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# A CHARACTERIZATION OF THE DEEP-SEA CORAL AND SPONGE COMMUNITY ALONG THE CALIFORNIA, OREGON, AND WASHINGTON COASTS USING A REMOTELY OPERATED VEHICLE ON THE EXPRESS 2019 EXPEDITION

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# A CHARACTERIZATION OF THE DEEP-SEA CORAL AND SPONGE COMMUNITY ALONG THE CALIFORNIA, OREGON, AND WASHINGTON COASTS USING A REMOTELY OPERATED VEHICLE ON THE EXPRESS 2019 EXPEDITION

## A REPORT TO NOAA DEEP-SEA CORAL RESEARCH AND TECHNOLOGY PROGRAM, 2022

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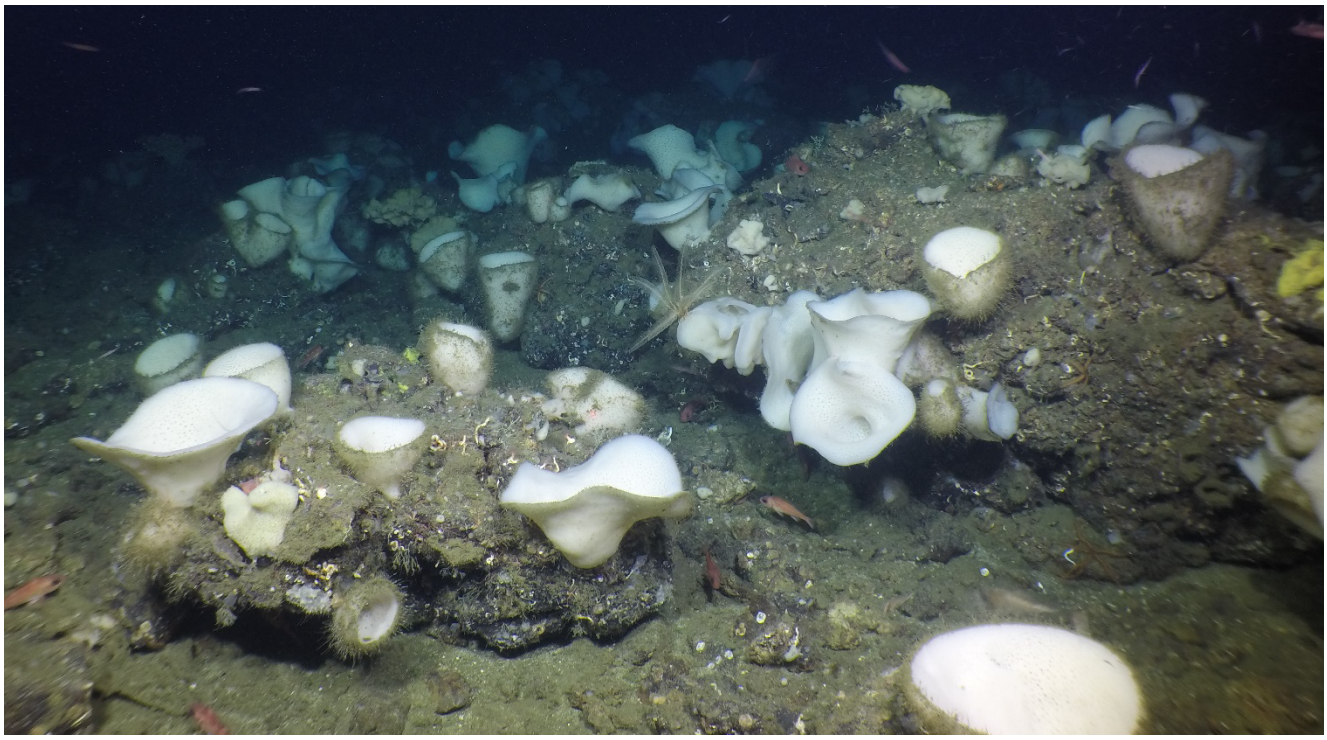


## INTRODUCTION AND SCIENTIFIC OBJECTIVES

On the U.S. West Coast, deep-sea coral and sponge (DSCS) communities occur generally in waters deeper than 50 m. All corals in this temperate, cold-water region are azooxanthellate heterotrophs that feed only on the animals and organic material that they can catch with their tentacles, unlike the shallow, reef-building corals found in warmer regions. DSCS communities increase biogenic structure, providing shelter and nursery habitat, and increasing biodiversity and prey availability (Freese and Wing, 2003; Bright, 2007; Baillon et al., 2012; Henderson et al., 2020). Threats to these long-lived, fragile organisms from bottom contact fishing gear, potential offshore renewable energy development, and ocean warming and acidification have increased the need for DSCS research along the U.S. West Coast (Gómez et al., 2018; Salgado et al., 2018; Yoklavich, et al., 2018; Gugliotti et al., 2019). To date, studies have varied from species distribution and abundance (Yoklavich and Love, 2005; Tissot et al.,

2006) to developing and validating predictive distribution models (Huff et al., 2013; Rooper et al., 2017; Kreidler, 2020) to finding medicinal uses for corals and sponges (Essack et al., 2011; Shrestha et al., 2018). Due to the vast area of unexplored seafloor within the U.S. exclusive economic zone (200 nautical miles off the coast) and the technological requirements of deep-sea research, there is still much to learn about the distribution and biology of DSCS. This information is critical to resource managers for effective conservation and management of DSCS habitats. The Magnuson-Stevens Fishery Conservation and Management Act and the National Marine Sanctuaries Act (NMSA) provide legal authorities to protect DSCS and/or their habitats. In 2006, the National Marine Fisheries Service (NMFS) and the Pacific Fishery Management Council (PFMC) designated 51 distinct seafloor areas as essential fish habitat conservation areas (EFHCA) to protect seafloor habitats from damage by either bottom trawls or all bottom contact fishing gears. In January 2020, NMFS and the PFMC implemented Amendment 28 to the Groundfish Fishery Management Plan (GFMP; Pacific Fishery Management Council, 2019), which modified EFHCAs by closing new areas identified as vulnerable and reopening areas deemed not vulnerable. The NMSA prohibits bottom disturbance from certain activities within areas designated as national marine sanctuaries, such as oil and gas exploration or extraction, cable laying, and other forms of seabed alteration or construction that disturb benthic communities.

NOAA's Deep-Sea Coral Research Technology Program (DSCRTP) began a 4-year funding initiative for the U.S. West Coast in 2018. The goals of the West Coast Deep-Sea Coral Initiative were to: 1) gather baseline information on DSCS in areas subject to fishing regulation changes prior to the implementation of Amendment 28; 2) improve our understanding of known DSCS bycatch "hot spots"; and 3) explore and assess DSCS resources within NOAA National Marine Sanctuaries with emphasis on areas of sanctuary resource protection and management concerns. Following the 2018 research expedition supported by NOAA Ship *Bell M. Shimada* (Laidig et al., 2021), a second research cruise was planned for 2019 to further survey seafloor communities in priority areas off the West Coast from Washington to California. The 2019 expedition spanned 35 days (4 Oct – 7 Nov) and was conducted from the NOAA Ship *Reuben Lasker* (hereafter referred to as "the ship"), beginning and ending in San Diego, CA. Surveys were conducted in deeper areas (generally 500-1200 m) in 2019 than in 2018 (limited to <650 m). These two expeditions provide data on seafloor communities and DSCS assemblages over a broad range of depths 50-1200 m.

The science team assembled for this cruise were members of the EXpanding Pacific Research and Exploration of Submerged Systems (EXPRESS) campaign, a consortium of researchers from federal and nonfederal institutions that collaborate on scientific expeditions focused on deep seafloor habitats off California, Oregon, and Washington. EXPRESS supports researchers by leveraging funding, resources, personnel, and expertise to accomplish more science than would be possible by a single entity alone. The 2019 coastwide expedition included research partners from NMFS Southwest Fisheries Science Center (SWFSC) and Northwest Fisheries Science Center (NWFSC), National Ocean Service (Channel Islands, Cordell Bank, Greater Farallones, and Monterey Bay National Marine Sanctuaries), Bureau of Ocean Energy Management (BOEM), U.S. Geological Survey (USGS), and Monterey Bay Aquarium Research Institute (MBARI).

In 2019, we conducted several scientific outreach programs during the cruise. Over the course of the expedition, two live broadcasts, one port event, and continuous telepresence during Remotely Operated Vehicle (ROV) dive operations were hosted to engage and educate the public on the cruise mission and DSCS research. Live broadcasts were made to four classes at Pierpont Elementary School in Ventura, CA, and to a general public audience at the Exploratorium in San Francisco, CA. In port in San Francisco, a behind the scenes tour aboard the NOAA Ship *Reuben Lasker* and the Exploratorium were hosted, where visitors learned about the cruise objectives, survey tools, sampling methods, and telepresence capabilities used to conduct scientific research during the cruise.

Research objectives for this cruise were to:

1) Collect DSCS baseline information at seven of the EFHCA sites and two groundfish trawl rockfish conservation areas undergoing protection modifications by the Pacific Fishery Management Council.

2) Document temporal changes in DSCS assemblages at previously surveyed sites.

3) Provide data to validate BOEM-supported cross-shelf habitat suitability models.

4) Collect samples for identifying and understanding west coast DSCS and expand use of new technologies (ROV, Autonomous Underwater Vehicle (AUV), environmental DNA [eDNA]).

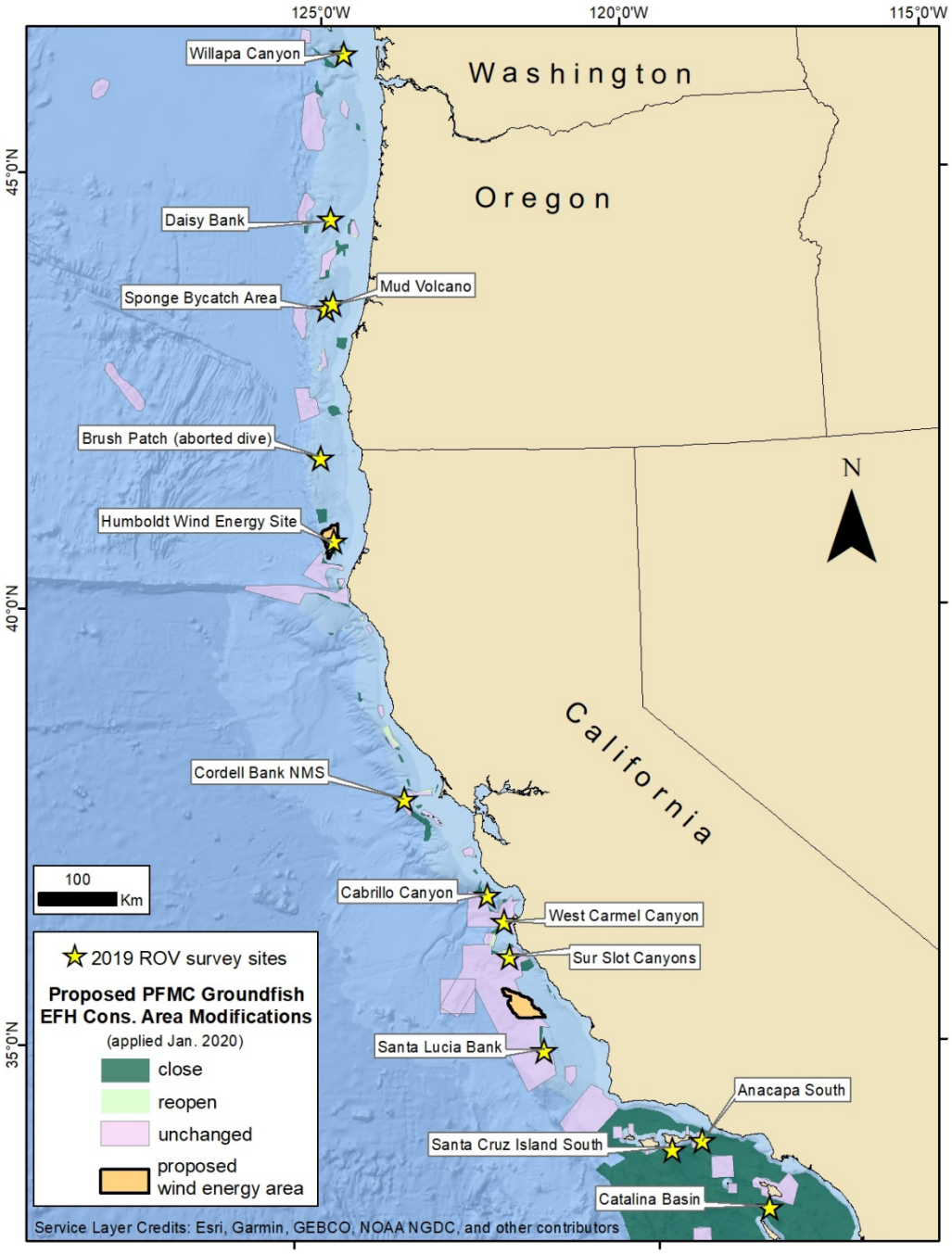
5) Collect water samples for coastwide eDNA and water chemistry studies.

6) Characterize DSCS and fish assemblages in unexplored areas of National Marine Sanctuaries.

7) Collect DSCS and fish baseline information at potential offshore wind development sites.

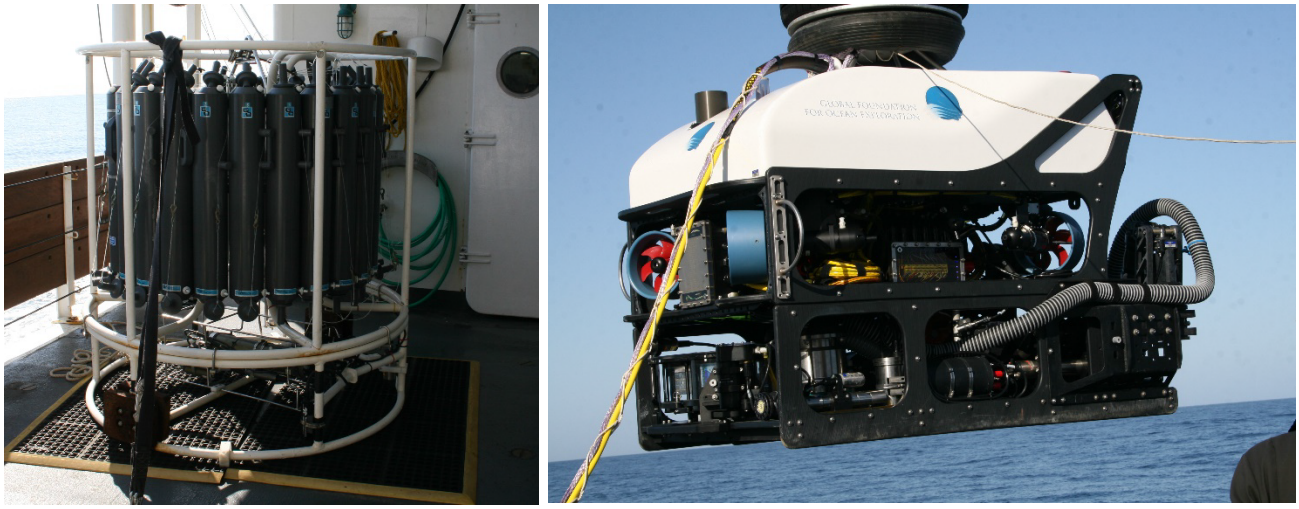
## STUDY SITES

We surveyed from Willapa Canyon in southern Washington to Santa Catalina Basin, south of Santa Catalina Island in southern California (see map below). Most sites were selected because they were EFHCAs designated for modification in proposed groundfish fishing regulations. One site off the coast of Humboldt County, CA (northern California), is being considered for offshore wind energy development and was surveyed for baseline information. Two sites (Daisy Bank and Santa Lucia Bank) were surveyed to assess faunal changes since previous surveys (last year and over a decade earlier). Santa Catalina Basin was chosen to assess changes in sponge communities first discovered in the 1980's. Three sites were selected to characterize unexplored areas within national marine sanctuaries (Cordell Bank NMS, Anacapa Island, and Santa Cruz Island [Channel Islands NMS]).




Map of the EXPRESS 2019 study area showing the sites surveyed using the Global Foundation for Ocean Exploration (GFOE) remotely operated vehicle (yellow stars), proposed modifications to groundfish EFH conservation areas, and candidate areas for wind energy development.

## FIELD SURVEY METHODS



Sampling tools: CTD rosette (left) and ROV *Yogi* (right).

Underwater visual surveys were conducted using the Global Foundation for Ocean Exploration's (GFOE) remotely operated vehicles (ROVs), *Yogi* and *Guru*, and the NWFSC/PIFSC's AUV, *Popoki*. AUV survey operations and results are discussed in a parallel site characterization (Laidig et al., 2021). The two ROVs were used in tandem during operations, where *Yogi* served as the primary survey vehicles and *Guru* provided operational support. A primary tether attached *Guru* to the ship and a secondary attached *Yogi* to *Guru*. *Guru* was deployed above *Yogi* and was equipped with a camera that monitored benthic operations from above; each vehicle had their own dedicated ROV pilot. Additionally, *Guru* functioned as a transformer for *Yogi*, as well as a stabilizing buoy or shock absorber that helped to protect *Yogi* from the motion of the ship. *Yogi* (hereafter referred to as "the ROV") was used to survey the seafloor and conduct quantitative visual transects at each site. To accomplish this task, the ROV was outfitted with the following equipment: one forward-facing HD video camera for survey transects, multiple auxiliary cameras to monitor operational aspects of the ROV (e.g., a camera on the biobox [container to hold collected samples] to aid in sample collection), a GoPro[1] camera affixed to the frame to capture still images inside the transect swath, six 9,000 lumen LED lights, two red, scaling lasers (spaced 10 cm apart), a Blueview multibeam sonar, and a Sea-Bird CTD that continuously recorded temperature, depth, and salinity. Although the ROV was rated to a depth of 1500 m, equipment issues limited survey depths to ~750 m for the first leg of the cruise (Washington to northern California). Repairs made while in port in San Francisco enabled the ROV to operate at depths >1000 m during the second leg of the cruise. The ROV position was tracked using an acoustic navigation system operated by GFOE personnel aboard the ship. ROV and ship positional data were displayed in real-time via Hypack® software to monitor the ROV relative to the seafloor and pre-planned routes. All routes were created in ESRI ArcGIS™ software. A five-function manipulator arm was used to collect the majority of specimens. This manipulator was also equipped with a suction sampler to collect small, fragile, or sediment samples. Collected specimens were stored in a compartmentalized biobox (located near the bottom of the ROV) or individual sample containers (for suctioned samples). Two 1.5 L Niskin bottles were attached to the ROV frame and were used to collect water samples at depth for water chemistry and eDNA analyses.

Multiple quantitative visual transects were conducted during each dive to record deep-sea coral, sponge, and fish communities. Transects lasted approximately 15-20 min and covered ~150-200 m of seafloor. During transects, the ROV was flown between 0.5 and 1 m above the seafloor at a speed of ~0.25 knots (0.1 m/s). Transects were separated by at least 200 m to increase sample independence. During transects, the pilots navigated the ROV to follow a pre-planned route or a straight line, avoiding directional changes as much as possible except to avoid obstacles or to follow a depth contour. While

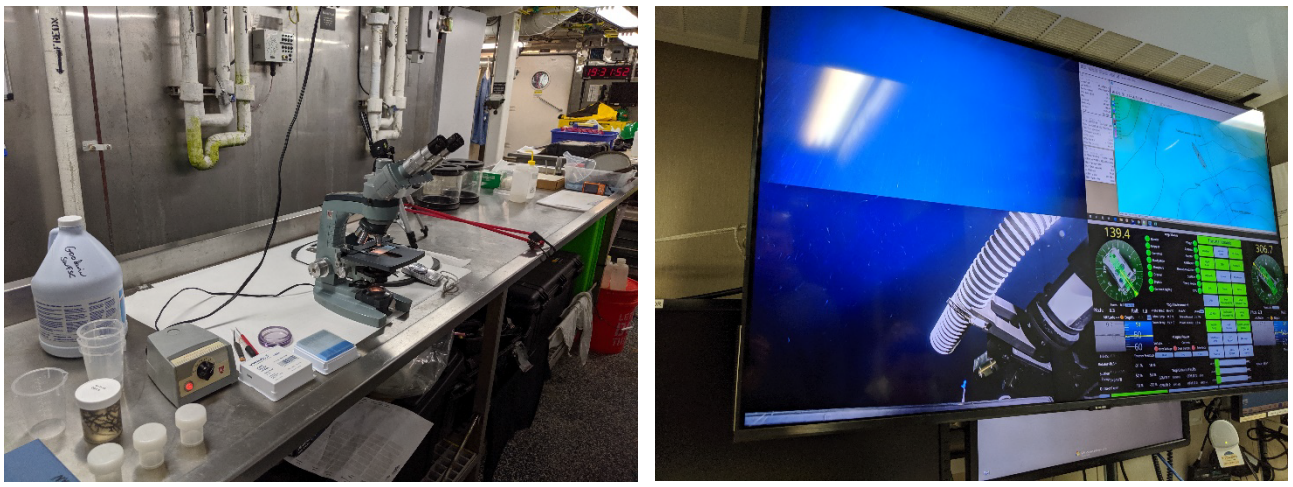
[1] Any use of trade, firm, or product names is for descriptive purposes only and does not imply endorsement by the U.S. Government.

transiting between transects, the ROV would stop to capture close-up video footage and still photos of DSCS and/or collect specimens. Collected specimens were later sent to NWFSC and taxonomic experts for identification.

After the ROV was recovered and secured, specimens were retrieved from the biobox and sample containers and processed on board. Biological specimens were individually photographed, measured, cataloged, and either frozen or placed in 95% ethanol. Some specimens were separated into subsamples for various projects and experts. Geologic samples were dried and packaged for further analysis at USGS.

Before or after most ROV dives, the ship's CTD rosette was deployed to measure oceanographic variables at depth in the study area and collect additional eDNA samples. The rosette was equipped with the standard temperature, depth, conductivity, and oxygen sensors (Sea-Bird SBE-9). Depth was determined using a Sea-Bird CTD digiquartz pressure sensor with a stated accuracy of 0.015%. Water samples were collected using a Niskin bottle rosette apparatus at discrete depths throughout the water column.

## POST-CRUISE DATA ANALYSES



Shipboard images: Lab space with dissecting microscope for examining coal sclerites and sponge spicules (left). Monitors displaying ROV operations (right).

