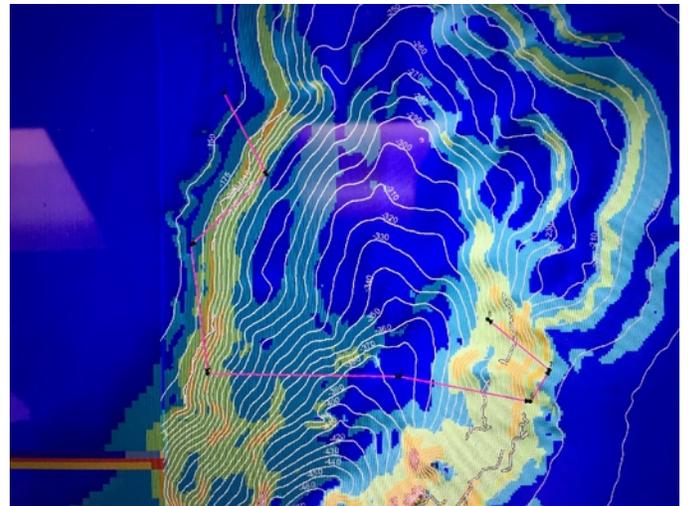


Figure 9. Image of the slope at Ascension Canyon; the pink line is the AUV transect, showing it traversed a variety of depths and slopes during this particular survey (low to high slope is shown in a color range from blue to red).

the trawling in this area was within a few days of the survey based on recent Automatic Identification System (AIS) data.

7/13/17 – Site 3a at Point Sur

We deployed the AUV at 8:45 AM to survey Site 3a at Point Sur. The transect began at 9:12 AM within a Voluntary Management Area at a depth of 106 meters, went through the Trawl Rockfish Conservation Area (RCA), then down a canyon head through a proposed re-open EFH area at a depth of 490 meters.

This area has little if any existing survey information so we were excited to review the images to better understand the habitat and benthic biology in this area. Highlighted images from this dive survey show a remarkable difference in habitat as the slope gets steeper and the AUV moves down into the canyon. The survey started in more shallow waters just south of the main Pt Sur Platform (also known as Schmieder Bank) at about 3 miles offshore, which has mainly rocky habitat, and progressed deeper into soft bottom habitat (Figure 11).