Post cruise, video analysts with expertise in deep-sea coral, sponge, fish, and habitat identification reviewed video transects. All individual fish and DSCS were identified to the lowest discernable taxonomic level, enumerated, and lengths were estimated, using the ROV lasers as guides. Maximum width and height of DSCS were estimated, as well as the total length of fishes. When available, the digital still images were used to assist in identifications of difficult to identify taxa and to determine invertebrate associations. Data on color, damage (e.g., pieces broken off the colony), health (healthy = <10% dead, dying = 10-50% dead, and dead = >50% dead), upright or knocked over, and fish and/or invertebrate associations were documented for each coral and sponge entry. A fish association was defined as any fish within one body length of the coral or sponge and an invertebrate association was any invertebrate touching a coral or sponge (as described in Yoklavich et al., 2013). During the video review, the width of the transect was estimated as the (video monitor width/width of the laser spots on the video monitor [both measured with ruler in cm]) multiplied by 10 cm (the actual laser width on the seafloor) = (Widthvideo monitor/Widthlasers on screen) * 10 cm = transect width.
Transect widths were estimated approximately every 1 min and at the start and end of each transect. Transect area was estimated by multiplying the average transect width by the transect length (as determined from the navigation data in ArcGIS™ software).

Post-expedition video analysis of additional fauna (excluding DSCS and fishes) for survey transects were performed using Ocean Floor Observation Protocol (OFOP) software version 3.3.9 (Huetten and

Greinert, 2008). Video clips and dive tracks were uploaded to OFOP, synchronized using the date-time stamp, and viewed using pause, replay, and slow-motion functions within OFOP. Fauna were identified to lowest known taxonomic levels and individuals counted during each transect. For areas with high fauna abundances (e.g., high numbers of crinoids, urchins, ophiuroids [brittle stars] and sea stars), a screen grab was taken and fauna counted within the grab before continuing along the transect.

General habitat features were identified in approximately one-minute intervals based on classification systems described in Ross et al. (2015) and were reported as a general percent cover (0%, <25%, 25-75%, >75%) of the area observed. Habitat features included soft sediment, rocks (boulders [>25 cm], cobbles [6.5-25 cm], pebbles [0.4 - 6.5 cm], rubble [a mixture of sizes and types]), vertical features (edge, ledge, mounds), chemosynthetic related features (carbonates, reduced sediment, and bacterial mats), clam beds/shell, and other features (trash, bone, detritus). Within transects, seafloor habitat was classified from the video, following Greene et al. (1999), in a series of contiguous patches. For each patch, a two-letter code depicted the primary (>50%) and secondary (>20% of the remaining) substratum types. Substratum types considered were bedrock outcrops (R), flat rock (horizontal slabs of rock or pavement; F) rock pinnacle (P), boulders (unattached, >25.6 cm; B), cobble (25.6-6.4 cm; C), pebble (64 mm-2 mm; P), veneer (rock covered with a thin layer of sediment; V), mud (M), and sand (S). A distinct patch was documented only if a new substrate type persisted for five seconds or more on the video transect.

CTD data were extracted from both the ship and ROV CTD devices. Raw data from the ship's CTD were processed using the manufacturer's software, Seasave V 7.23.2. Data were exported into tab-delimited ASCII text files (.cnv) and are available from Prouty and Baker (2020). These CTD files include profiles with temperature, conductivity, pressure, oxygen, turbidity, fluorescence, salinity, and depth. Raw data from the CTD attached to the ROV (Sea-Bird SBE-49 FastCAT V 1.2a) were processed using the manufacturer's software, Seasave V 7.23.2 and then MS Excel. These data are available through a USGS data release, Baker and Prouty (2022).

Data from Niskin water samples were processed for pH, total alkalinity (TA), dissolved nutrients, and calcite and aragonite saturation states. The pH was determined spectrophotometrically and TA was determined by means of automated Gran titration on a Metrohm 809 Titrando (Dickson et al., 2007), both at the University of California at Davis, Bodega Marine Lab. Dissolved nutrient (ammonium and nitrate [N+N], phosphate, and silicate) concentrations were measured at the University of California at Santa Barbara, Marine Science Institute using flow injection analysis. Calcite and aragonite saturation states were calculated using an Excel Workbook Macro translation of the original CO2SYS program (Lewis and Wallace, 1998; Pierrot et al., 2006) by USGS scientists. Output from CO2SYS program and geochemistry lab analyses combined with CTD data from water sample collection are reported in Prouty and Baker (2020).

Select tissue samples from DSCS and clams, as well as filtered seawater for particulate organic matter (POM) were analyzed for stable carbon ($\delta^{13}C$) and nitrogen ($\delta^{15}N$) isotope composition following methods from Demopoulos et al. (2010). Prior to isotope analysis, faunal tissue samples were dried to a constant weight at 50 to 60°C, ground to a fine powder and weighed into tin capsules. Invertebrate samples were acidified with 10% platinum chloride to remove inorganic carbon. POM filters were dried and treated with 1.0 N hydrochloric acid, then transferred into tin boats. Analyses were conducted at University of California Davis Stable Isotope Facility. Fauna were analyzed using a PDZ Europa ANCA-GSL elemental analyzer interfaced to a PDZ Europa 20-20 isotopes ratio mass spectrometer (IRMS) (Sercon Ltd., Cheshire, United Kingdom). POM samples were analyzed using either an Elementar Vario EL Cube or Micro Cube elemental analyzer (Elementar Analysensysteme GmbH, Hanau, Germany) interfaced to either an Isoprime VisION IRMS (Elementar UK Ltd., Cheadle, United Kingdom) or a PDZ Europa 20-20 IRMS (Sercon Ltd., Cheshire, United Kingdom). Prior to isotope analysis, tissue samples were dried to a constant weight at 50 to 60°C, ground to a fine powder and weighed into tin capsules. Invertebrate samples were acidified with 10% platinum chloride to remove inorganic carbon. POM filters were dried and treated with 1.0 N hydrochloric acid, then transferred into tin boats. Results from the stable isotope analysis are available at Demopoulos et al. (2021) and are reported using delta ($\delta$) notation as per mil (‰): $\delta^{13}C$ or $\delta^{15}N = [(R_{sample}/R_{standard}) - 1] \times 1{,}000$, where R is the ratio of heavy to

light isotope of the sample ($R_{sample}$) and standard ($R_{standard}$), respectively, referenced to that of atmospheric $N_2$ (air) for $\delta^{15}N$ and Vienna PeeDee Belemnite (VPDB) for $\delta^{13}C$. The long-term standard deviation is 0.2‰ for $^{13}C$ and 0.3‰ for $^{15}N$. Precision and reproducibility were monitored using several reference standards calibrated against international reference materials and duplicate samples. Values were finalized by correcting the entire run based on known values of the included reference materials.

DSCS tissue samples collected during dives were DNA sequenced for standard molecular barcodes (MutS, COI for corals; 28s for sponges) in order to confirm species identification and further develop the sequence voucher database for West Coast DSCS species. Standard Sanger sequencing methods were carried out at NOAA NWFSC on an ABI 3500 sequencer as described in Everett and Park (2018). Additionally, select samples from coral species of interest were prepared using bestRAD methods (Ali et al., 2016) for population genetics and taxonomy. Library preparation was carried out at NWFSC, and the libraries were sequenced at the University of Oregon GC3 High-throughput sequencing facility. Initial sequencing of all samples has been completed and resulting molecular barcodes are being prepared for submission to National Center for Biotechnology Information, with an anticipated release date of September 2022. Select samples, especially sponges, require resequencing that is currently ongoing. Select samples are currently undergoing scanning electron microscopy at NWFSC using standard methods to further characterize their taxonomy.

eDNA samples collected via the ROV or ship's CTD rosette were extracted and sequenced at NWFSC following the methods described in Everett and Park (2018). eDNA samples were amplified using primers for octocorals described in Everett and Park (2018) with the addition of a novel reverse primer for the Paragorgiidae (Octo_eDNA_2R_Para-Illumina – GTCTCGTGGGCTCGGAGATGTGTATAAGAGACAGGCAGTCTTCTAAATTGCAACCGGGAGAATA) as well as primers developed for West Coast groundfish (Ford et al., 2016), and the resulting amplicons sequenced on an Illumina MiSeq at NWFSC. Initial extraction and sequencing of all eDNA samples has been completed and analysis of resulting sequence data is ongoing.

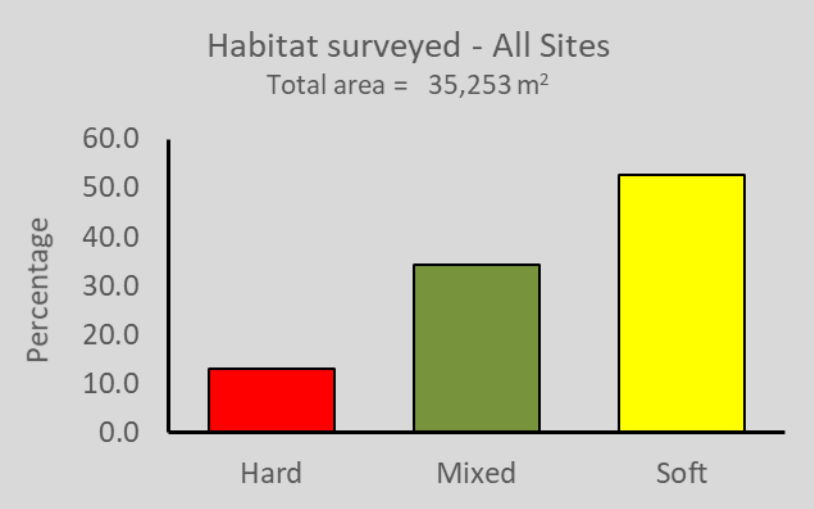
## SITE SUMMARY

Fourteen unique sites were surveyed during 18 dives along the West Coast of the United States (Table 1). A total of 50 quantitative visual transects were completed. About 118 hours of video images and 89,700 still images were collected during nighttime ROV operations (~1600-0500). Depths of survey transects ranged from 131-1,246 m.

Table 1. Dive information for the 2019 EXPRESS cruise

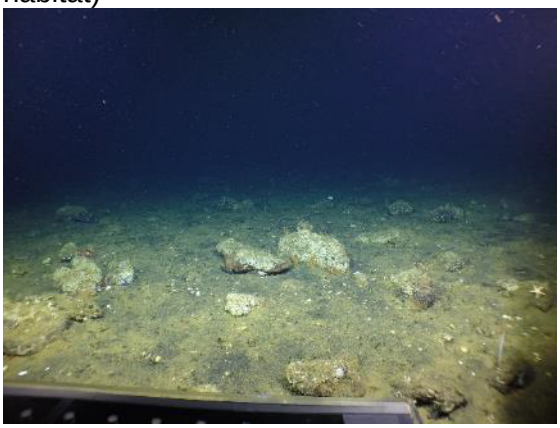
| Start Date | End Date | Site | Method | # of Transects | Start Lat First day | Start Lon First day | End Lat Last day | End Lon Last day |
|---|---|---|---|---|---|---|---|---|
| 10/9 | 10/9 | Willapa Canyon | ROV, CTD | 3 | 46° 33.156’ | 124° 35.797’ | 46° 33.978’ | 124° 36.122’ |
| 10/10 | 10/10 | Daisy Bank | ROV, CTD | 4 | 44° 38.832’ | 124° 44.342’ | 44° 38.520’ | 124° 44.514’ |
| 10/11 | 10/11 | Sponge Bycatch | ROV, CTD | 5 | 43° 36.588’ | 124° 48.432’ | 43° 36.486’ | 124° 49.578’ |
| 10/12 | 10/12 | Mud Volcano | ROV, CTD | 0 | 43° 40.550’ | 124° 42.042’ | 43° 40.956’ | 124° 41.916’ |
| 10/14 | 10/14 | Brush Patch | ROV, CTD | 0 | | | | |
| 10/15 | 10/15 | Humboldt Wind Energy | ROV, CTD | 1 | 40° 56.327’ | 124° 36.432’ | 44° 56.319’ | 124° 36.360’ |
| 10/23 | 10/25 | Cordell Bank NMS | ROV, CTD | 5 | 37° 57.659’ | 123° 32.002’ | 37° 49.764’ | 123° 25.512’ |
| 10/27 | 10/27 | Cabrillo Canyon | ROV, CTD | 1 | 36° 52.010’ | 122° 19.073’ | 36° 52.105’ | 122° 19.144’ |
| 10/28 | 10/28 | West Carmel Canyon | ROV, CTD | 3 | 36° 33.612’ | 122° 04.590’ | 36° 33.390’ | 122° 04.212’ |
| 10/29 | 10/29 | Point Sur Slot Canyons | ROV, CTD | 3 | 36° 38.121’ | 122° 44.246’ | 36° 39.918’ | 122° 48.477’ |
| 10/30 | 11/2 | Santa Lucia Bank | ROV, CTD | 11 | 35° 03.739’ | 121° 31.919’ | 34° 54.156’ | 121° 03.231’ |
| 11/3 | 11/3 | Santa Cruz Island South | ROV | 6 | 33° 53.290’ | 119° 47.114’ | 33° 53.917’ | 119° 47.459’ |
| 11/4 | 11/4 | Anacapa Island South | ROV, CTD | 4 | 33° 58.921’ | 119° 21.603’ | 33° 59.363’ | 119° 21.751’ |
| 11/5 | 11/6 | Santa Catalina Basin | ROV, CTD | 4 | 33° 11.316’ | 118° 28.081’ | 33° 11.326’ | 118° 28.092’ |

A total of 35,253 $m^2$ of seafloor habitat was classified from the 50 quantitative transects. We combined the two-character habitat codes into three groups; hard, mixed, and soft. Hard habitat consisted of any combination of bedrock, boulder, cobble, flat rock or pinnacle. Soft habitat consisted of any combination of sand or mud. Mixed habitat was any combination of hard and soft habitats. The most common habitat type was soft at 52.7% followed by 34.2% for mixed and 13.1% for hard habitats.



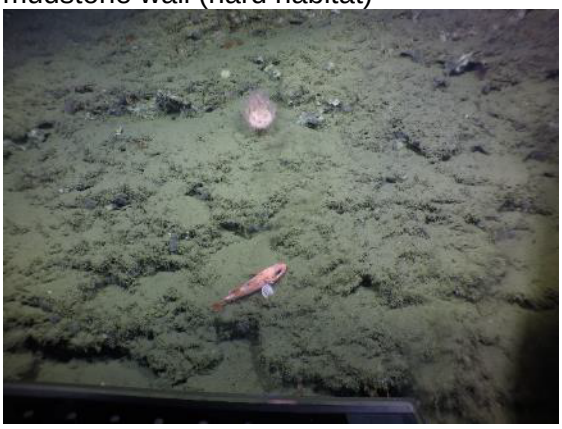

A sea star on a mud seafloor (soft habitat)

A cobble, boulder, and mud seafloor (mixed habitat)



A rock ridge (hard habitat)

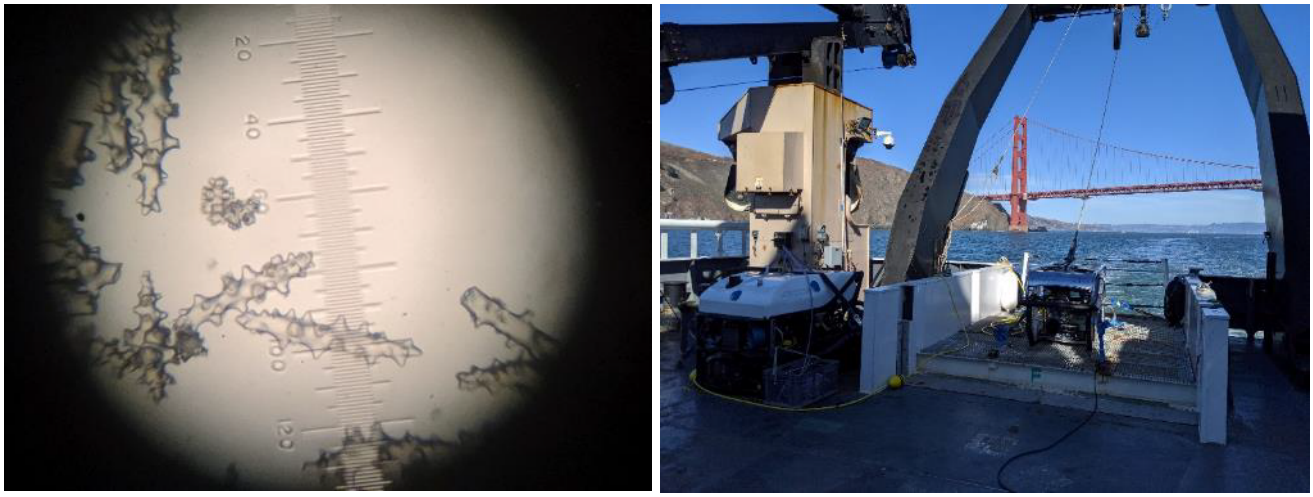
A mushroom coral and thornyhead on a mudstone wall (hard habitat)



A total of 29 coral taxa/morphotypes, 29 sponge taxa/morphotypes, and 69 fish taxa were identified from the transects conducted from Willapa Canyon in southern Washington south to the Santa Catalina Basin in southern California (Tables 2-4). An additional 35 invertebrate taxa (8 phyla) were also identified during video transects (see Table 10 in the conclusions). We collected 97 samples, including 33 corals, 44 sponges, 11 other invertebrates (e.g., clams, urchins) and 9 geologic specimens (four push cores, five rock samples). Genetic analyses are in progress for many of these specimens.

A total of 3,467 deep-sea corals, 7,960 sponges, 5,987 fishes, and over 200,000 invertebrates other than DSCS were counted during the quantitative transects. The three most abundant coral taxa/morphotypes were all sea pens: thin (2,081 counted), thick (299 counted), and droopy sea pens (211 counted). Mushroom corals were the most abundant non-sea pen taxon with 188 observations. One of the most abundant species was *Swiftia* cf. *beringi* (118 observations), which was only observed at Daisy Bank. Unidentified barrel and vase sponges were the most abundant sponges (3,856 and 1,633 sponges, respectively). *Staurocalyptus* spp., *Haliclona* spp., and *Heterochone calyx* were all abundant vase sponge taxa and were observed throughout the study area. Foliose sponges were also fairly common with a total of 244 unidentified individuals and 272 white nipple sponges. Fish taxa were dominated by thornyheads (2,529 observations), most of which were unidentified (2,144 individuals) followed by longspine (349) and shortspine (36) thornyheads. Large numbers of thornyheads were expected because we generally surveyed depths deeper than 500 m where thornyheads are abundant. The second most abundant taxon was sharpchin rockfish with 1,110 individuals. All but one of these was observed during surveys at Daisy Bank. Rosethorn rockfish were abundant overall but only seen at Daisy Bank. Overall densities for each survey area varied considerably for corals from a high of 70.0 corals/100 $m^2$ at Point Sur Slot Canyons to a low of 0.04 corals/100 $m^2$ of seafloor at Willapa Canyon. Sponge densities varied from a high of 158.2 sponges/100 $m^2$ (Daisy Bank) to a low of 0 sponges/100 $m^2$ at three sites (Cordell Bank NMS, West Carmel Canyon, and Point Sur Slot Canyons). Fish densities were highest at Daisy Bank (38.6 fish/100 $m^2$; mostly sharpchin rockfish) to a low of 3.4 fish/100 $m^2$ at Santa Catalina Basin. There were 34 recorded occurrences of anthropogenic debris with 28 instances of fishing gear and 6 pieces of trash (two glass bottles, one small can, one plastic mesh, one black tube, and one small PVC pipe).

Below we present summaries, by dive, of the diversity and density of corals, sponges, and fishes and associated habitats observed in the 50 quantitative transects. One site had no quantitative transects (Mud Volcano) and, instead, researchers were examining the geology of the area. Surveys at Brush Patch were aborted due to a water alarm in the ROV. Even though these sites did not have quantitative transects, they included CTD and water quality measurements, sampling, and benthic investigations and are included in this site summaries. These shipboard CTD profiles of sea temperature, salinity, oxygen concentration, pH, and fluorescence with depth from before or after the ROV dives are provided below. Health and condition of the corals and sponges are reported, along with incidence of marine debris on each dive.



Coral sclerites viewed through the dissection microscope (left). The ROVs *Yogi* and *Guru* with the Golden Gate Bridge in the background (right).

Table 2. Coral taxa observed from video surveys using a remotely operated vehicle (ROV) during the EXPRESS cruise along the West Coast from 8 Oct – 7 Nov 2019.

| Scientific name | Common name | Number | Scientific name | Common name | Number |
|---|---|---|---|---|---|
| *Acanthogorgia* spp. | gold coral | 4 | Isididae | unknown bamboo coral | 4 |
| Alcyonacea | unidentified sea fan | 1 | *Narella* spp. | white coral | 5 |
| *Anthoptilum grandiflorum* | feather boa sea pen | 7 | *Paragorgia pacifica* | bubblegum coral | 17 |
| Antipatharia | unknown black coral | 1 | *Paragorgia* spp. | sea fan (white with red polyps) | 124 |
| *Antipathes dendrochristos* | Christmas tree black coral | 12 | *Paragorgia stephencairnsi* | peppermint coral | 3 |
| *Bathypathes* spp. | black coral | 7 | *Parastenella ramosa* | primnoid | 19 |
| *Swiftia* cf. *beringi*[2] | white *Swiftia* fan | 118 | Pennatulacea #1 | sea pen (thin) | 2081 |
| *Chromoplexura cordellbankensis* | yellow stick coral | 1 | Pennatulidae | sea pen (thick) | 299 |
| *Clavularia* spp. | soft coral | 45 | *Placogorgia* sp. | brown coral | 1 |
| *Desmophyllum dianthus* | cockscomb cup coral | 8 | Plexauridae #1 | *Swiftia* type (red w/ white polyps) | 2 |
| *Funiculina* spp. | unidentified sea pen | 14 | Plexauridae #3 | *Swiftia* type (red w/ unk polyps) | 110 |
| *Gersemia* spp. | soft coral | 99 | *Plumarella longispina* | primnoid | 2 |
| *Halipteris californica* | sea pen | 7 | *Swiftia pacifica* | sea fan (red with yellow polyps) | 72 |
| *Heteropolypus ritteri* | mushroom coral | 188 | *Umbellula lindahli* | droopy sea pen | 211 |
| Hexacorallia/Octocorallia | unidentified coral | 5 | | | |

[2] *Swiftia* cf. *beringi* is not a recognized name. The new name is *Calcigorgia beringi*. However, our specimens do not genetically align with *Calcigorgia*. Therefore we chose to use *Swiftia* cf. *beringi* as name in this publication until the specimens can be properly identified.

Table 3. Sponge taxa observed from video surveys using a remotely operated vehicle (ROV) during the EXPRESS cruise along the West Coast from 8 Oct – 7 Nov 2019.

| Scientific name | Common name | Number |
|---|---|---|
| *Asbestopluma* spp. #1 | predatory pipecleaner sponge | 133 |
| *Asbestopluma* spp. #2 | predatory sponge (clear) | 90 |
| *Farrea occa* | lace (or cloud) foliose sponge | 85 |
| *Haliclona* (Gellius) spp. | tan vase/trumpet sponge | 324 |
| *Heterochone calyx* | fingered goblet vase sponge | 127 |
| *Hexactinella* spp. | sponge (white) | 7 |
| *Hyalonema populiferum* | fiber optic sponge | 4 |
| *Latrunculia* spp. | purple moon sponge | 9 |
| *Mycale* spp. | upright flat sponge (yellow) | 86 |
| *Poecillastra* spp. | fringed shelf sponge | 16 |
| *Polymastia* spp. #1 | white nipple foliose sponge | 272 |
| Porifera #1 | unidentified foliose sponges | 244 |
| Porifera #12 | unidentified sponge | 77 |
| Porifera #14 | Valentines sponge | 8 |
| Porifera #15 | green moon sponge | 25 |
| Porifera #16 | crumpet sponge | 19 |
| Porifera #2 | unidentified upright flat sponges | 41 |
| Porifera #3 | unidentified barrel sponges | 3856 |
| Porifera #4 | unidentified shelf sponges | 22 |
| Porifera #5 | unidentified vase sponges | 1633 |
| Porifera #6 | unidentified mound sponges | 42 |
| Porifera #7 | unidentified branching sponge | 67 |
| Porifera #8 | unidentified tube sponge | 11 |
| Porifera #9 | unidentified puffball mound sponge | 60 |
| *Rhabdocalyptus dawsoni* | brown barrel sponge | 4 |
| *Rhizaxinella gadus* | club sponge | 3 |
| *Staurocalyptus* spp. #1 | Picasso sponge | 9 |
| *Staurocalyptus* spp. #2 | white vase sponge | 653 |
| *Thenea muricata* | foliose sponge (clear) | 33 |

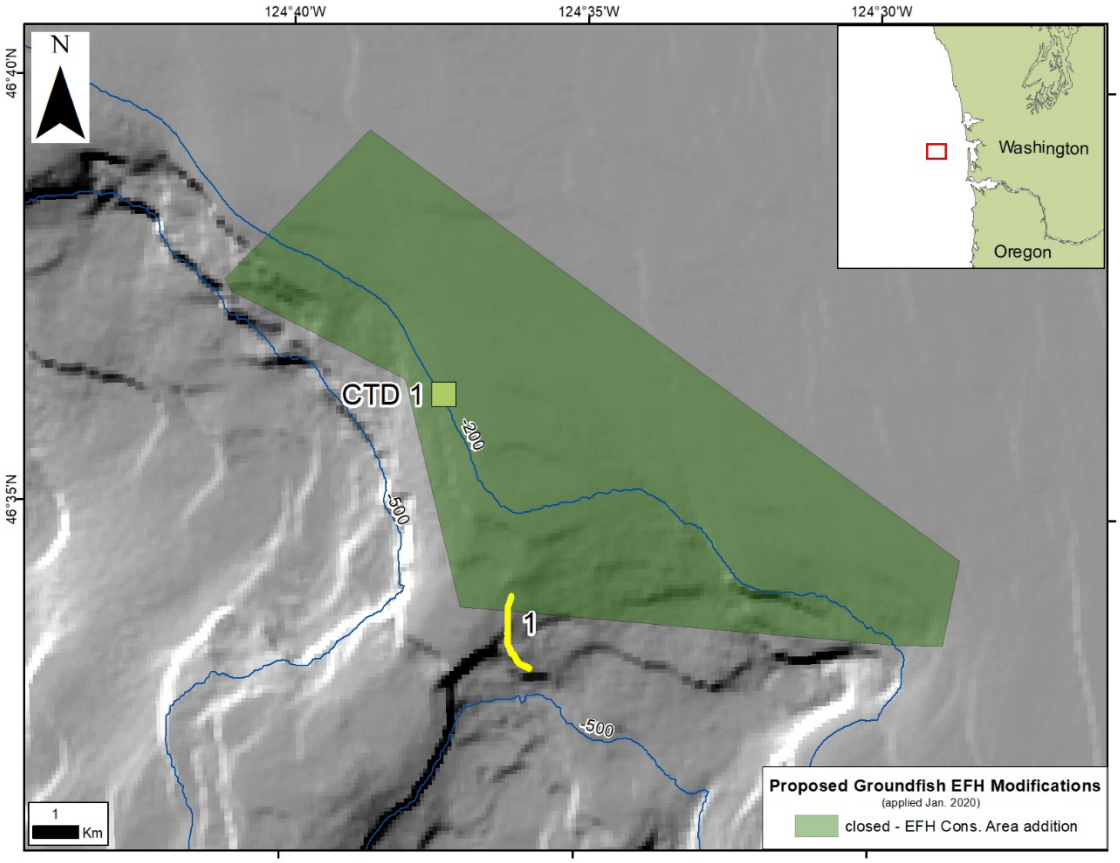
Table 4. Fish taxa observed from video surveys using a remotely operated vehicle (ROV) during the EXPRESS cruise along the West Coast from 8 Oct – 7 Nov 2019. * = taxa in Fisheries Management Plan.

| Scientific name | Common name | Number |
|---|---|---|
| Agonidae | unidentified poachers | 48 |
| *Alepocephalus tenebrosus* | California slickhead | 7 |
| *Anarrhichthys ocellatus* | wolfeel | 1 |
| *Anoplopoma fimbria** | sablefish | 12 |
| *Antimora microlepis* | Pacific flatnose | 4 |
| *Bathyagonus nigripinnis* | blackfin poacher | 7 |
| *Bathyraja interrupta* | sandpaper skate | 1 |
| *Bathyraja trachura* | roughtail skate | 6 |
| *Bothrocara brunneum* | twoline eelpout | 2 |
| *Cataetyx rubrirostris* | rubynose brotula | 59 |
| *Embassichthys bathybius* | deepsea sole | 68 |
| *Eptatretus* spp. | unidentified hagfish | 169 |
| *Facciolella equatorialis* | dogface witch eel | 4 |
| *Glytocephalus zachirus** | rex sole | 72 |
| *Hydrolagus colliei* | spotted ratfish | 5 |
| *Icelinus* spp. | *Icelinus* sculpins | 4 |
| *Idiacanthus antrostomus* | Pacific blackdragon | 1 |
| Liparididae | unidentified snailfish | 6 |
| *Lycenchelys crotalinus* | snakehead eelpout | 126 |
| *Lycodes cortezianus* | bigfin eelpout | 32 |
| *Lycodes diapterus* | black eelpout | 54 |
| *Lyopsetta exilis* | slender sole | 4 |
| Macrouridae | unidentified grenadier | 41 |
| *Merluccius productus** | Pacific hake | 33 |
| *Microstomus pacificus** | Dover sole | 452 |
| Myctophidae | unidentified lanternfish | 22 |
| *Nezumia stelgidolepis* | California grenadier | 3 |
| *Ophiodon elongatus** | lingcod | 7 |
| Osteichthyes | unidentified fishes | 2 |
| *Paricelinus hopliticus* | thornback sculpin | 1 |
| Pleuronectiformes | unidentified flatfishes | 10 |
| *Psychrolutes phrictus* | blob sculpin | 1 |
| *Raja rhina** | longnose skate | 4 |
| *Raja stellulata* | starry skate | 1 |
| Rajidae | unidentified skate | 2 |
| Rajiformes egg cases | skate egg cases | 1 |
| Scyliorhinidae | unidentified cat shark | 7 |
| *Sebastes alutus** | Pacific Ocean perch | 1 |
| *Sebastes aurora** | aurora rockfish | 20 |
| *Sebastes brevispinis** | silvergray rockfish | 4 |
| *Sebastes chlorostictus** | greenspotted rockfish | 1 |
| *Sebastes crameri** | darkblotched rockfish | 25 |
| *Sebastes diploproa** | splitnose rockfish | 207 |
| *Sebastes elongatus** | greenstriped rockfish | 3 |
| *Sebastes entomelas** | widow rockfish | 2 |
| *Sebastes helvomaculatus** | rosethorn rockfish | 243 |
| *Sebastes melanostomus** | blackgill rockfish | 76 |
| *Sebastes paucispinis** | bocaccio | 2 |
| *Sebastes phillipsi** | chameleon rockfish | 5 |
| *Sebastes pinniger** | canary rockfish | 45 |
| *Sebastes proriger** | redstripe rockfish | 1 |
| *Sebastes ruberrimus** | yelloweye rockfish | 5 |
| *Sebastes rubrivinctus** | flag rockfish | 1 |
| *Sebastes rufus** | bank rockfish | 9 |
| *Sebastes simulator** | pinkrose rockfish | 3 |
| *Sebastes* spp. | unidentified rockfishes | 7 |
| *Sebastes* spp. YOY | juvenile rockfish | 1 |
| *Sebastes wilsoni** | pygmy rockfish | 85 |
| *Sebastes zacentrus** | sharpchin rockfish | 1110 |
| *Sebastolobus alascanus** | shortspine thornyhead | 36 |

| Scientific name | Common name | Number |
|---|---|---|
| *Sebastolobus altivelis** | longspine thornyhead | 349 |
| *Sebastolobus* spp. | thornyheads | 2144 |
| *Squalus suckleyi* | Pacific spiny dogfish | 4 |
| *Tetronarce californica* | Pacific electric ray | 1 |
| *Sebastomus* | unidentified *Sebastomus* | 103 |
| *Xeneretmus latifrons* | blacktip poacher | 1 |
| *Xeneretmus leiops* | smootheye poacher | 1 |
| *Zaniolepis frenata* | shortspine combfish | 5 |
| Zoarcidae | unidentified eelpout | 208 |

# STUDY AREA: Willapa Canyon
# DIVE NUMBER: ROV 0001

## GENERAL LOCATION AND DIVE TRACKS




## STATION OVERVIEW (Willapa Canyon)

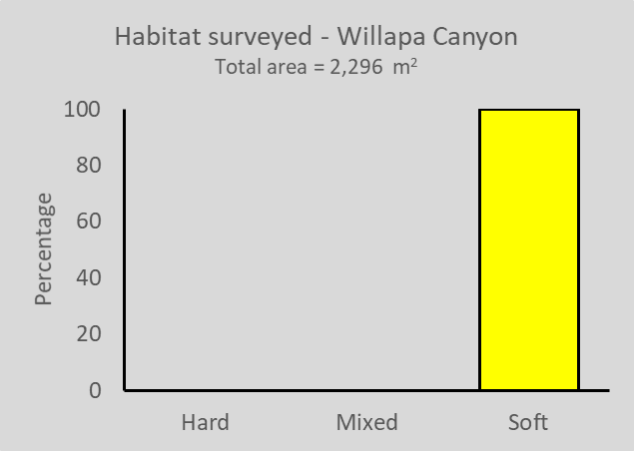
| | |
|---|---|
| **Project** | EXPRESS 2019 |
| **Chief Scientists** | Tom Laidig, Elizabeth Clarke, Chris Caldow |
| **Contact Information** | NMFS, SWFSC, tom.laidig@noaa.gov |
| **Purpose** | Survey deep-sea coral communities along the West Coast |
| **Vessel** | NOAA Ship *Reuben Lasker*; ROV *Yogi* (GFOE) |
| **Science Observers** | Diana Watters, Meredith Everett |
| **Digital Video** | 5.3 hours |
| **Digital Still Photos** | 4,176 images |
| **Positioning System** | Ship: GPS; ROV: USBL |
| **CTD Sensors** | Yes |
| **$O_2$ Sensor (ship CTD only)** | Yes |
| **pH Sensor** | Yes |
| **Specimens collected** | 5 |
| **Water sample** | 3 eDNA; 12 water chemistry |
| **Other** | Logbook, SQL server database |
| **Report Analyst** | Tom Laidig |
| **Date Compiled** | 15 Jun 2022 |

## DIVE DATA (Willapa Canyon)

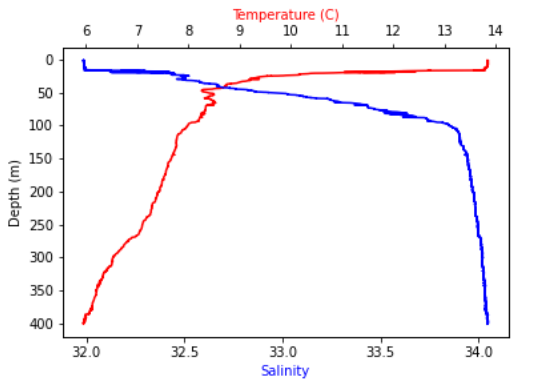
| | | | |
|---|---|---|---|
| Date | 9 Oct 2019 | Starting Latitude (N) | 46° 33.156’ |
| Minimum Bottom Depth (m) | 242 | Starting Longitude (W) | 124° 35.797’ |
| Maximum Bottom Depth (m) | 468 | Ending Latitude (N) | 46° 33.978’ |
| Start Bottom Time (UTC) | 23:01:36 | Ending Longitude (W) | 124° 36.122’ |
| End Bottom Time (UTC) | 3:01:18 | Surface Current | n/a |
| Number 15-min Transects | 3 | Bottom Current | n/a |

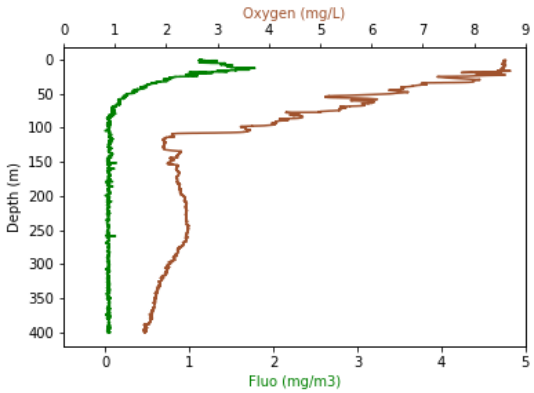
## PHYSICAL ENVIRONMENT (Willapa Canyon)

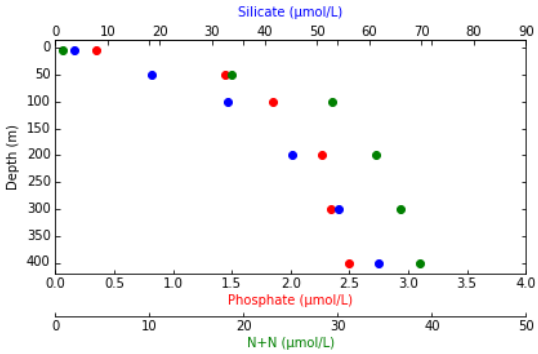
In total, 2,296 m$^2$ of seafloor were surveyed during three quantitative transects conducted during Dive 0001 at Willapa Canyon off southern Washington. Only soft sediments were observed in this area which consisted entirely of mud.

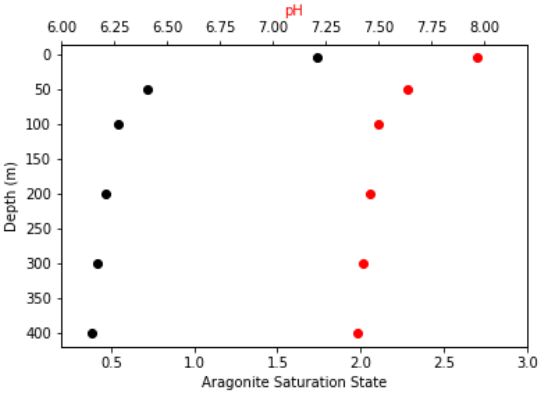



A thermocline existed (as measured from the shipboard CTD) from the surface to about 40 m, and thereafter the temperature gradually decreased with depth. Salinity increased with depth with a halocline from the surface to about 100 m. Oxygen decreased rapidly until about 110 m then slowly to 400 m. Nutrient load (phosphate, silicate, and nitrate [N+N]) gradually increased with depth. Saturation of pH and aragonite dropped quickly during the first 100 m and slowly thereafter.



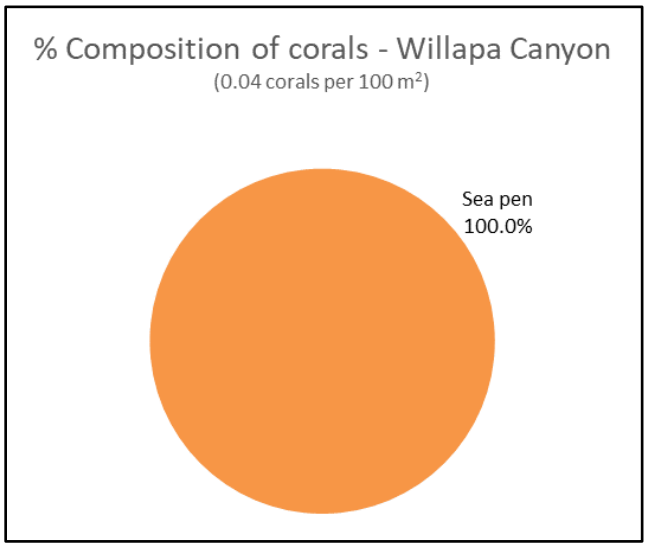



## BIOLOGICAL ENVIRONMENT: CORALS (Willapa Canyon)

Only one individual coral colony was enumerated from three quantitative transects conducted during Dive 0001 in Willapa Canyon off southern Washington. Coral density was very low at 0.04 corals per 100 $m^2$ of seafloor.



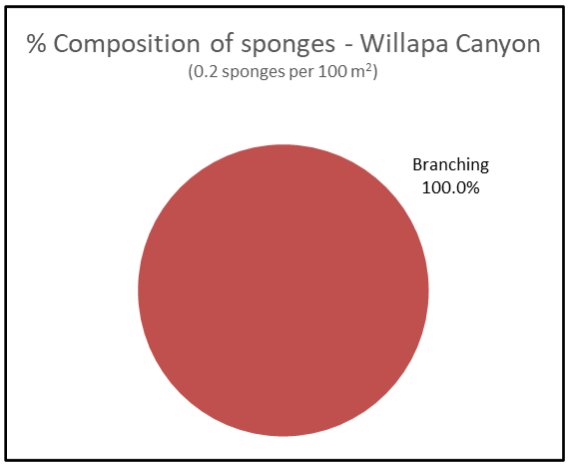

Colors in the pie diagram match colors in the list of coral taxa (below).

| | Scientific name | Common name | Number |
|---|---|---|---|
| | Pennatulacea #1 | sea pen (thin) | 1 |

No coral specimens were collected during dives at Willapa Canyon. The eDNA sample was taken with no corals observed in the general area; the eDNA sample failed to sequence with octocoral primers.

## BIOLOGICAL ENVIRONMENT: SPONGES (Willapa Canyon)

A total of four individual sponges from at least one taxon were enumerated from three quantitative transects conducted during Dive 0001 in Willapa Canyon off southern Washington. An overall density of 0.2 sponges per 100 $m^2$ of seafloor was estimated. Only small (<20 cm) branching sponges were observed.



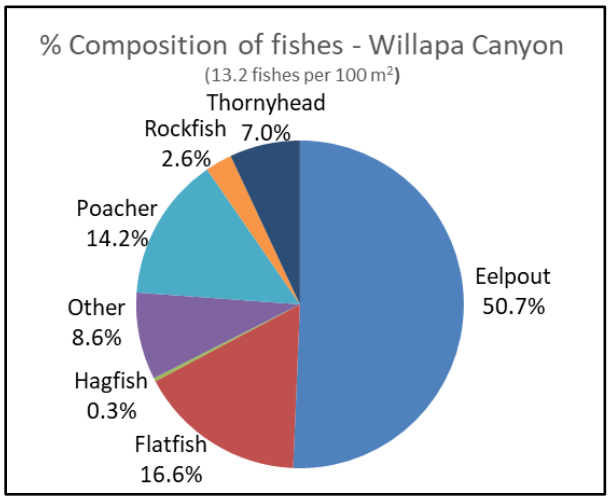

Colors in the pie diagram match colors in the list of sponge taxa (below).

| | Scientific name | Common name | Number |
|---|---|---|---|
| | Porifera #7 | unidentified branching sponge | 4 |

One sponge specimen was collected during Dive 0001 in Willapa Canyon and sent to experts for identification. Shipboard identification was a finger sponge. DNA barcoding and analysis for this specimen is ongoing; verified identification from experts is still pending.

## BIOLOGICAL ENVIRONMENT: FISHES (Willapa Canyon)

At least 23 taxa of fishes were identified from three quantitative transects conducted during Dive 0001 in Willapa Canyon off southern Washington. A total of 302 individual fishes were enumerated, with an estimated overall density of 13.2 fishes per 100 $m^2$ of seafloor. Eelpouts dominated the fish assemblage (51%), with flatfishes (16.6%; mostly Dover and rex sole) and poachers (21%) also abundant. The remainder of the fish assemblage included other (8.6%; mostly Pacific hake), thornyheads (7%), rockfishes (2.6%), and hagfishes (0.3%).