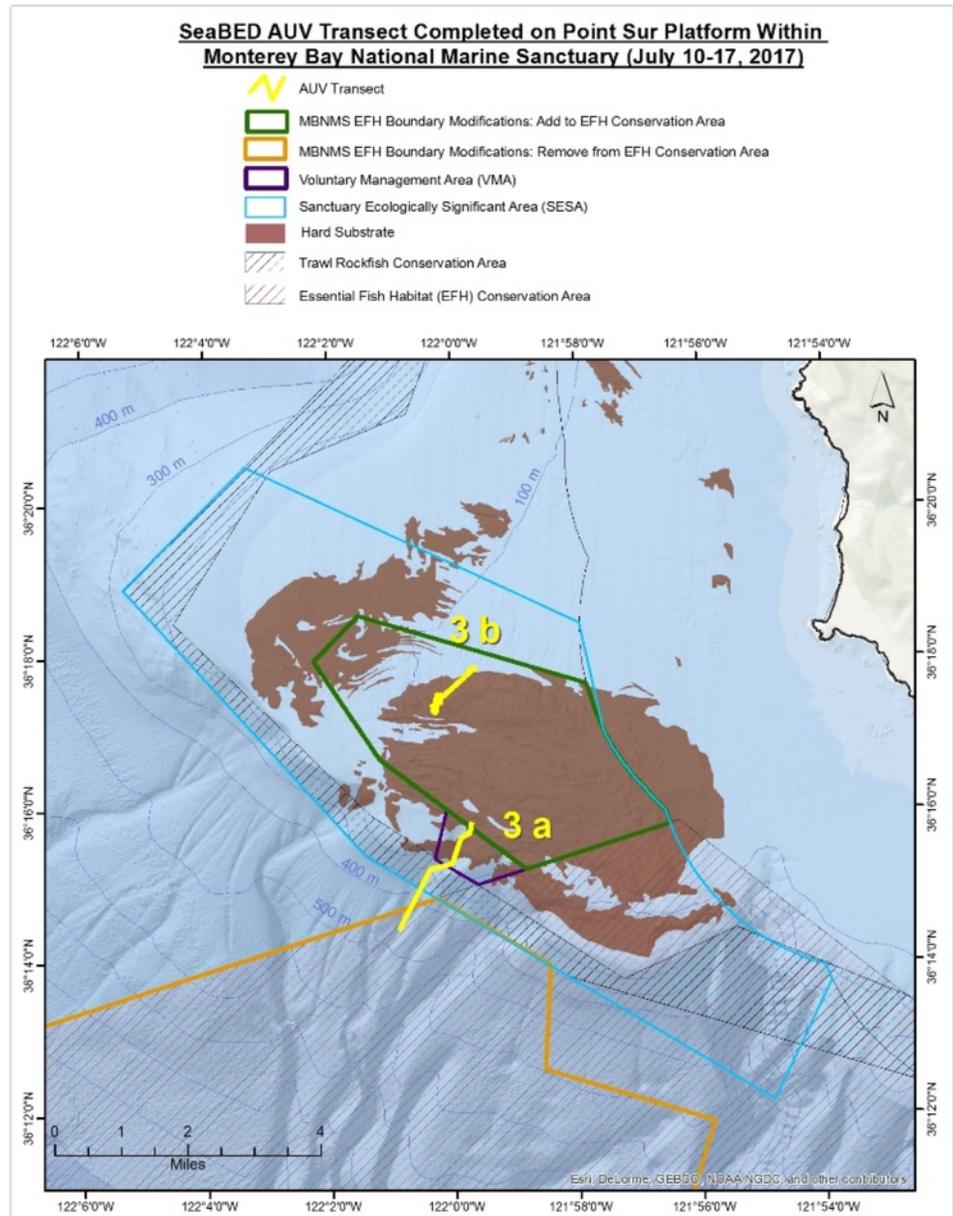


Figure 11. Completed AUV transects at Point Sur.



Figure 13. Rockfish in a sponge at Site 3a.



Figure 12. Vase sponges on rocky substrate at Site 3a.

The AUV completed the entire planned transect by 12:39 PM and the R/V Fulmar headed back to port at 1:30 PM while the AUV was on the bottom, we enjoyed quite a show from Pacific White-sided Dolphins close to the boat and continued to see a lot of sooty shearwaters.



Figure 14. Metridium on a yellow metal tank which is marine debris.

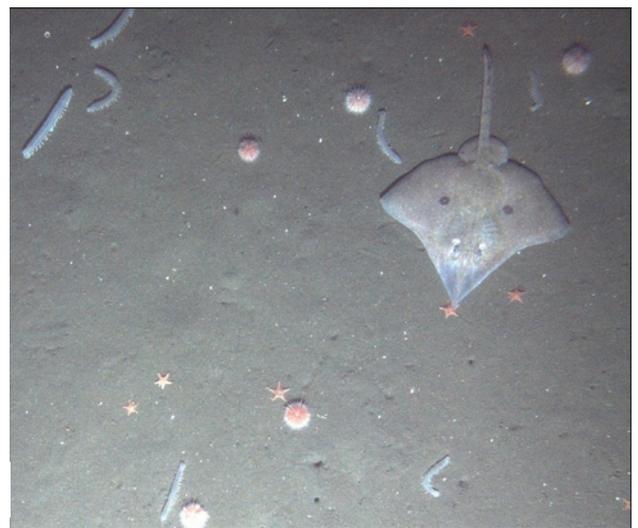


Figure 15. Longnose skate, pink sea-urchins, star fish and sea cucumbers on soft bottom at site 3a.

7/14/17: Site 2 – Davenport Reef EFH Closure

We started the AUV dive at 8:50 AM to survey Site 2 at Davenport Reef, off Santa Cruz. The survey transect began at 9:05 AM within a proposed EFH closure at a depth of 90 to 100 meters (Figure 18). This area has some existing data from MBARI and CSUMB, and the purpose is to see how the habitat has changed since the last survey.

The dive survey at Davenport Reef provided interesting images of hard and soft bottom habitats (Figure 16) that included boulders and large flat rocks many of which were covered in crinoids (Figure 19). In addition, we see some cobble patches of brachiopod beds which are small bivalves (Figure 17).



Figure 17. A sole sits next to a sea whip surrounded by white brittle stars at Site 2.



Figure 16. Brachiopods beds are found in patches in this area.

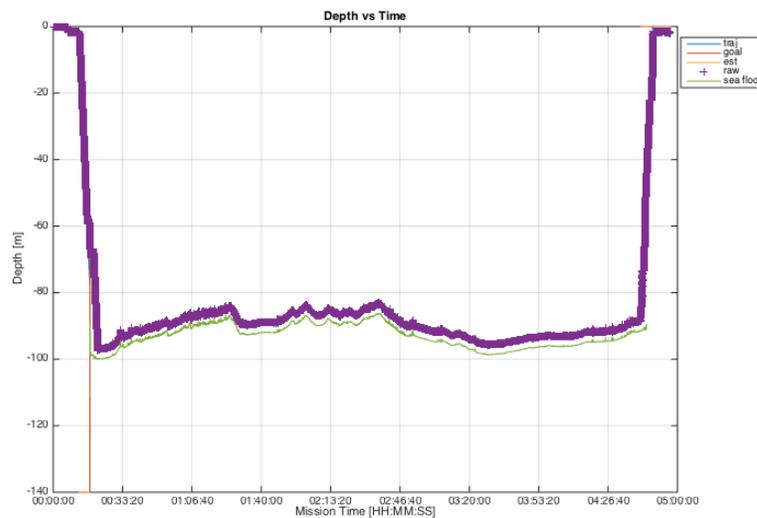


Figure 18. Popoki the AUV follows the seafloor at an altitude of three meters and you can see by this profile how closely she can profile the bottom. The purple line is the AUV and the green line is the seafloor bottom at Site 2.

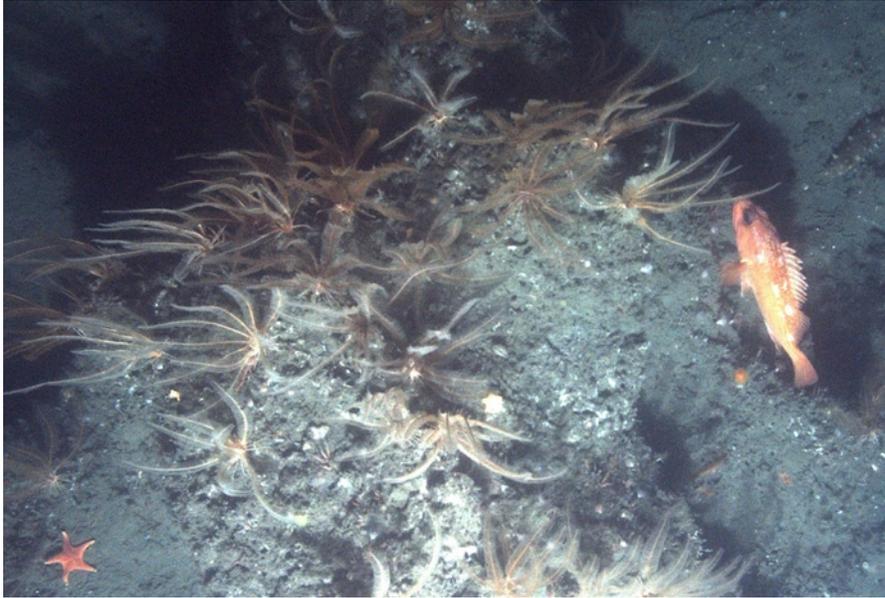


Figure 19. A starry rockfish hangs out with crinoids on hard bottom substrate at Site 2.

The AUV completed the entire planned transect by 1:50pm and all operations went smoothly. Topside the team enjoyed a breaching humpback and again, hundreds of sooty shearwaters were seen on the water.

7/15/17: Site 7 – West of Carmel Canyon

This site is west of Carmel Canyon, and is a proposed re-open EFH site. Until this survey, there has been very little survey effort in this area. NOAA Fisheries occurrence models predict high probability habitat for sablefish and thornyhead rockfish, both of which were seen in the AUV surveys.

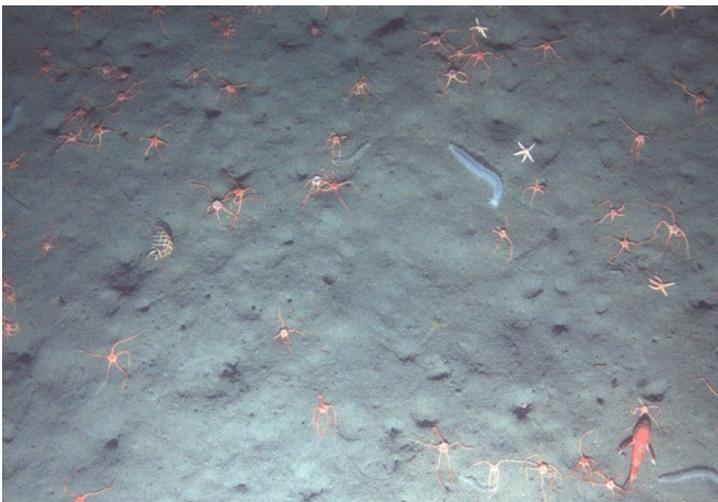


Figure 20. Orange brittle stars and white cucumbers with a thornyhead rockfish on soft bottom habitat.

We departed Monterey in heavy fog at 6:30am and motored to outer Carmel Canyon and deployed the AUV at 7:53am for an almost 5 hour survey dive (Figure 21). This area is proposed to re-open to trawl fishing as the soft sediment slope habitat provides suitable habitat for some groundfish species and it's close to Monterey Bay ports for easier access to fishing grounds (Figure 20 and Figure 22).



Figure 21. Deployment of the AUV. The AUV is not released until after confirming that we have communication with it to share navigation data.