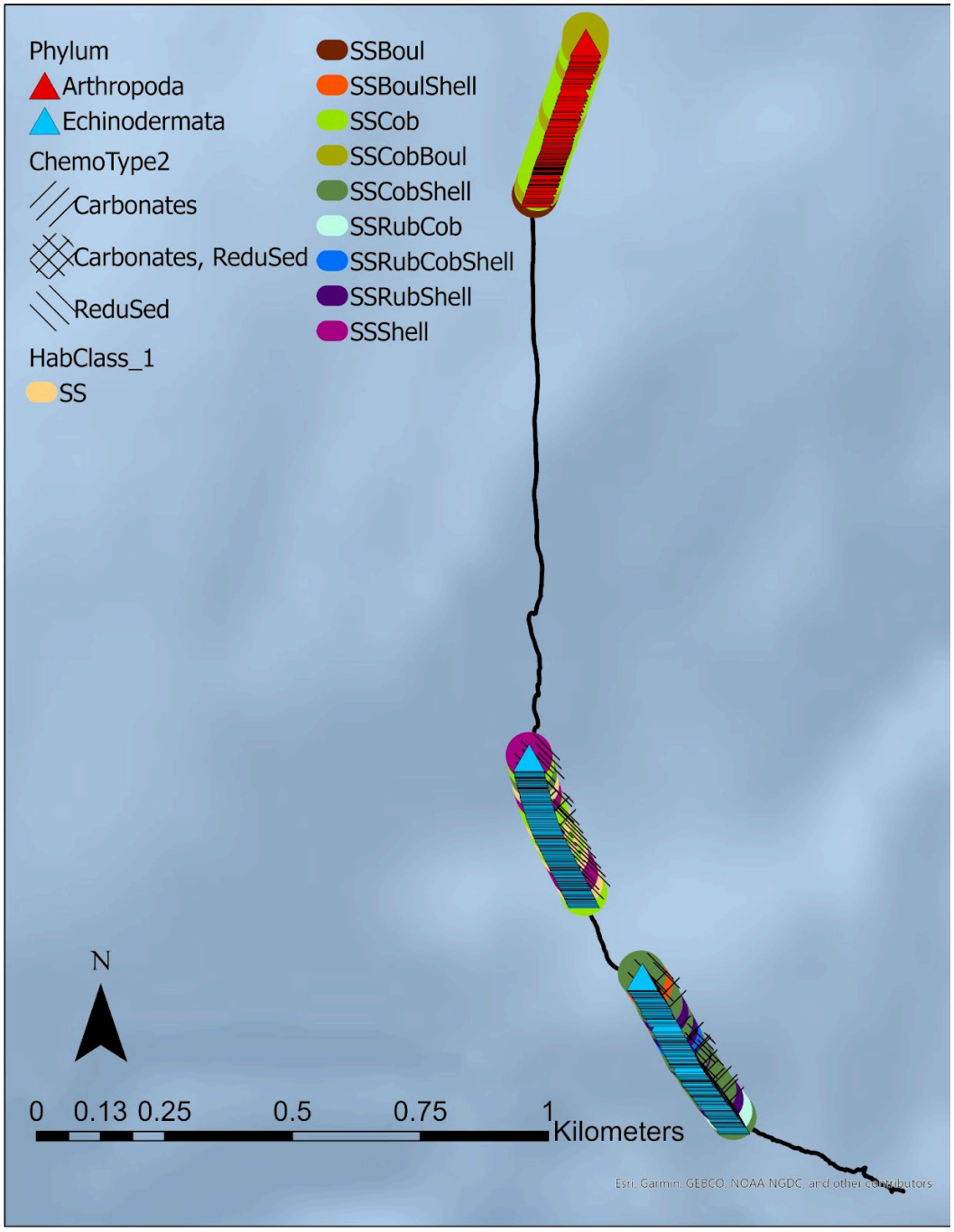

Colors in the pie diagram match colors in the list of fish taxa (below).

Only one fish was associated (within one body length) with a sponge (20% of all corals and sponges) - a 20 cm thornyhead that was laying on the mud next to the rock that held the 10 cm branching sponge.

| Scientific name | Common name | Number |
|---|---|---|
| Agonidae | unidentified poachers | 43 |
| *Bathyraja interrupta* | sandpaper skate | 1 |
| *Eptatretus* spp. | unidentified hagfish | 1 |
| *Glytocephalus zachirus* | rex sole | 18 |
| *Hydrolagus colliei* | spotted ratfish | 1 |
| *Lycodes cortezianus* | bigfin eelpout | 12 |
| *Lycodes diapterus* | black eelpout | 47 |
| *Lyopsetta exilis* | slender sole | 3 |
| *Merluccius productus* | Pacific hake | 18 |
| *Microstomus pacificus* | Dover sole | 19 |
| Osteichthyes | unidentified fishes | 1 |
| Pleuronectiformes | unidentified flatfishes | 10 |
| Rajidae | unidentified skate | 1 |
| *Sebastes alutus* | Pacific Ocean perch | 1 |
| *Sebastes crameri* | darkblotched rockfish | 1 |
| *Sebastes diploproa* | splitnose rockfish | 1 |
| *Sebastes* spp. | unidentified rockfishes | 4 |
| *Sebastes zacentrus* | sharpchin rockfish | 1 |
| *Sebastolobus alascanus* | shortspine thornyhead | 2 |
| *Sebastolobus altivelis* | longspine thornyhead | 1 |
| *Sebastolobus* spp. | unidentified thornyheads | 18 |
| *Squalus suckleyi* | Pacific spiny dogfish | 4 |
| Zoarcidae | unidentified eelpout | 94 |

## BIOLOGICAL ENVIRONMENT: OTHER FAUNA (Willapa Canyon)

At least 16 taxa of fauna other than DSCS and fishes were identified from three quantitative transects conducted during Dive 0001 in Willapa Canyon off southern Washington. The dominant phyla were Arthropoda (mostly shrimp) and Echinodermata (mostly urchins). The map below shows habitat classification and dominant phyla for each transect. Habitat classifications include soft sediment (SS), boulders (Boul), cobbles (Cob), rubble (Rub), and clam shells (Shell). Chemosynthetic features were overlaid on the habitat classification and include carbonates and reduced sediments (ReduSed).



## IMAGE GALLERY (Willapa Canyon)

A Pacific halibut smiling for the camera at 409 m on a mud seafloor.

A pom pom anemone on a mud seafloor at 430 m.

A shortraker rockfish (*Sebastes borealis*) at 450 m on a mud seafloor.

A sea star on a mud seafloor at 440 m.

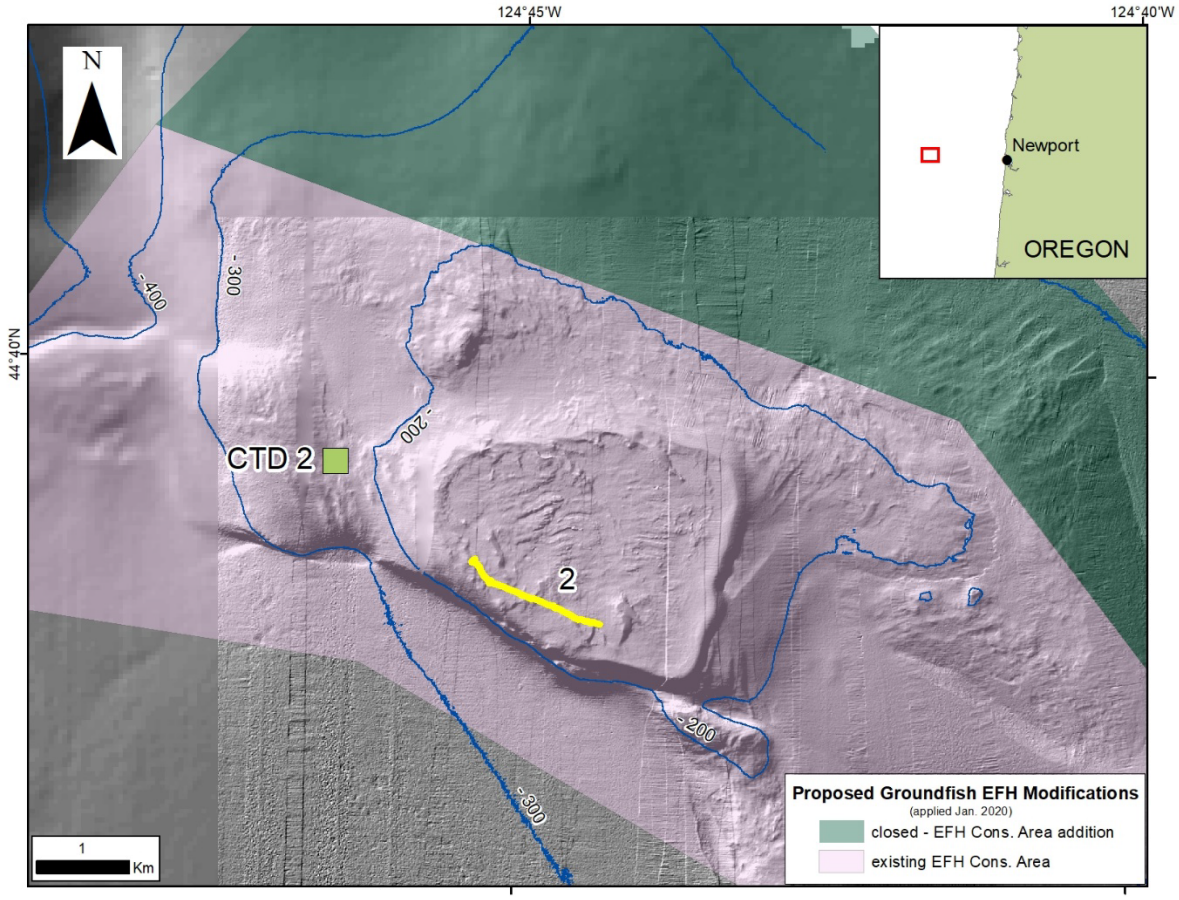
## ADDITIONAL COMMENTS (Willapa Canyon)

No anthropogenic debris items were documented during dives at Willapa Canyon.

No corals or sponges were observed to be damaged, knocked over, or dead or dying.

# STUDY AREA: Daisy Bank
# DIVE NUMBER: ROV 0002

## GENERAL LOCATION AND DIVE TRACKS




## STATION OVERVIEW (Daisy Bank)

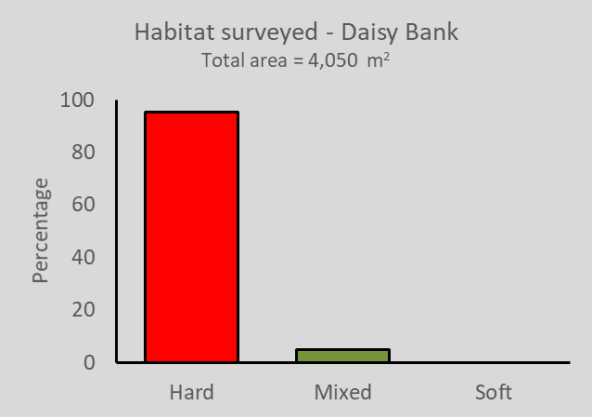
| | |
|---|---|
| **Project** | EXPRESS 2019 |
| **Chief Scientists** | Tom Laidig, Elizabeth Clarke, Chris Caldow |
| **Contact Information** | NMFS, SWFSC, tom.laidig@noaa.gov |
| **Purpose** | Survey deep-sea coral communities along the West Coast |
| **Vessel** | NOAA Ship *Reuben Lasker*; ROV *Yogi* (GFOE) |
| **Science Observers** | Diana Watters, Meredith Everett |
| **Digital Video** | 7.4 hours |
| **Digital Still Photos** | 5,732 images |
| **Positioning System** | Ship: GPS; ROV: USBL |
| **CTD Sensors** | Yes |
| **$O_2$ Sensor (ship CTD only)** | Yes |
| **pH Sensor** | Yes |
| **Specimens collected** | 10 |
| **Water sample** | 3 eDNA; 6 water chemistry |
| **Other** | Logbook, SQL server database |
| **Report Analyst** | Tom Laidig |
| **Date Compiled** | 15 Jun 2022 |

## DIVE DATA (Daisy Bank)

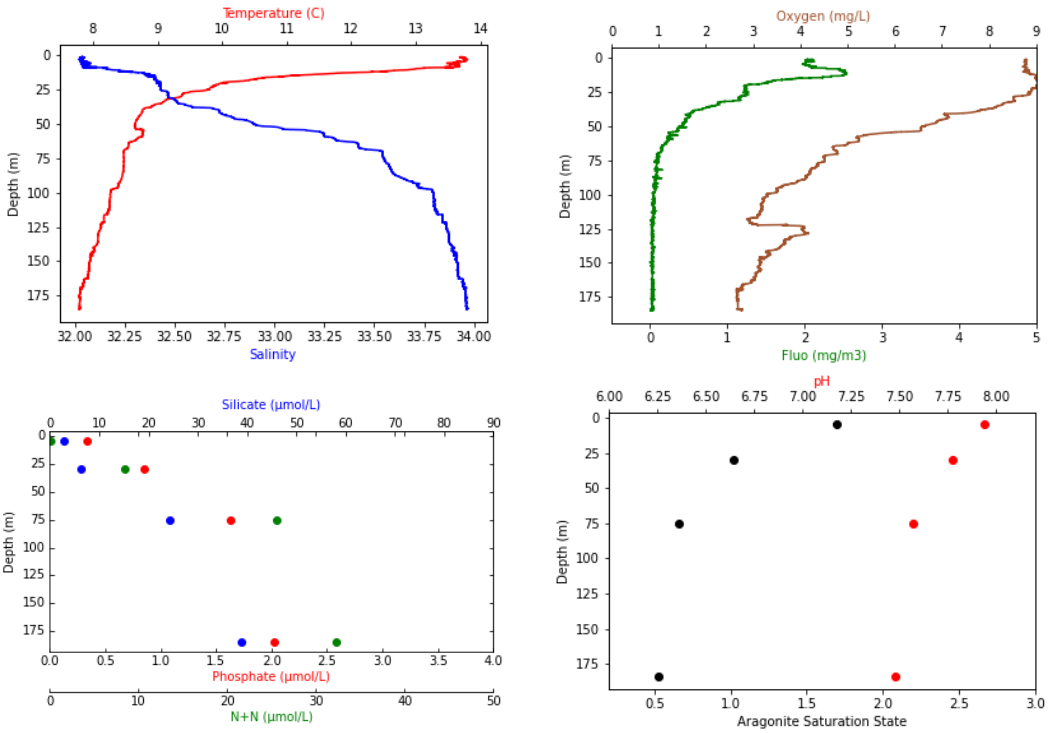
| | | | |
|---|---|---|---|
| Date | 10 Oct 2019 | Starting Latitude (N) | 44° 38.832’ |
| Minimum Bottom Depth (m) | 131 | Starting Longitude (W) | 124° 44.342’ |
| Maximum Bottom Depth (m) | 140 | Ending Latitude (N) | 44° 38.520’ |
| Start Bottom Time (UTC) | 2:55:00 | Ending Longitude (W) | 124° 44.514’ |
| End Bottom Time (UTC) | 9:14:47 | Surface Current | n/a |
| Number 15-min Transects | 4 | Bottom Current | n/a |

## PHYSICAL ENVIRONMENT (Daisy Bank)

In total, 4,050 $m^2$ of seafloor were surveyed during four quantitative transects conducted during Dive 0002 on Daisy Bank off central Oregon. Habitat types were classified as (1) hard (95% of the total area surveyed), which included large boulders and cobbles; and (2) mixed (5%), including a combination of mud with boulder and cobbles. No (3) soft habitat was observed on transect.

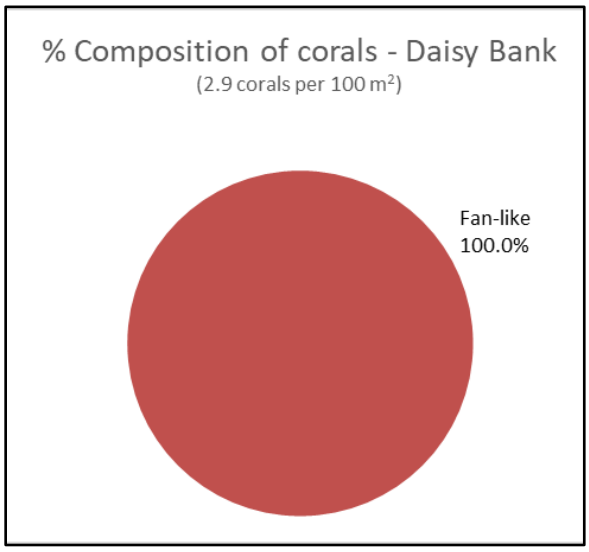



A thermocline existed (as measured from the shipboard CTD) from the surface to 30 m; thereafter the temperature gradually decreased with depth. Salinity increased with depth. Oxygen decreased rapidly until about 110 m, spiked slightly at 120-130 m, then decreased to 180 m. Nutrient load (phosphate, silicate, and nitrate [N+N]) gradually increased with depth. Saturation of pH and aragonite decreased with depth.



## BIOLOGICAL ENVIRONMENT: CORALS (Daisy Bank)

A total of 118 individual coral colonies, comprising at least one taxon, were enumerated from four quantitative transects conducted during Dive 0002 on Daisy Bank off central Oregon. Coral density was relatively low at 2.9 corals per 100 $m^2$ of seafloor. Fan-like corals were the only group observed and all corals were *Swiftia* cf. *beringi*[3] All of the *S*. cf. *beringi* were small (10 cm or less).




Colors in the pie diagram match colors in the list of coral taxa (below).

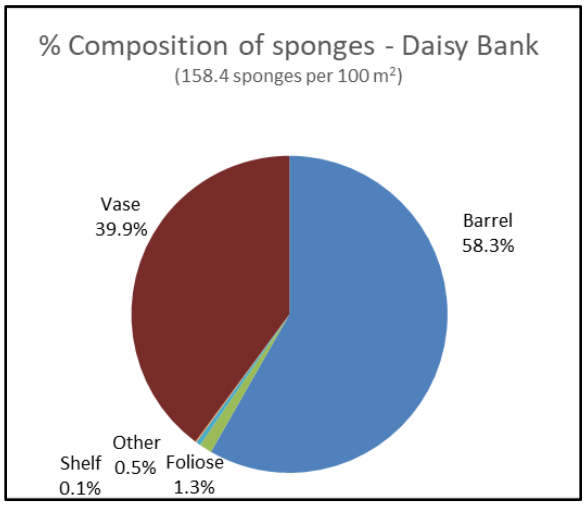
| | Scientific name | Common name | Number |
|---|---|---|---|
| | *Swiftia* cf. *beringi* | white *Swiftia* fan | 118 |

Three coral specimens were collected during Dive 0002 at Daisy Bank and sent to experts for identification. Shipboard identifications were *Swiftia* cf. *beringi*[2] (three specimens). DNA barcoding with MutS places these individuals as sister taxa to *S. pacifica* and RAD sequencing for taxonomic verification is ongoing. Verified identifications are still pending. Sequencing of eDNA from this site for octocorals is ongoing.

[3] *Swiftia* cf. *beringi* is not a recognized name. The new name is *Calcigorgia beringi*. However, our specimens do not genetically align with *Calcigorgia*. Therefore, we chose to use *Swiftia* cf. *beringi* as name in this publication until the specimens can be properly identified.

## BIOLOGICAL ENVIRONMENT: SPONGES (Daisy Bank)

A total of 6,415 individual sponges from at least eight different taxa were enumerated from four quantitative transects conducted during Dive 0002 on Daisy Bank off central Oregon. Overall density was relatively high at 158.4 sponges per 100 $m^2$ of seafloor. The sponge assemblage was dominated by unidentified barrel (58%) and vase (40%) sponges.



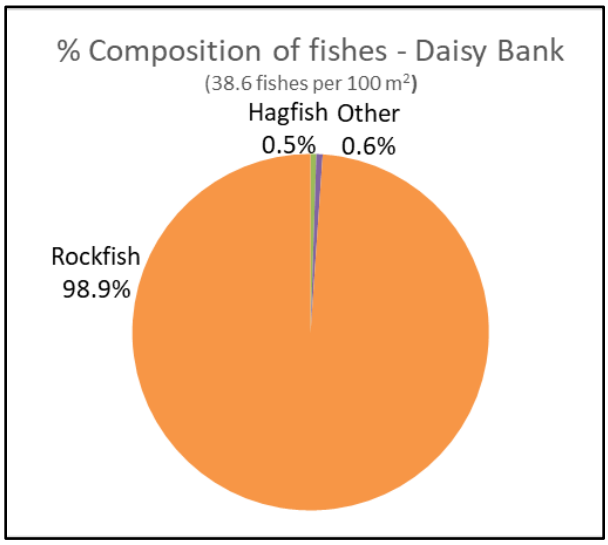

Colors in the pie diagram match colors in the list of sponge taxa (below).

| Scientific name | Common name | Number |
|---|---|---|
| *Haliclona* (Gellius) spp. | tan vase/trumpet sponge | 324 |
| *Heterochone calyx* | fingered goblet vase sponge | 111 |
| Porifera #1 | unidentified foliose sponges | 83 |
| Porifera #12 | unidentified sponge | 31 |
| Porifera #3 | unidentified barrel sponges | 3738 |
| Porifera #4 | unidentified shelf sponges | 7 |
| Porifera #5 | unidentified vase sponges | 1468 |
| *Staurocalyptus* spp. #2 | white vase sponge | 653 |

Six sponge specimens were collected during Dive 0002 on Daisy Bank and sent to experts for identification. Shipboard identifications were white frilly vase sponge (one specimen), barrel with dirty fringe (one specimen), *Heterochone calyx* (one specimen), potato sponge (one specimen), small pipe sponge (one specimen), and *Aphrocallistes vastus* (one specimen). DNA barcodes have been obtained for three of the sponge specimens with additional sequencing ongoing. Verified identification from experts is still pending.

## BIOLOGICAL ENVIRONMENT: FISHES (Daisy Bank)

At least 16 taxa of fishes were identified from four quantitative transects conducted during Dive 0002 on Daisy Bank off central Oregon. A total of 1,565 individual fishes were enumerated, with an estimated overall density of 38.6 fishes per 100 $m^2$ of seafloor. Rockfishes dominated the fish assemblage (98.9%) and sharpchin rockfish were the most abundant rockfishes. Other fishes (0.6%) and hagfishes (0.5%) were the only other groups observed at this site. Other fishes included lingcod, a wolfeel, and a thornback sculpin.



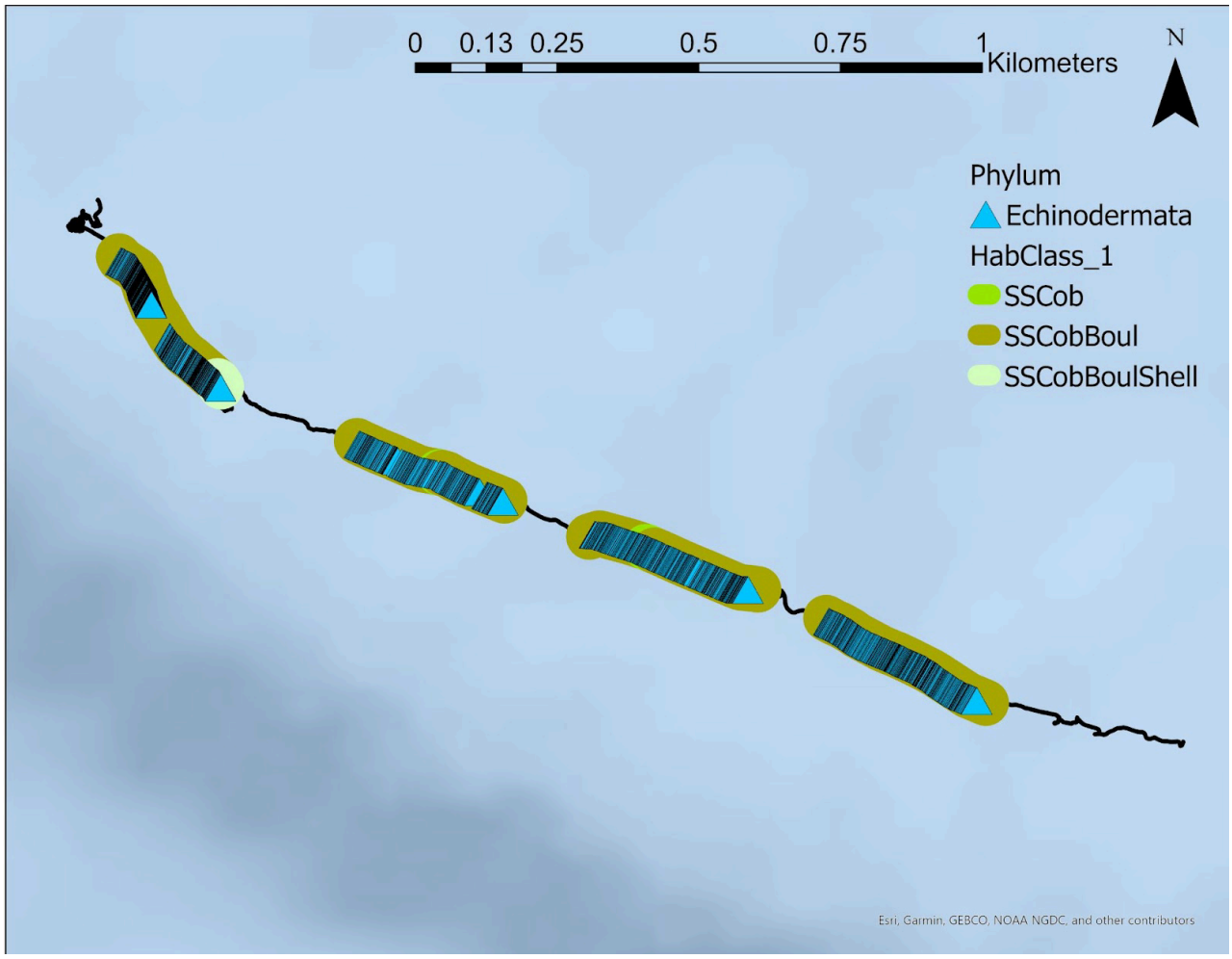

Colors in the pie diagram match colors in the list of fish taxa (below).

Eight percent (499 individuals) of the 6,533 corals and sponges had a fish association within one body length. All the fish associations were with sponges. The most common sponge taxa that had fish associations were barrel (176 individuals), vase (148) sponges and white *Staurocalyptus* spp. (113). Sharpchin rockfish were the most abundant fish species and also had the most associations with 343 individuals associated with DSCS. Many of these fishes were associated with multiple corals and sponges. Other species with associations were rosethorn (46 individuals were associated with 54 DSCS), canary (14 individuals were associated with 33 DSCS), pygmy (5), and yelloweye (3) rockfishes, hagfish (2), and lingcod (2).

| Scientific name | Common name | Number |
|---|---|---|
| *Anarrhichthys ocellatus* | wolfeel | 1 |
| *Eptatretus* spp. | unidentified hagfish | 8 |
| *Ophiodon elongatus* | lingcod | 7 |
| *Paricelinus hopliticus* | thornback sculpin | 1 |
| *Sebastes brevispinis* | silvergray rockfish | 4 |
| *Sebastes entomelas* | widow rockfish | 1 |
| *Sebastes helvomaculatus* | rosethorn rockfish | 243 |
| *Sebastes paucispinis* | bocaccio | 1 |
| *Sebastes pinniger* | canary rockfish | 45 |
| *Sebastes proriger* | redstripe rockfish | 1 |
| *Sebastes ruberrimus* | yelloweye rockfish | 5 |
| *Sebastes* spp. | unidentified rockfishes | 3 |
| *Sebastes* spp. YOY | juvenile rockfish | 1 |
| *Sebastes wilsoni* | pygmy rockfish | 85 |
| *Sebastes zacentrus* | sharpchin rockfish | 1109 |
| *Sebastomus* | unidentified *Sebastomus* | 50 |

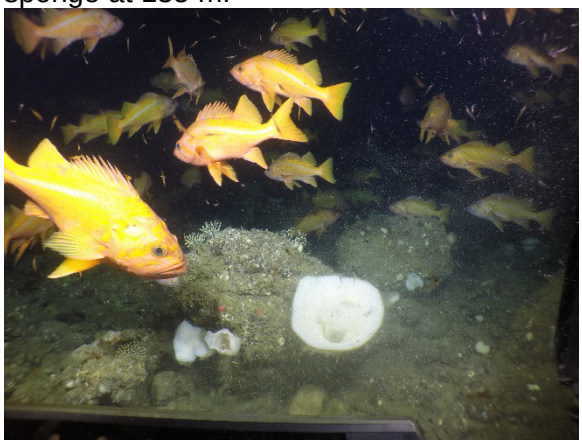
## BIOLOGICAL ENVIRONMENT: OTHER FAUNA (Daisy Bank)

At least eight taxa of fauna other than DSCS and fishes were identified from four quantitative transects conducted during Dive 0002 in Daisy Bank off central Oregon. The dominant phylum was Echinodermata (mostly crinoids [53,079 individuals] and ophiuroids [4,628]). The map below shows habitat classification and dominant phyla for each transect. Habitat classifications include soft sediment (SS), boulders (Boul), cobbles (Cob), and clam shells (Shell). No chemosynthetic features were documented during the dive.

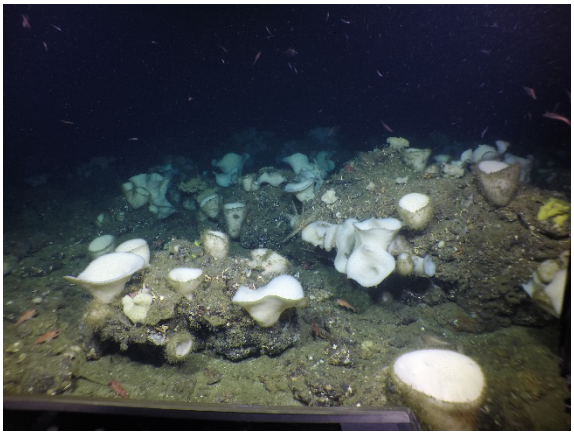


## IMAGE GALLERY (Daisy Bank)

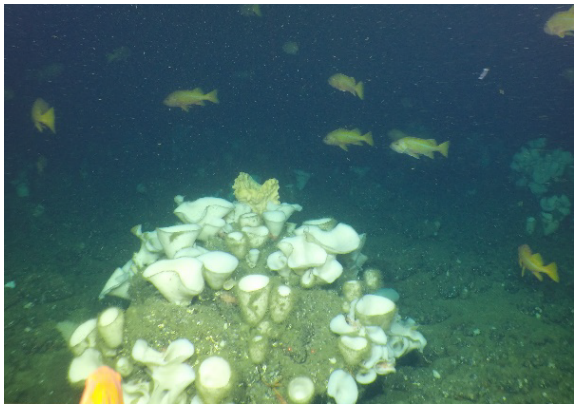
A school of canary rockfish and a large vase sponge at 135 m.



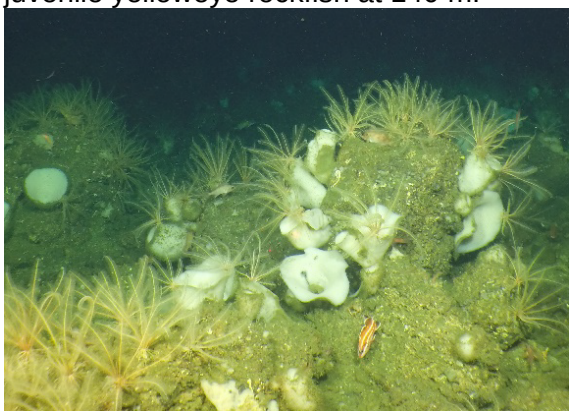
A field of sponges on a rock and boulder seafloor at 138 m.



A sponge covered boulder at 137 m.



Crinoids (feather stars) and sponges with a juvenile yelloweye rockfish at 140 m.



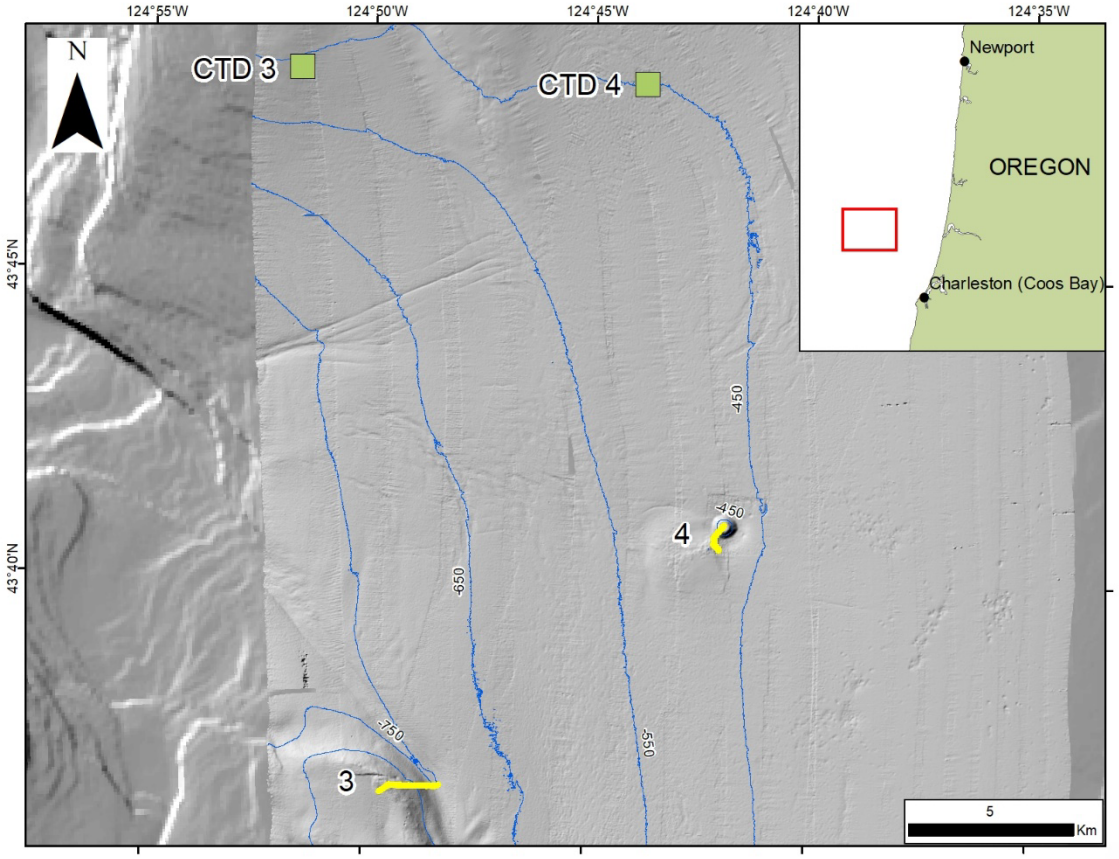
## ADDITIONAL COMMENTS (Daisy Bank)

Four anthropogenic debris items were documented during dives at Daisy Bank. One old longline was strewn across the seafloor and two old trawl nets were in piles on the seafloor. Damage from these items to DSCS was not observed. One longline was wrapped around some sponges and stretched over the tops of rocks; however, no damage to the sponges was observed.

No corals and six sponges (two white *Staurocalyptus* spp., two unidentified vase, one unidentified barrel, and one unidentified sponge) showed damage with broken sections. No corals and two sponges (a white *Staurocalyptus* spp. and an unidentified vase) were knocked over. No corals were determined to be dying or dead, while most of the sponges were dying (59% of all sponges) or dead (10%). These sponges were mostly barrel sponges that displayed non-living sections or were fully dead. This site had the highest percent of dying sponges of all sites.

# STUDY AREA: Sponge Bycatch
# DIVE NUMBER: ROV 0003

## GENERAL LOCATION AND DIVE TRACKS




## STATION OVERVIEW (Sponge Bycatch)

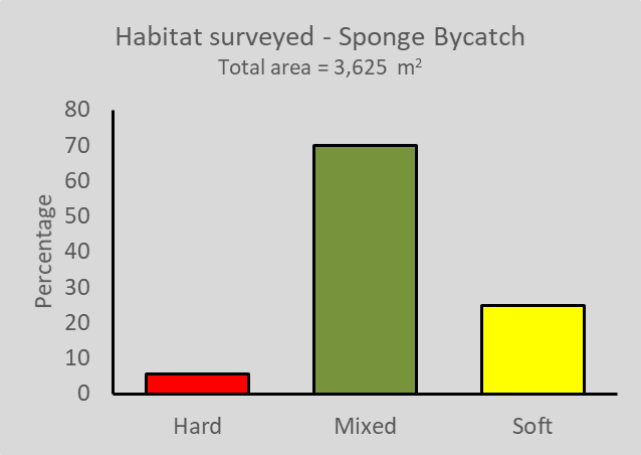
| | |
|---|---|
| **Project** | EXPRESS 2019 |
| **Chief Scientists** | Tom Laidig, Elizabeth Clarke, Chris Caldow |
| **Contact Information** | NMFS, SWFSC, tom.laidig@noaa.gov |
| **Purpose** | Survey deep-sea coral communities along the West Coast |
| **Vessel** | NOAA Ship *Reuben Lasker*; ROV *Yogi* (GFOE) |
| **Science Observers** | Diana Watters, Meredith Everett |
| **Digital Video** | 10.5 hours |
| **Digital Still Photos** | 7,688 images |
| **Positioning System** | Ship: GPS; ROV: USBL |
| **CTD Sensors** | Yes |
| **$O_2$ Sensor (ship CTD only)** | Yes |
| **pH Sensor** | Yes |
| **Specimens collected** | 9 |
| **Water sample** | 3 eDNA; 12 water chemistry |
| **Other** | Logbook, SQL server database |
| **Report Analyst** | Tom Laidig |
| **Date Compiled** | 15 Jun 2022 |

## DIVE DATA (Sponge Bycatch)

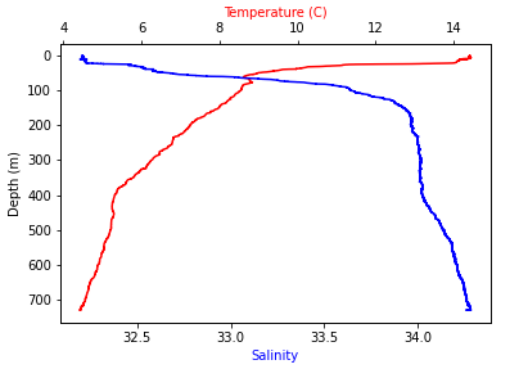
| | | | |
|---|---|---|---|
| Date | 11 Oct 2019 | Starting Latitude (N) | 43° 36.588’ |
| Minimum Bottom Depth (m) | 556 | Starting Longitude (W) | 124° 48.432’ |
| Maximum Bottom Depth (m) | 753 | Ending Latitude (N) | 43° 36.486’ |
| Start Bottom Time (UTC) | 5:23:38 | Ending Longitude (W) | 124° 49.578’ |
| End Bottom Time (UTC) | 11:04:44 | Surface Current | n/a |
| Number 15-min Transects | 5 | Bottom Current | n/a |

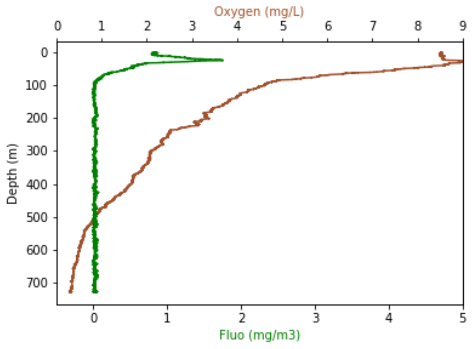
## PHYSICAL ENVIRONMENT (Sponge Bycatch)

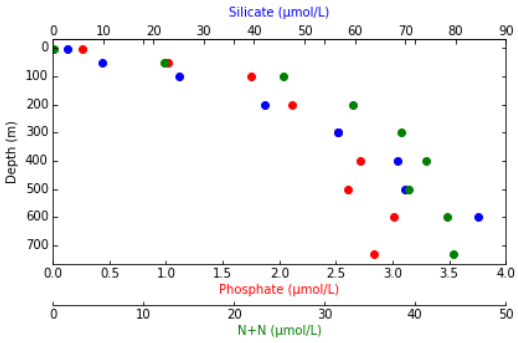
In total, 3,625 $m^2$ of seafloor were surveyed during five quantitative transects conducted during Dive 0003 at the Sponge Bycatch area off southern Oregon. Habitat types were classified as (1) hard (5% of the total area surveyed), which included large boulders, rock outcrops, flat rocks, and cobbles; and (2) mixed (70%), including a combination of mud with boulders, flat rocks, and cobbles; and (3) soft (25%), which consisted entirely of mud.

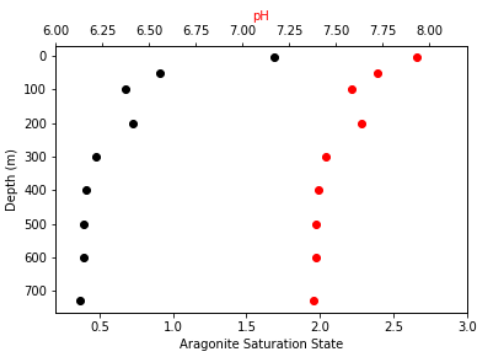



A thermocline existed (as measured from the shipboard CTD) from the surface to 50 m; thereafter the temperature slowly decreased with depth. Salinity increased with depth, with a halocline from 0-100 m. Oxygen decreased rapidly until about 100 m and decreased thereafter. Fluorescence decreased to 0 by 100 m. Nutrient load (phosphate, silicate, and nitrate [N+N]) gradually increased with depth. Saturation of pH and aragonite decreased with depth.



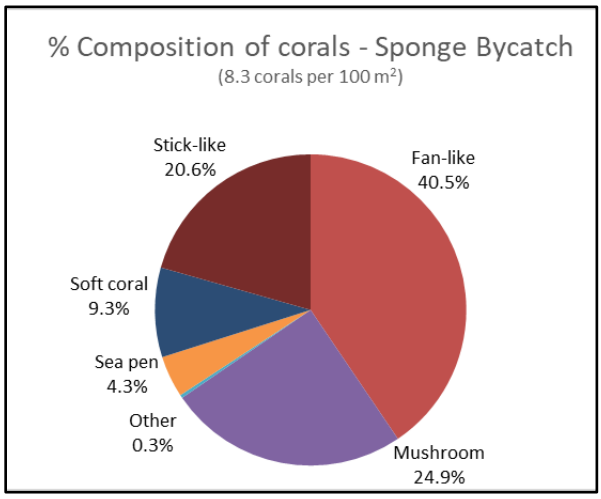



## BIOLOGICAL ENVIRONMENT: CORALS (Sponge Bycatch)

A total of 301 individual coral colonies, comprising at least 14 taxa, were enumerated from five quantitative transects conducted during Dive 0003 at the Sponge Bycatch area off southern Oregon. Coral density was 8.3 corals per 100 $m^2$ of seafloor. Fan-like corals dominated the coral assemblage with 40.5% of all corals, with *Paragorgia* spp. accounting for >80% of the fan-like corals. Mushroom corals were the next most abundant taxa accounting for almost a quarter of all corals observed followed by stick-like corals (all *Swiftia* type – red, unbranched or singly branched sticks). A few sea pens were observed in the soft sediments.



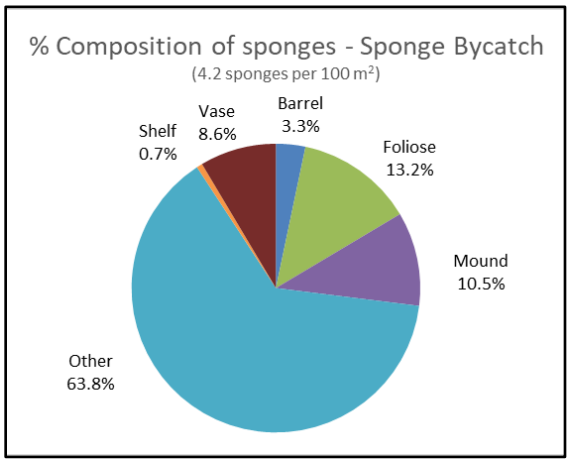

Colors in the pie diagram match colors in the list of coral taxa (below).

| Scientific name | Common name | Number |
|---|---|---|
| *Clavularia* spp. | soft coral | 5 |
| *Funiculina* spp. | unidentified sea pen | 6 |
| *Gersemia* spp. | soft coral | 23 |
| *Halipteris californica* | sea pen | 2 |
| *Heteropolypus ritteri* | mushroom coral | 75 |
| Hexacorallia/Octocorallia | unidentified coral | 1 |
| Isididae | unknown bamboo coral | 4 |
| *Paragorgia pacifica* | bubblegum coral | 7 |
| *Paragorgia* spp. | sea fan (white with red polyps) | 103 |
| *Parastenella ramosa* | primnoid | 3 |
| Plexauridae #3 | *Swiftia* type (red w/ unknown polyps) | 62 |
| *Plumarella longispina* | primnoid | 1 |
| *Swiftia pacifica* | sea fan (red with yellow polyps) | 4 |
| *Umbellula lindahli* | droopy sea pen | 5 |

Four coral specimens were collected during Dive 0003 at the Sponge Bycatch area and sent to experts for identification. Shipboard identifications were *Gersemia* cf. *juliepackardae* (one specimen), *Paragorgia* spp. (probably *P. yutilinux*; 2 specimens), and *Parastenella ramosa* (one specimen). Identification of *G. juliepackardae* was confirmed by Gary Williams of California Academy of Sciences, where the specimen has been archived. DNA barcoding was completed on *P. ramosa* confirming the shipboard identification. Verified identifications on the *Paragorgia* spp. are still pending. Sequencing of eDNA for octocorals from samples from this location is ongoing.

## BIOLOGICAL ENVIRONMENT: SPONGES (Sponge Bycatch)

A total of 152 individual sponges from at least eight different taxa were enumerated from five quantitative transects conducted during Dive 0003 at the Sponge Bycatch area off southern Oregon. An overall density of 4.2 sponges per 100 $m^2$ of seafloor was calculated. Other sponges were the most abundant taxa (78%), followed by foliose (13.2%), mound (10.5%), vase (8.6%), barrel (3.3%), and shelf (0.7%) sponges.