Figure 22. A sablefish (aka black cod) with a dover sole and a thornyhead rockfish

7/16/17

Taken as a weather day due to high winds estimated at 15 to 25 knots.

7/17/17: Site 3b-Point Sur

We departed the Monterey harbor at 6:30am to transit to Site 3b at Point Sur Platform. The team was on site at 8:15am, deployed the vehicle at 8:43am and the AUV descended to depth and started the dive survey at 9:05am. The AUV transect was conducted on the north side and across the shelf. We decided to end the dive at 11:45am after the AUV became stuck five consecutive times in the rocks. Later in the afternoon, we were able to review the photos and saw that the AUV was navigating across some very large fractured outcrops that look to be massive granite slabs (Figure 23-Figure 25).

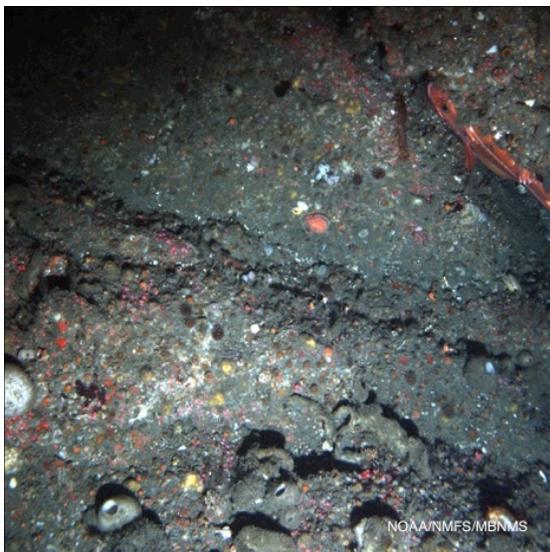


Figure 23. Scallop, barrel sponges, and a hiding vermilion rockfish (top right).

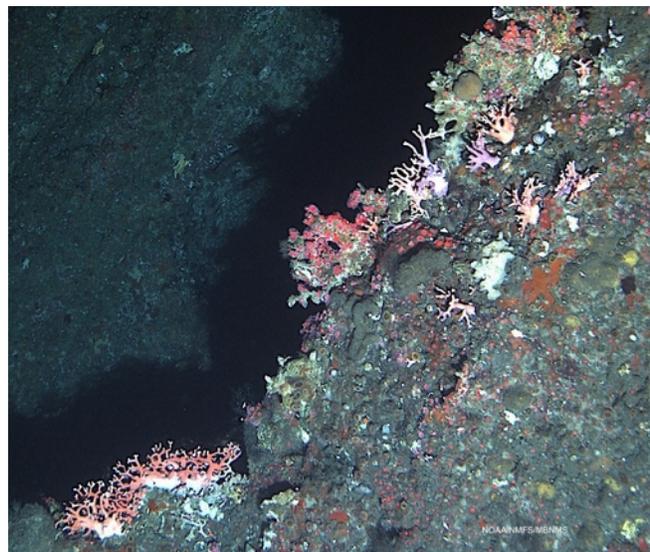


Figure 24. Hydrocorals and cup corals on a rocky ledge.

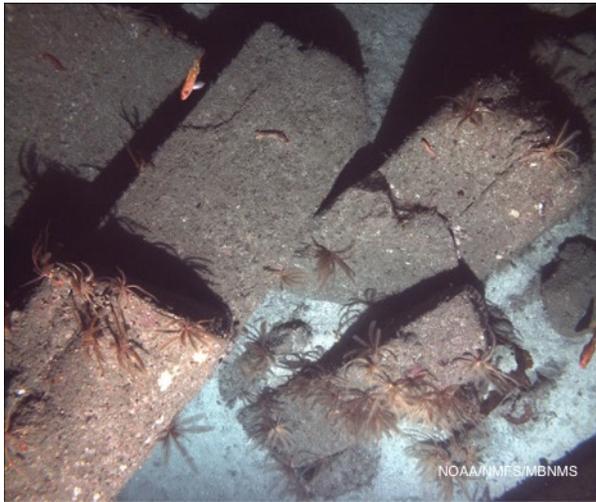


Figure 25. Crinoids on large granite blocks with Sebastomus rockfish.

7/18/17

We departed the Monterey harbor at 6:30am to transit to Site 8b in the Cabrillo Canyon area. We were about 10 minutes from the site at 9:50 am but due to the mixed swell state, the 20 knot wind, some breaking waves and the short period of the swell, both the scientists and the crew of the R/V Fulmar decided not to risk deploying the AUV. We headed back to the dock and started demobilizing.

7/19/17

The crew and team demobilized in Monterey, and unloaded at the fuel dock during lunch. US Coast Guard again provided support with a fork lift to unload the AUV and containers from Fulmar and load into the U-Haul for transport.