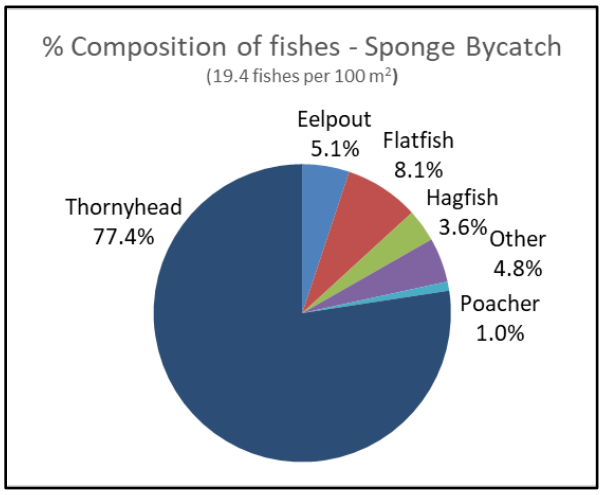

Colors in the pie diagram match colors in the list of sponge taxa (below).

| Scientific name | Common name | Number |
|---|---|---|
| *Asbestopluma* spp. #2 | predatory sponge (clear) | 80 |
| *Farrea occa* | lace (or cloud) foliose sponge | 13 |
| Porifera #1 | unidentified foliose sponges | 7 |
| Porifera #12 | unidentified sponge | 17 |
| Porifera #3 | unidentified barrel sponges | 5 |
| Porifera #4 | unidentified shelf sponges | 1 |
| Porifera #5 | unidentified vase sponges | 13 |
| Porifera #9 | unidentified puffball mound sponge | 16 |

Two sponge specimens were collected during Dive 0003 at the Sponge Bycatch and sent to experts for identification. Shipboard identifications were *Asbestopluma* spp. (one specimen) and *Farrea occa* (one specimen). Verified identification from experts is still pending. DNA barcoding of these samples is ongoing.

## BIOLOGICAL ENVIRONMENT: FISHES (Sponge Bycatch)

At least 17 taxa of fishes were identified from five quantitative transects conducted during Dive 0003 at the Sponge Bycatch area off southern Oregon. A total of 704 individual fishes were enumerated, with an estimated overall density of 19.4 fishes per 100 $m^2$ of seafloor. Thornyheads dominated the fish assemblage (77.4%). The remainder of the fish assemblage included flatfishes (8.1%; mostly deepsea sole), eelpouts (5.1%), other fishes (4.8%; mostly rubynose brotula), hagfishes (3.6%), and poachers (1.0%).



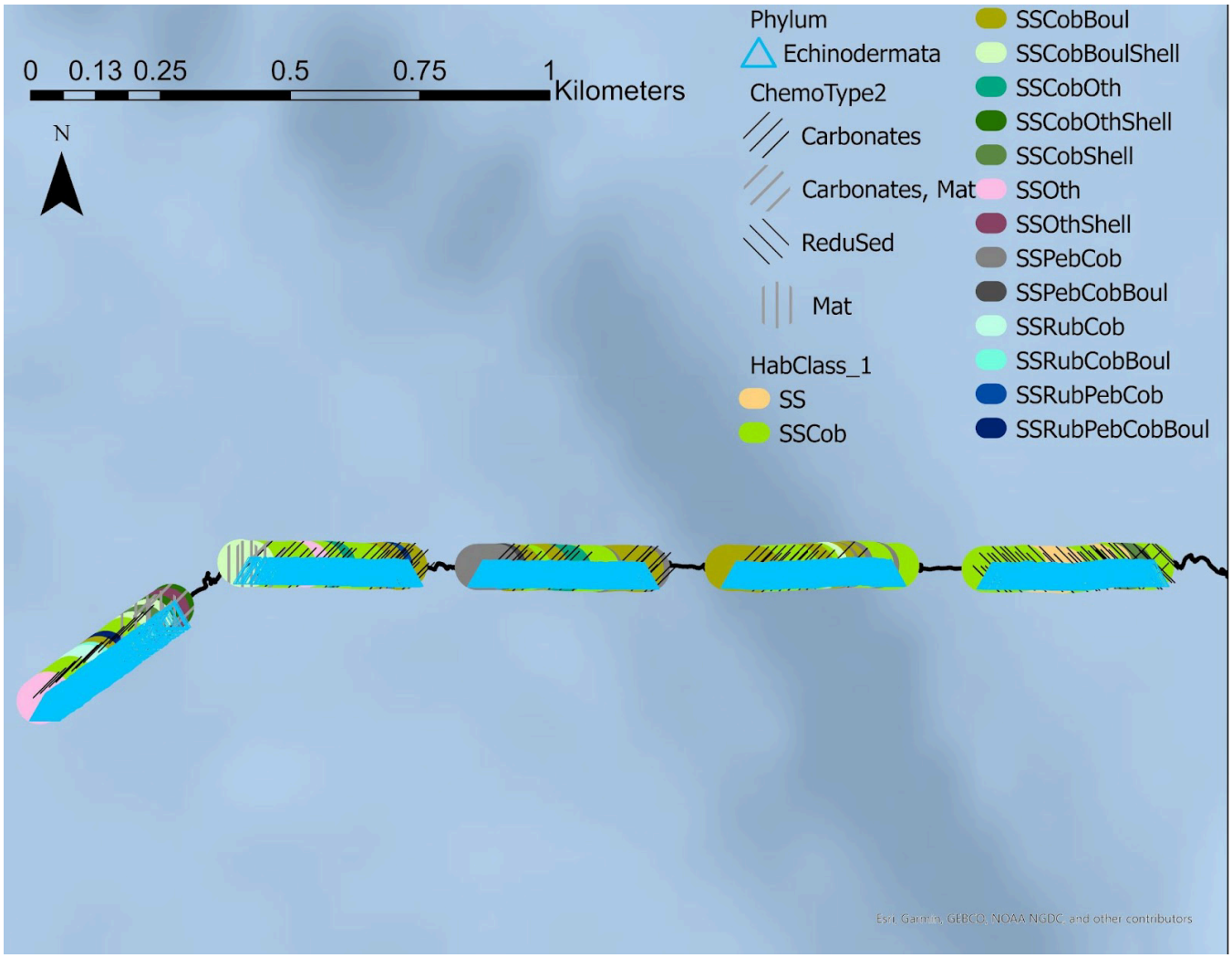

Colors in the pie diagram match colors in the list of fish taxa (below).

Ten of the 453 corals and sponges (2%) had a fish association within one body length. For corals, *Paragorgia* spp. had the most associations (3) along with one mushroom coral and one *Swiftia* type with unknown polyps. Palm frond, vase, puffball, and unidentified sponges each had one association, while foliose sponges had two associations. Fishes that were associated with the corals and sponges were thornyheads, and deepsea and Dover soles.

| Scientific name | Common name | Number |
|---|---|---|
| *Anoplopoma fimbria* | sablefish | 1 |
| *Bathyagonus nigripinnis* | blackfin poacher | 7 |
| *Cataetyx rubrirostris* | rubynose brotula | 25 |
| *Embassichthys bathybius* | deepsea sole | 38 |
| *Eptatretus* spp. | unidentified hagfish | 25 |
| *Idiacanthus antrostomus* | Pacific blackdragon | 1 |
| Liparididae | unidentified snailfish | 4 |
| *Lycenchelys crotalinus* | snakehead eelpout | 1 |
| *Lycodes cortezianus* | bigfin eelpout | 5 |
| *Microstomus pacificus* | Dover sole | 19 |
| Myctophidae | unidentified lanternfish | 1 |
| Osteichthyes | unidentified fishes | 1 |
| Rajidae | unidentified skate | 1 |
| *Sebastolobus alascanus* | shortspine thornyhead | 8 |
| *Sebastolobus altivelis* | longspine thornyhead | 113 |
| *Sebastolobus* spp. | unidentified thornyheads | 424 |
| Zoarcidae | unidentified eelpout | 30 |

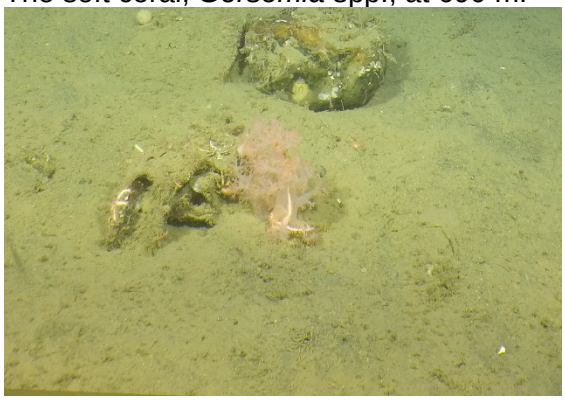
## BIOLOGICAL ENVIRONMENT: OTHER FAUNA (Sponge Bycatch)

At least 22 taxa of fauna other than DSCS and fishes were identified from five quantitative transects conducted during Dive 0003 in Sponge Bycatch Area off southern Oregon. The dominant phylum was Echinodermata (mostly ophiuroids [28,241 individuals]). The map below shows habitat classification and dominant phyla for each transect. Habitat classifications include soft sediment (SS), boulders (Boul), cobbles (Cob), rubble (Rub), and clam shells (Shell) and other less common substrates (OTH). The other classification includes crevices and trash. Chemosynthetic features were overlaid on the habitat classification and include carbonates, reduced sediments (ReduSed), and bacterial mats (Mat).

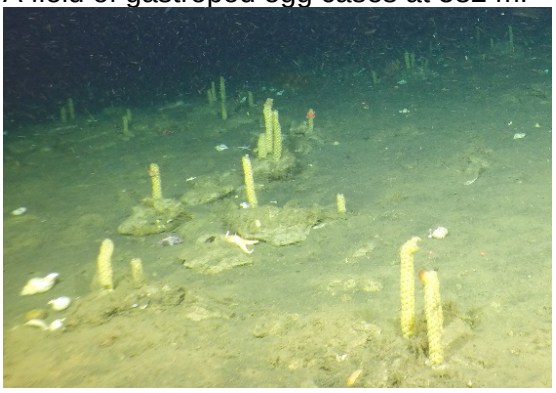


## IMAGE GALLERY (Sponge Bycatch)

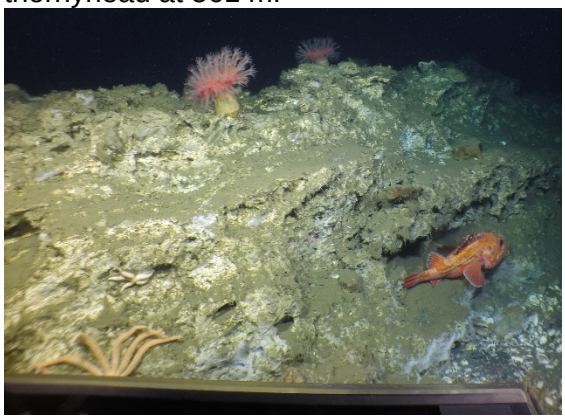
The soft coral, *Gersemia* spp., at 690 m.



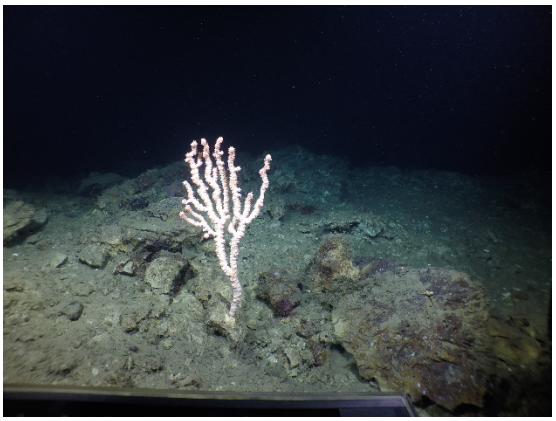
A field of gastropod egg cases at 582 m.



A mushroom coral and a large shortspine thornyhead at 561 m.



A tall *Paragorgia* spp. in a boulder field at 559 m.



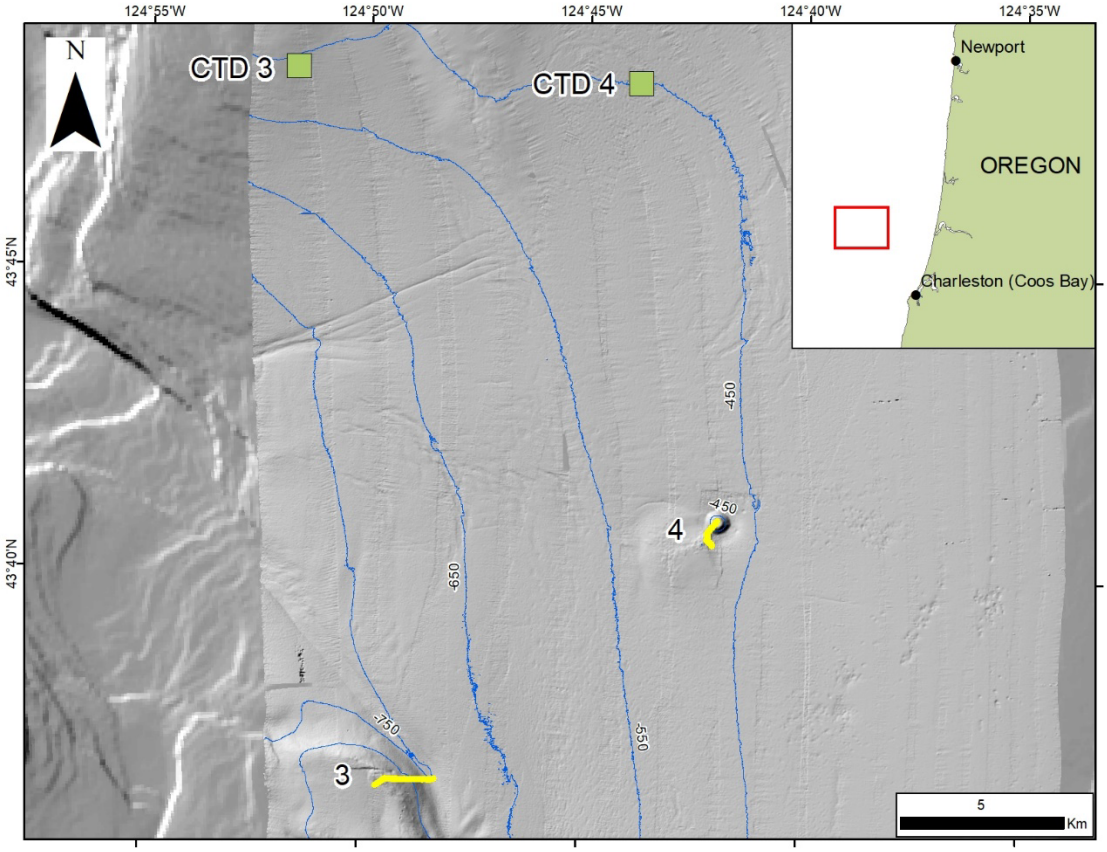
## ADDITIONAL COMMENTS (Sponge Bycatch)

One anthropogenic debris item (a brown bottle) was documented during dives at the Sponge Bycatch area. The bottle was sitting on a muddy section of the seafloor. Damage potentially caused by this item was not observed.

Three corals (*Umbellula lindahli*, *Paragorgia* spp. and a bamboo) and one vase sponge had physical damage and were knocked over. Eleven corals (4%, mostly *Swiftia pacifica* and *Paragorgia* spp.) and 14 sponges (9%, mostly *Farrea occa* and vase sponges) were dying while only 2% of corals (three *Swiftia pacifica*, one bamboo, and one *Umbellula lindahli*) and 1% of sponges (one vase and one *Farrea occa*) were dead.

# STUDY AREA: Mud Volcano
# DIVE NUMBER: ROV 0004

## GENERAL LOCATION AND DIVE TRACKS




## STATION OVERVIEW (Mud Volcano)

| | |
|---|---|
| **Project** | EXPRESS 2019 |
| **Chief Scientists** | Tom Laidig, Elizabeth Clarke, Chris Caldow |
| **Contact Information** | NMFS, SWFSC, tom.laidig@noaa.gov |
| **Purpose** | Survey deep-sea coral communities along the West Coast |
| **Vessel** | NOAA Ship *Reuben Lasker*; ROV *Yogi* (GFOE) |
| **Science Observers** | Diana Watters, Meredith Everett |
| **Digital Video** | 7.1 hours |
| **Digital Still Photos** | 5,445 images |
| **Positioning System** | Ship: GPS; ROV: USBL |
| **CTD Sensors** | Yes |
| **$O_2$ Sensor (ship CTD only)** | Yes |
| **pH Sensor** | Yes |
| **Specimens collected** | 5 |
| **Water sample** | 3 eDNA; 3 water chemistry |
| **Other** | Logbook, SQL server database |
| **Report Analyst** | Tom Laidig |
| **Date Compiled** | 15 Jun 2022 |

## DIVE DATA (Mud Volcano)

| | | | |
|---|---|---|---|
| Date | 12 Oct 2019 | Starting Latitude (N) | 43° 40.550’ |
| Minimum Bottom Depth (m) | 459 | Starting Longitude (W) | 124° 42.042’ |
| Maximum Bottom Depth (m) | 483 | Ending Latitude (N) | 43° 40.956’ |
| Start Bottom Time (UTC) | 3:28:31 | Ending Longitude (W) | 124° 41.916’ |
| End Bottom Time (UTC) | 8:57:01 | Surface Current | n/a |
| Number 15-min Transects | 0 | Bottom Current | n/a |

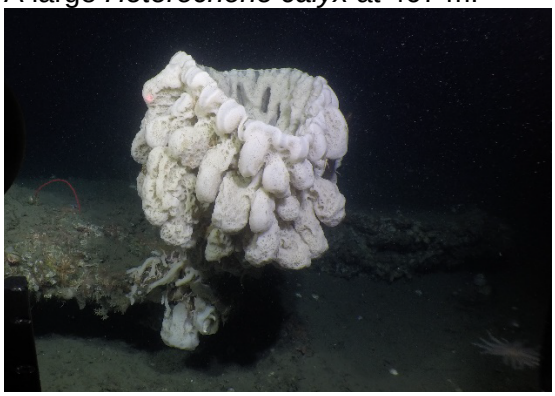
No transects were conducted during a single exploratory dive

Physical data (CTD) are the same as the Sponge Bycatch area (above).

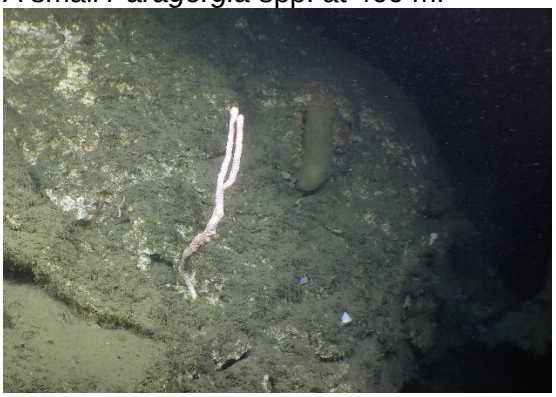
One sponge specimen was collected during Dive 0004 at the Mud Volcano and sent to experts for identification. Shipboard identification was *Polymastia* spp. (one specimen). Verified identification from experts is still pending

## IMAGE GALLERY (Mud Volcano)

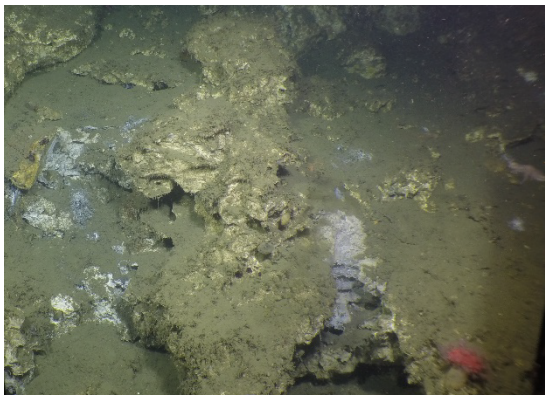
A large *Heterochone calyx* at 467 m.



A small *Paragorgia* spp. at 460 m.



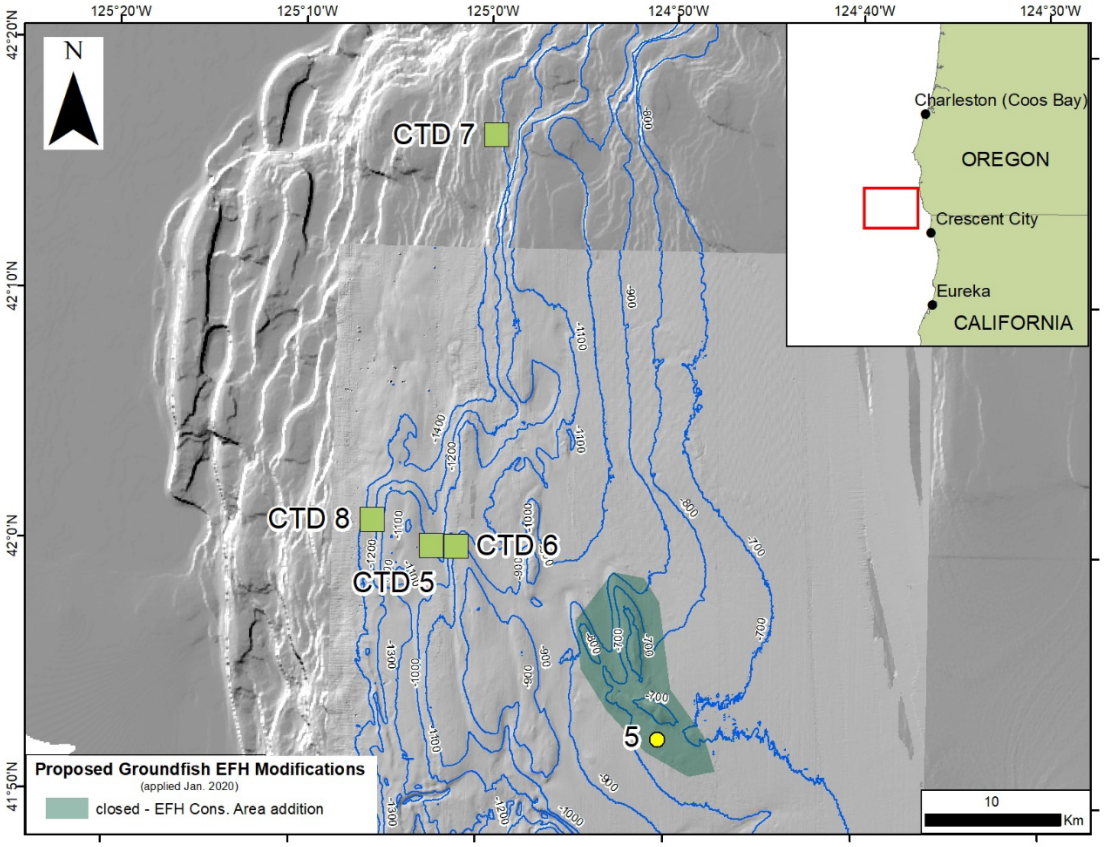
A carbonate reef with numerous bacterial mats and one mushroom coral at 465 m.



A tall barrel sponge at 460 m.

# STUDY AREA: Brush Patch
# DIVE NUMBER: ROV 0005

## GENERAL LOCATION AND DIVE TRACKS




## STATION OVERVIEW (Brush Patch)

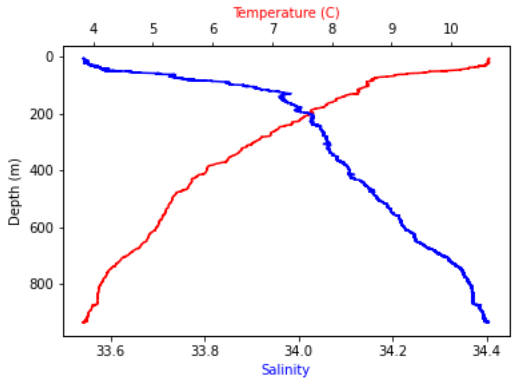
| | |
|---|---|
| **Project** | EXPRESS 2019 |
| **Chief Scientists** | Tom Laidig, Elizabeth Clarke, Chris Caldow |
| **Contact Information** | NMFS, SWFSC, tom.laidig@noaa.gov |
| **Purpose** | Survey deep-sea coral communities along the West Coast |
| **Vessel** | NOAA Ship *Reuben Lasker*; ROV *Yogi* (GFOE) |
| **Science Observers** | Diana Watters, Meredith Everett |
| **Digital Video** | 3.7 hours |
| **Digital Still Photos** | 2,826 images |
| **Positioning System** | Ship: GPS; ROV: USBL |
| **CTD Sensors** | Yes |
| **$O_2$ Sensor (ship CTD only)** | Yes |
| **pH Sensor** | Yes |
| **Specimens collected** | 0 |
| **Water sample** | 4 eDNA; 18 water chemistry |
| **Other** | Logbook, SQL server database |
| **Report Analyst** | Tom Laidig |
| **Date Compiled** | 15 Jun 2022 |

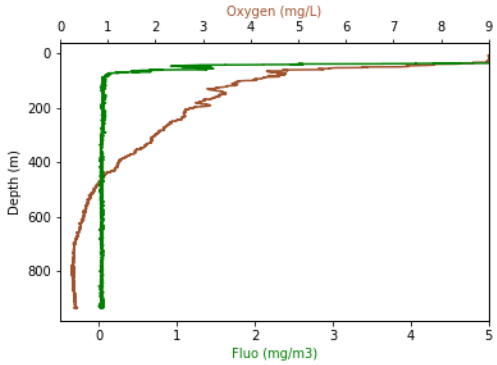
## DIVE DATA (Brush Patch)

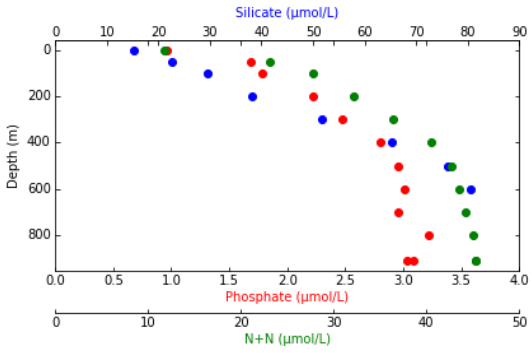
| | | | |
|---|---|---|---|
| Date | 14 Oct 2019 | Starting Latitude (N) | n/a |
| Minimum Bottom Depth (m) | 0 | Starting Longitude (W) | n/a |
| Maximum Bottom Depth (m) | 631 | Ending Latitude (N) | n/a |
| Start Bottom Time (UTC) | 01:57:00 | Ending Longitude (W) | n/a |
| End Bottom Time (UTC) | 04:26:00 | Surface Current | n/a |
| Number 15-min Transects | 0 | Bottom Current | n/a |

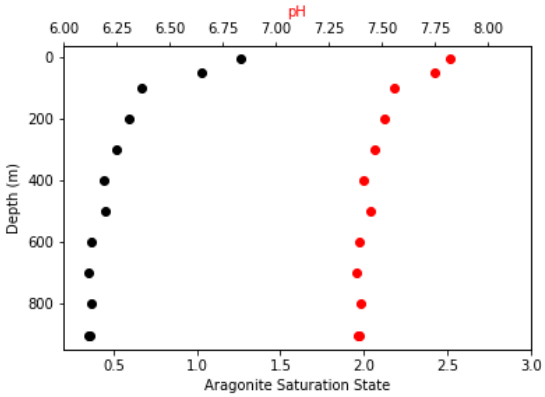
Dive aborted due to water alarm while descending.

A thermocline existed (as measured from the shipboard CTD) from the surface to 100 m and temperature slowly decreased with depth. Salinity increased with depth. Oxygen decreased rapidly until about 100 m, and decreased thereafter, with a slight increase at the deepest depths. Fluorescence decreased to 0 by 100 m. Nutrient load (phosphate, silicate, and nitrate [N+N]) gradually increased with depth. Saturation of pH and aragonite decreased with depth.



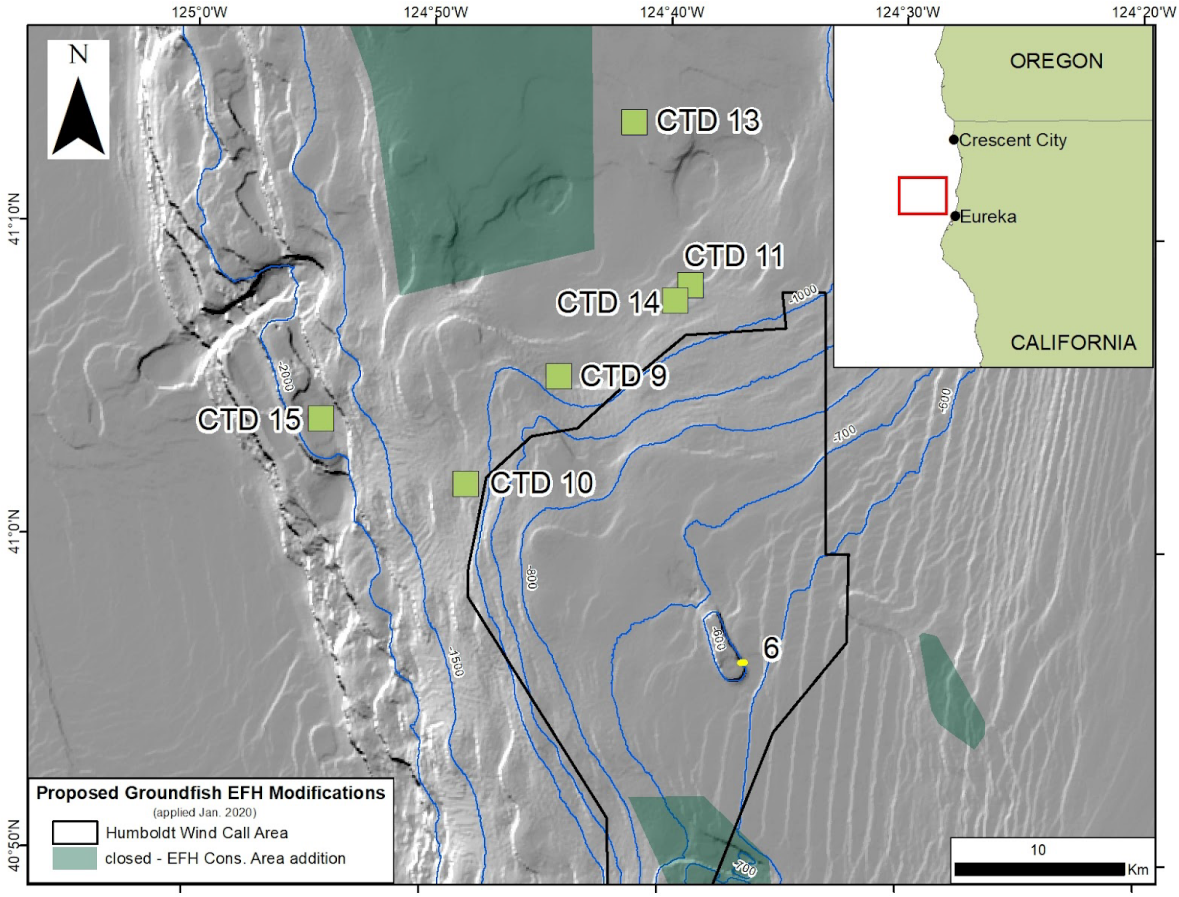



# STUDY AREA: Humboldt Wind Energy
# DIVE NUMBER: ROV 0006

## GENERAL LOCATION AND DIVE TRACKS




## STATION OVERVIEW (Humboldt Wind Energy)

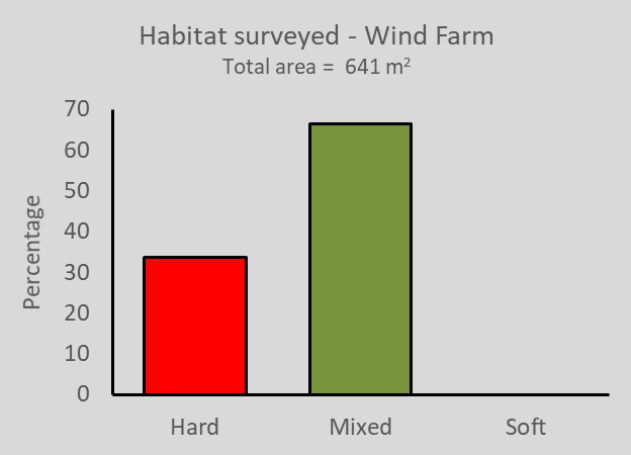
| | |
|---|---|
| **Project** | EXPRESS 2019 |
| **Chief Scientists** | Tom Laidig, Elizabeth Clarke, Chris Caldow |
| **Contact Information** | NMFS, SWFSC, tom.laidig@noaa.gov |
| **Purpose** | Survey deep-sea coral communities along the West Coast |
| **Vessel** | NOAA Ship *Reuben Lasker*; ROV *Yogi* (GFOE) |
| **Science Observers** | Diana Watters, Meredith Everett |
| **Digital Video** | 3.0 hours |
| **Digital Still Photos** | 2,389 images |
| **Positioning System** | Ship: GPS; ROV: USBL |
| **CTD Sensors** | Yes |
| **$O_2$ Sensor (ship CTD only)** | Yes |
| **pH Sensor** | Yes |
| **Specimens collected** | 4 |
| **Water sample** | 7 eDNA; 22 water chemistry |
| **Other** | Logbook, SQL server database |
| **Report Analyst** | Tom Laidig |
| **Date Compiled** | 15 Jun 2022 |

## DIVE DATA (Humboldt Wind Energy)

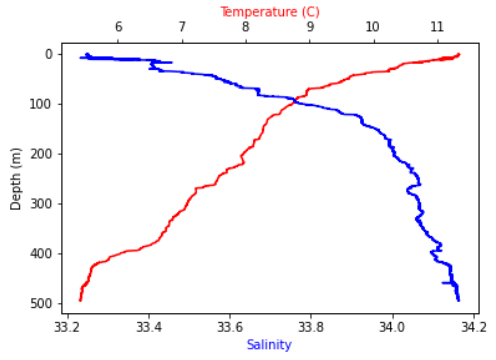
| | | | |
|---|---|---|---|
| Date | 15 Oct 2019 | Starting Latitude (N) | 40° 56.327’ |
| Minimum Bottom Depth (m) | 548 | Starting Longitude (W) | 124° 36.432’ |
| Maximum Bottom Depth (m) | 606 | Ending Latitude (N) | 40° 56.319’ |
| Start Bottom Time (UTC) | 8:45:06 | Ending Longitude (W) | 124° 36.360’ |
| End Bottom Time (UTC) | 10:02:57 | Surface Current | n/a |
| Number 15-min Transects | 1 | Bottom Current | n/a |

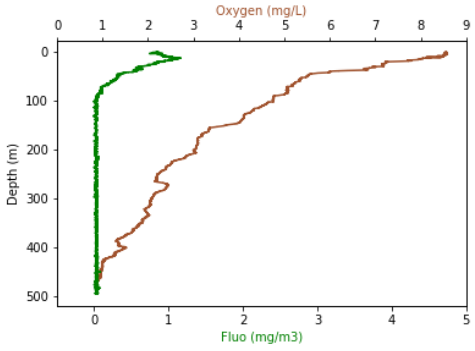
## PHYSICAL ENVIRONMENT (Humboldt Wind Energy)

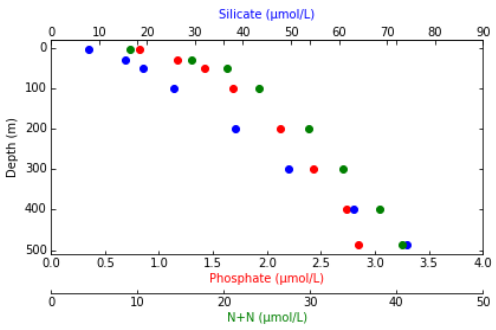
In total, 641 m$^2$ of seafloor were surveyed during one quantitative transect conducted during Dive 0006 at the proposed Humboldt Wind Energy site off northern California. Habitat types were classified as (1) hard (34% of the total area surveyed), which included large boulders, rock outcrops, and cobbles; and (2) mixed (66%), including a combination of mud with boulders and cobbles; while no (3) soft (0%) was observed while on transect.

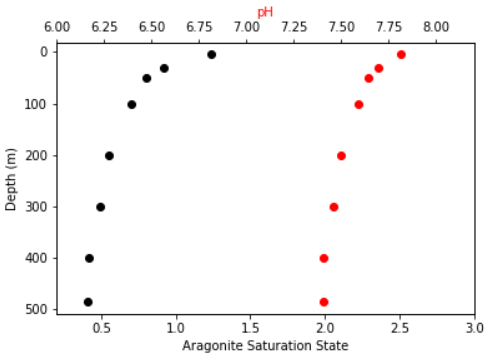



There was no obvious thermocline (as measured from the shipboard CTD); temperature decreased with depth. Salinity increased with depth, but there was no obvious halocline. Oxygen decreased with depth at a relatively fast rate. Fluorescence decreased to 0 by 100 m. Nutrient load (phosphate, silicate, and nitrate [N+N]) gradually increased with depth. Saturation of pH and aragonite saturation decreased with depth.



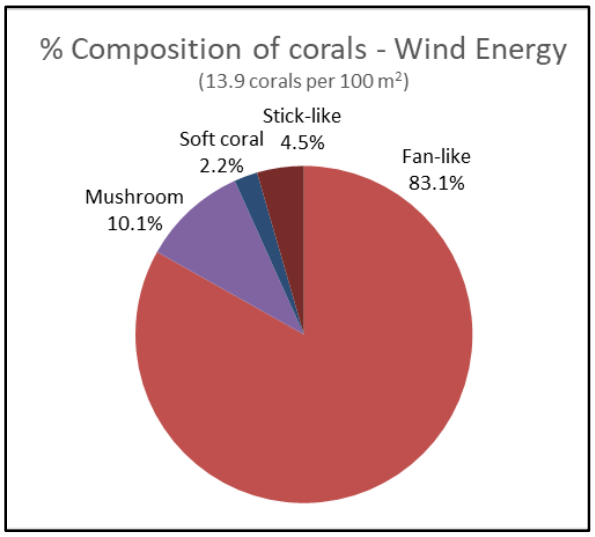



## BIOLOGICAL ENVIRONMENT: CORALS (Humboldt Wind Energy)

A total of 89 individual coral colonies, comprising at least seven taxa, were enumerated from one quantitative transect conducted during Dive 0006 at the proposed Humboldt Wind Energy site off northern California. Coral density was 13.9 corals per 100 $m^2$ of seafloor. Fan-like corals dominated the coral assemblage with 83% of all corals, and the most abundant taxa was *Swiftia pacifica*. Mushroom corals were the next most abundant taxa (10.1%) followed by stick-like corals (4.5%) and soft corals (2.2%).



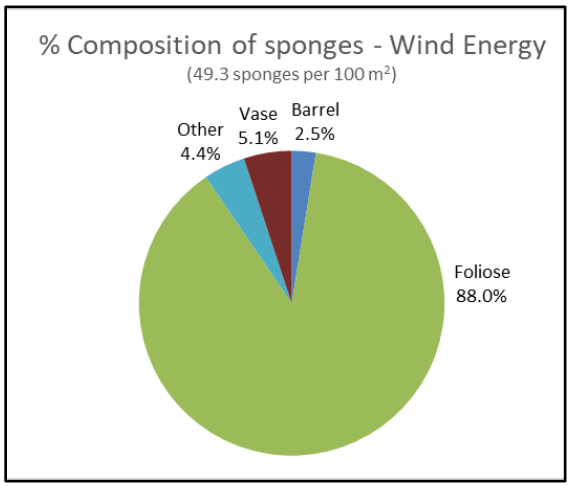

Colors in the pie diagram match colors in the list of coral taxa (below).

| Scientific name | Common name | Number |
|---|---|---|
| *Clavularia* spp. | soft coral | 2 |
| *Heteropolypus ritteri* | mushroom coral | 9 |
| *Paragorgia* spp. | sea fan (white with red polyps) | 19 |
| *Parastenella ramosa* | primnoid | 5 |
| Plexauridae #3 | *Swiftia* type (red w/ unknown polyps) | 4 |
| *Plumarella longispina* | primnoid | 1 |
| *Swiftia pacifica* | sea fan (red with yellow polyps) | 49 |

Three coral specimens were collected during Dive 0006 at the proposed Humboldt Wind Energy site off northern California and sent to experts for identification. Shipboard identifications were *Paragorgia* cf. *yutilinux* (one specimen), *Parastenella* spp. (one specimen), *Swiftia* spp., (possibly *S. torreyi*?; one specimen). DNA barcoding has confirmed identification of the *Parastenella* individual as *Parastenella ramosa.* Additional sequencing of *Paragorgia* and *Swiftia* is ongoing. Additional verified identifications are still pending. Two eDNA samples have been successfully sequenced from this location with analysis ongoing.

## BIOLOGICAL ENVIRONMENT: SPONGES (Humboldt Wind Energy)

A total of 316 individual sponges from at least eight different taxa were enumerated from one quantitative transect conducted during Dive 0006 at the proposed Humboldt Wind Energy site off northern California. An overall density of 49.3 sponges per 100 $m^2$ of seafloor was calculated. Unidentified foliose sponges were the most abundant taxa (88%), with *Polymastia* spp. being the most abundant taxa. Vase sponges (5.1%) were the next most abundant group, followed by other (4.4%) and barrel sponges (2.5%).



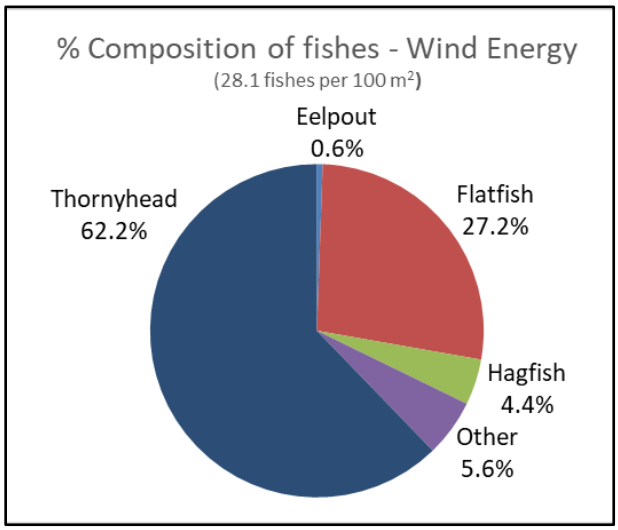

Colors in the pie diagram match colors in the list of sponge taxa (below).

| Scientific name | Common name | Number |
|---|---|---|
| *Asbestopluma* spp. #2 | predatory sponge (clear) | 3 |
| *Farrea occa* | lace (or cloud) foliose sponge | 5 |
| *Heterochone calyx* | fingered goblet vase sponge | 5 |
| *Polymastia* spp. #1 | white nipple foliose sponge | 272 |
| Porifera #1 | unidentified foliose sponges | 1 |
| Porifera #12 | unidentified sponge | 11 |
| Porifera #3 | unidentified barrel sponges | 8 |
| Porifera #5 | unidentified vase sponges | 11 |

One sponge specimen was collected during Dive 0006 at the proposed Humboldt Wind Energy site and sent to experts for identification. Shipboard identification was *Polymastia* spp. (one specimen). DNA barcoding clusters this individual with other known *Polymastia* species. Verified identification from experts is still pending.

## BIOLOGICAL ENVIRONMENT: FISHES (Humboldt Wind Energy)

At least 11 taxa of fishes were identified from one quantitative transect conducted Dive 0006 at the proposed Humboldt Wind Energy site off northern California. A total of 180 individual fishes were enumerated, with an estimated overall density of 28.1 fishes per 100 $m^2$ of seafloor. Thornyheads dominated the fish assemblage (62.2%), followed by flatfishes (27.2%; mostly Dover sole), other fishes (5.6%), hagfishes (4.4%), and eelpouts (0.6%). No poachers or rockfishes were observed at these deeper depths.



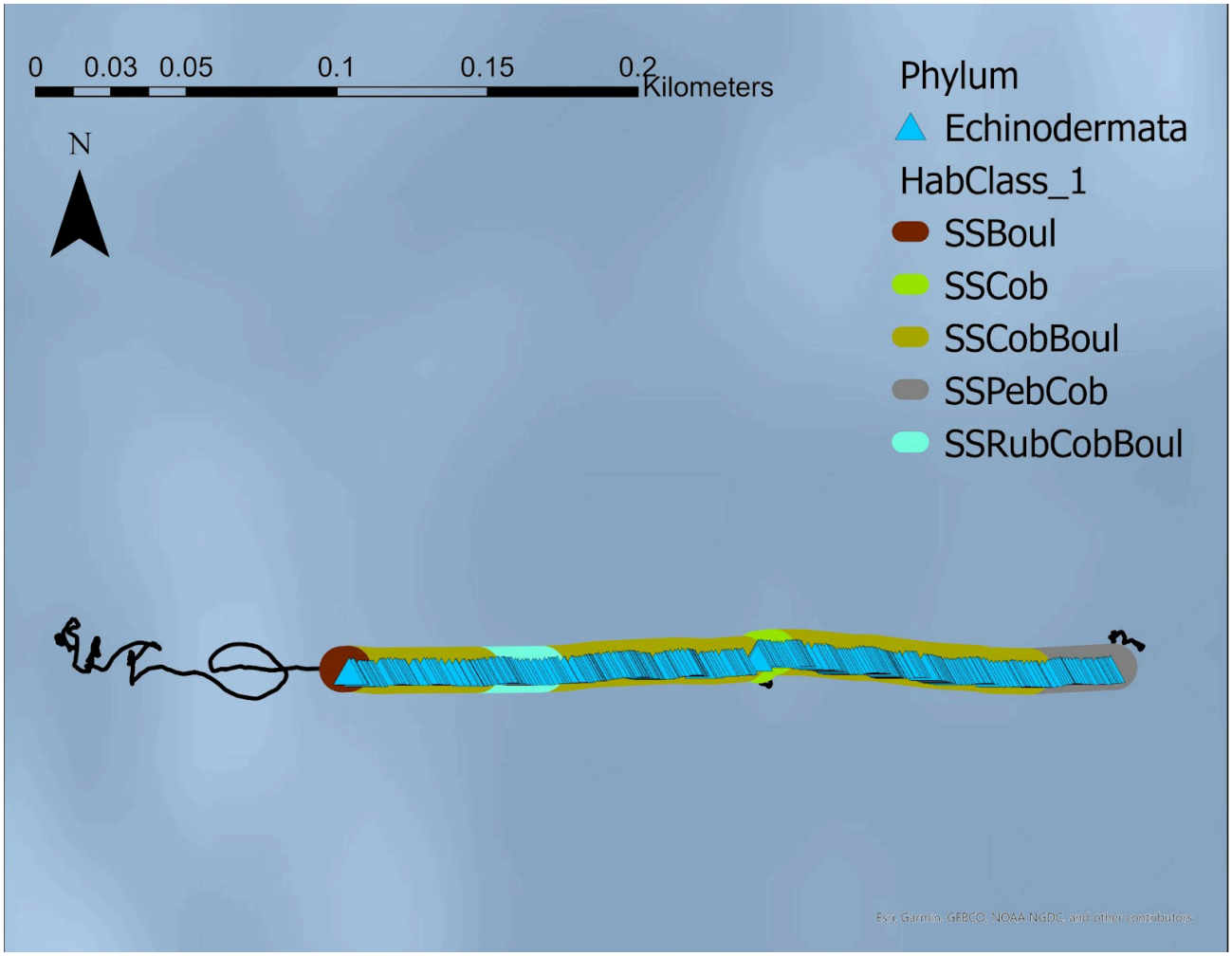

Colors in the pie diagram match colors in the list of fish taxa (below).

Eight percent (31 individuals) of the 405 corals and sponges had a fish association within one body length. White nipple sponges had the most associations (20), followed by *Swiftia pacifica* (7), *Heterochone calyx* (2) and *Paragorgia* spp. (2). Thornyheads (15), Dover sole (14), and hagfishes (2) were the only fish taxa associations.

| Scientific name | Common name | Number |
|---|---|---|
| *Anoplopoma fimbria* | sablefish | 2 |
| *Cataetyx rubrirostris* | rubynose brotula | 6 |
| *Embassichthys bathybius* | deepsea sole | 5 |
| *Eptatretus* spp. | unidentified hagfish | 8 |
| *Microstomus pacificus* | Dover sole | 44 |
| Myctophidae | unidentified lanternfish | 1 |
| Rajiformes egg cases | skate egg cases | 1 |
| *Sebastolobus alascanus* | shortspine thornyhead | 4 |
| *Sebastolobus altivelis* | longspine thornyhead | 9 |
| *Sebastolobus* spp. | unidentified thornyheads | 99 |
| Zoarcidae | unidentified eelpout | 1 |

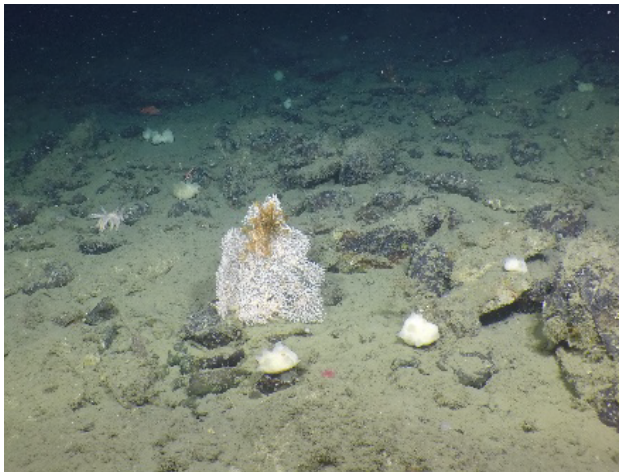
## BIOLOGICAL ENVIRONMENT: OTHER FAUNA (Humboldt Wind Energy)

At least 12 taxa of fauna other than DSCS and fishes were identified from one quantitative transect conducted during Dive 0006 in Humboldt Wind Energy site off northern California. The dominant phylum was Echinodermata (mostly ophiuroids [519 individuals] and sea stars [166]). The map below shows habitat classification and dominant phyla for each transect. Habitat classifications include soft sediment (SS), boulders (Boul), cobbles (Cob), pebbles (Peb), and rubble (Rub). No chemosynthetic features were documented during the dive.

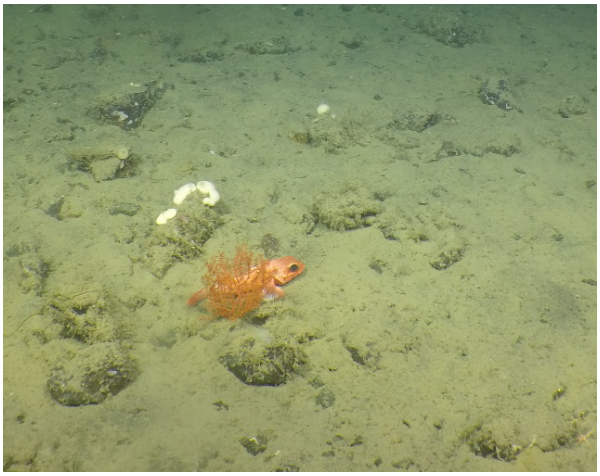


## IMAGE GALLERY (Humboldt Wind Energy)

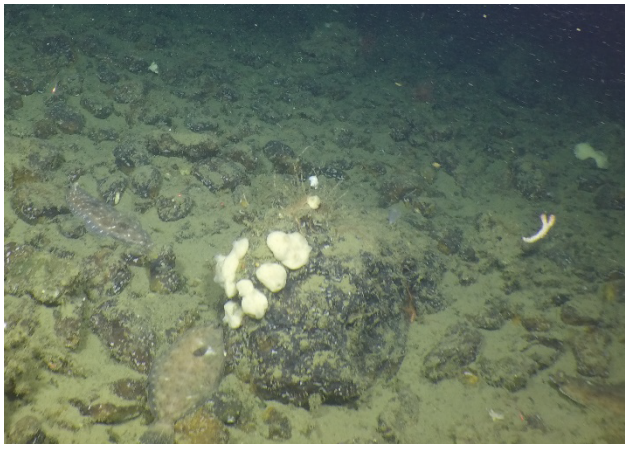
A *Parastenella* spp. and many *Polymastia* spp. sponges on a cobble and boulder seafloor at 552 m.



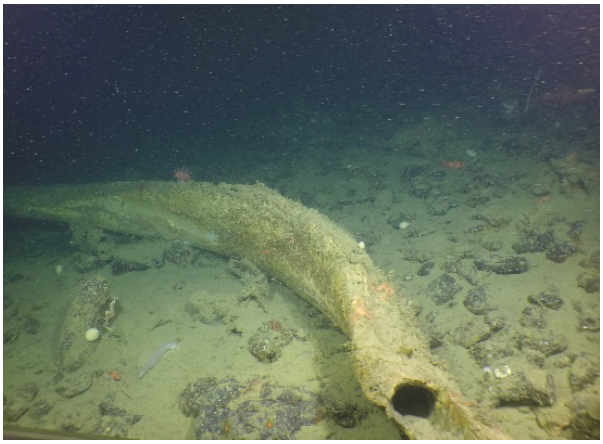
A thornyhead hiding behind a *Swiftia pacifica* at 600 m.



Two Dover sole and a group of sponges on a boulder at 565 m.



A whale bone (presumably a jaw bone) with a lone mushroom coral at 574 m.



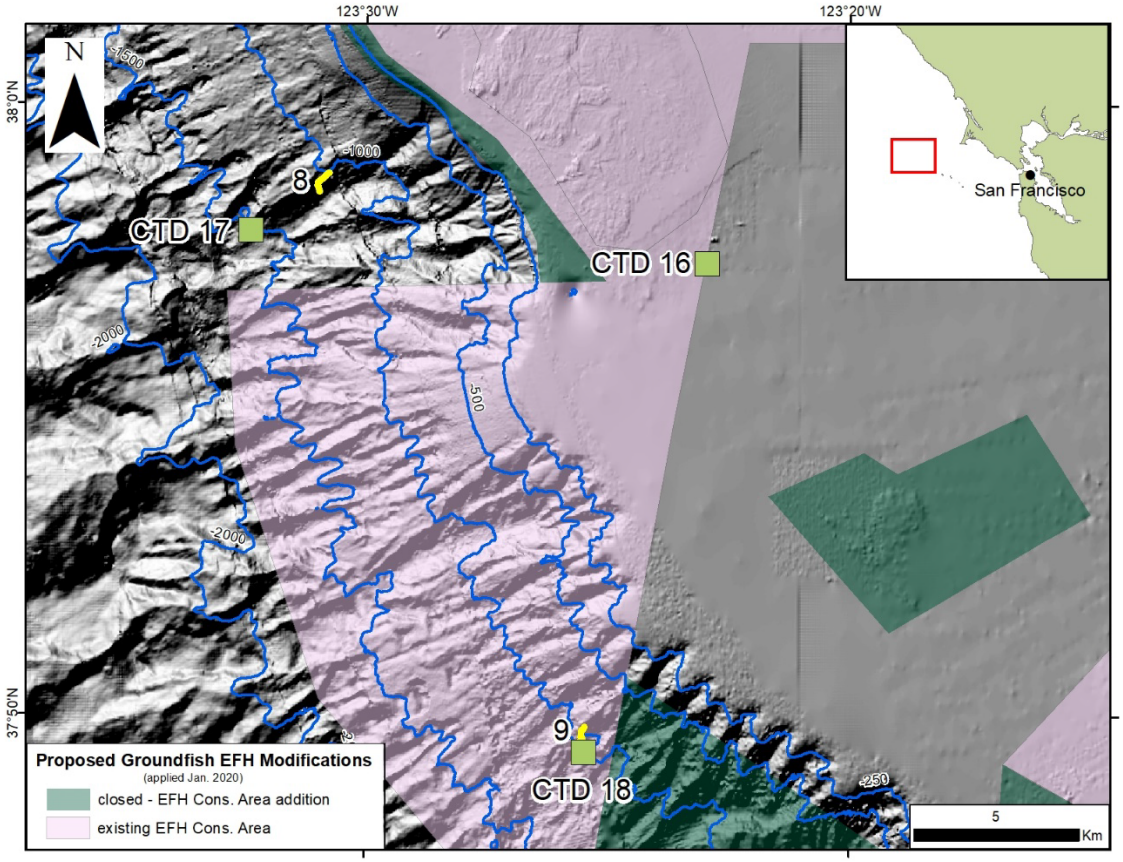
## ADDITIONAL COMMENTS (Humboldt Wind Energy)

No anthropogenic debris items were documented during dives at the proposed Humboldt Wind Energy site.

No corals or sponges were damaged or knocked over. Fifteen percent of corals (13 *Swiftia pacifica*) and 4% of sponges (13 individuals mostly *Polymastia* spp.) were dying. Five percent of corals (three *Swiftia pacifica* and one *Paragorgia* sp.) and 6% of sponges (19 individuals, mostly unidentified sponges) were dead.

# STUDY AREA: Cordell Bank
# DIVE NUMBER: ROV 0007-0009

## GENERAL LOCATION AND DIVE TRACKS




## STATION OVERVIEW (Cordell Bank)

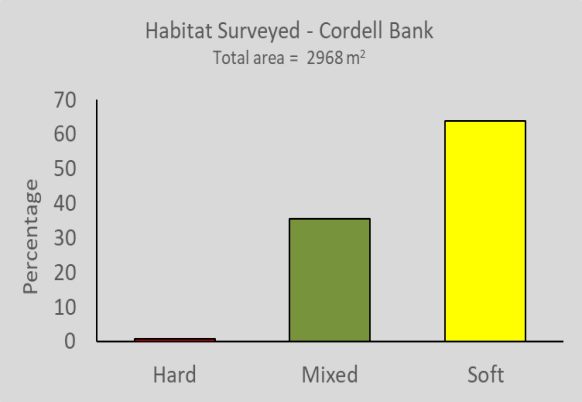
| | |
|---|---|
| **Project** | EXPRESS 2019 |
| **Chief Scientists** | Tom Laidig, Elizabeth Clarke, Chris Caldow |
| **Contact Information** | NMFS, SWFSC, tom.laidig@noaa.gov |
| **Purpose** | Survey deep-sea coral communities along the West Coast |
| **Vessel** | NOAA Ship *Reuben Lasker*; ROV *Yogi* (GFOE) |
| **Science Observers** | Tom Laidig, Meredith Everett, Craig Stuart |
| **Digital Video** | 15.3 hours |
| **Digital Still Photos** | 11,496 images |
| **Positioning System** | Ship: GPS; ROV: USBL |
| **CTD Sensors** | Yes |
| **$O_2$ Sensor (ship CTD only)** | Yes |
| **pH Sensor** | Yes |
| **Specimens collected** | 9 |
| **Water sample** | 4 eDNA; 35 water chemistry |
| **Other** | Logbook, SQL server database |
| **Report Analyst** | Tom Laidig |
| **Date Compiled** | 15 Jun 2022 |

## DIVE DATA (Cordell Bank)

| | | | |
|---|---|---|---|
| Date | 23-25 Oct 2019 | Starting Latitude (N) | 37° 57.659’ |
| Minimum Bottom Depth (m) | 854 | Starting Longitude (W) | 123° 32.002’ |
| Maximum Bottom Depth (m) | 1,261 | Ending Latitude (N) | 37° 49.764’ |
| Start Bottom Time (UTC) | 3:26:47 | Ending Longitude (W) | 123° 25.512’ |
| End Bottom Time (UTC) | 5:53:18 | Surface Current | n/a |
| Number 15-min Transects | 5 | Bottom Current | n/a |

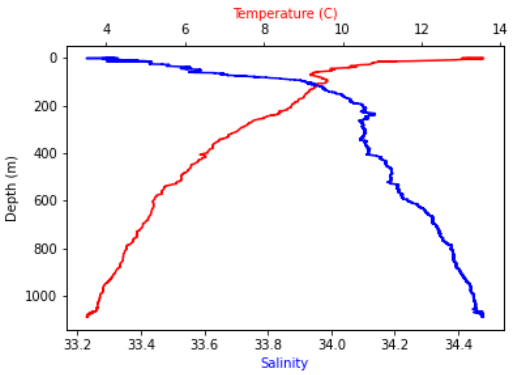
## PHYSICAL ENVIRONMENT (Cordell Bank)

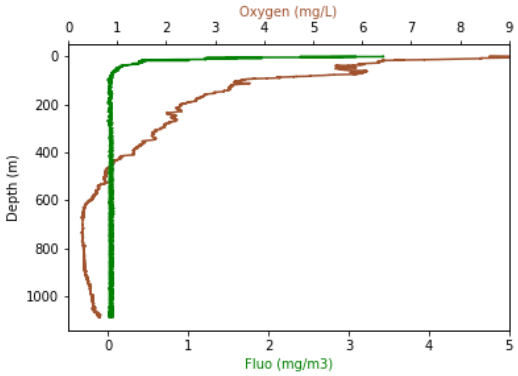
In total, 2,968 $m^2$ of seafloor were surveyed during five quantitative transects conducted during Dives 0008-0009 within Cordell Bank National Marine Sanctuary off central California. Habitat types were classified as (1) hard (1% of the total area surveyed), which was consisted entirely of rock outcrops of various sizes; (2) mixed (35%), including a combination of mud with rock outcrops; and (3) soft (64%) which consisted entirely of mud.

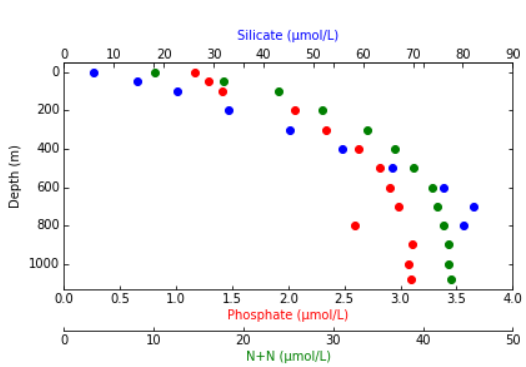


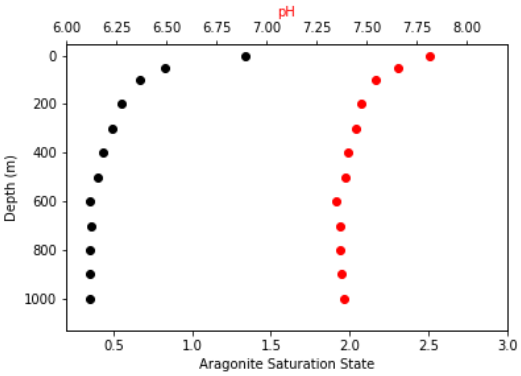

Dive 0007 was a test dive for Guru and no data were recorded.

There was a thermocline (as measured from the shipboard CTD) over the first 50 m and thereafter temperature decreased more slowly with depth. Salinity increased quickly until ~200 m and slowed thereafter. Oxygen decreased with depth with a minimum zone occurring between 600 – 900 m. Fluorescence decreased to 0 around 100 m. Nutrient load (phosphate, silicate, and nitrate [N+N]) gradually increased with depth. Saturation of pH and aragonite decreased with depth.



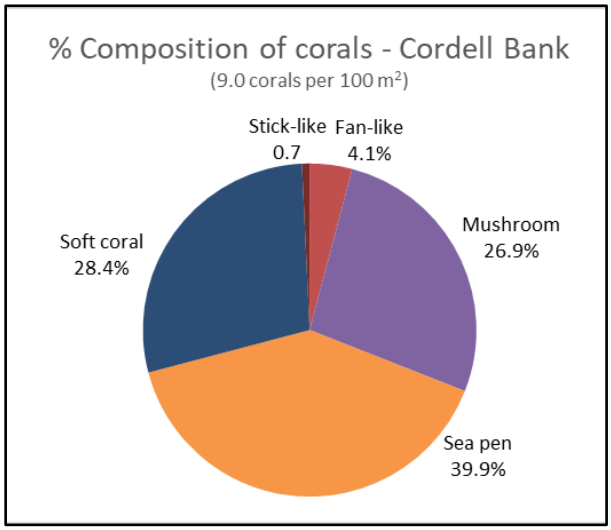



## BIOLOGICAL ENVIRONMENT: CORALS (Cordell Bank)

A total of 268 individual coral colonies, comprising at least 10 taxa, were enumerated from five quantitative transects conducted during Dives 0008-0009 within Cordell Bank National Marine Sanctuary off central California. Overall coral density was 9.0 corals per 100 $m^2$ of seafloor. Sea pens dominated the coral assemblage (39.9% of all corals). Soft corals (*Gersemia* spp. 28.4%) and mushroom corals (26.9%) were also abundant.



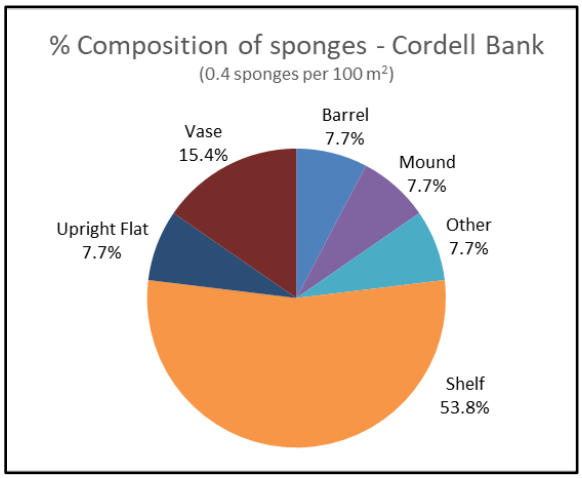

Colors in the pie diagram match colors in the list of coral taxa (below).

| Scientific name | Common name | Number |
|---|---|---|
| *Bathypathes* spp. | black coral | 7 |
| *Funiculina* spp. | unidentified sea pen | 8 |
| *Gersemia* spp. | soft coral | 76 |
| *Halipteris californica* | sea pen | 2 |
| *Heteropolypus ritteri* | mushroom coral | 72 |
| Pennatulacea #1 | sea pen (thin) | 82 |
| Pennatulidae | sea pen (thick) | 1 |
| Plexauridae #3 | *Swiftia* type (red w/ unknown polyps) | 2 |
| *Swiftia pacifica* | sea fan (red with yellow polyps) | 4 |
| *Umbellula lindahli* | droopy sea pen | 14 |

Five coral specimens were collected during Dives 0008-0009 Cordell Bank National Marine Sanctuary and sent to experts for identification. Shipboard identifications were *Gersemia* cf. *juliepackardae* (one specimen), two unknown sea pens (possibly *Kophobelemnon*; two specimens), *Alternatipathes* or *Heteropathes* (one specimen), and *Swiftia* spp., (possibly *S. torreyi*; one specimen). Identification of *G. juliepackardae* has been verified by Dr. Gary Williams at California Academy of Sciences, where the specimen has been archived. All three octocoral specimens have been successfully DNA barcoded. DNA barcoding identified the *Swiftia* sp. individual as *Swiftia kofoidi,* and the sea pens as *Funiculina quadrangularis* and *Umbellula sp*. Additional verified identifications are still pending. Several eDNA samples were successfully sequenced from this location, with analysis ongoing.

## BIOLOGICAL ENVIRONMENT: SPONGES (Cordell Bank)

A total of 13 individual sponges from at least seven different taxa were enumerated from five quantitative transects conducted during Dives 0008-0009 within Cordell Bank National Marine Sanctuary off central California. An overall density of 0.4 sponges per 100 $m^2$ of seafloor was calculated. The most abundant taxon was shelf sponges accounting for over half of all sponges (54%). The remaining groups had only one or two individuals.



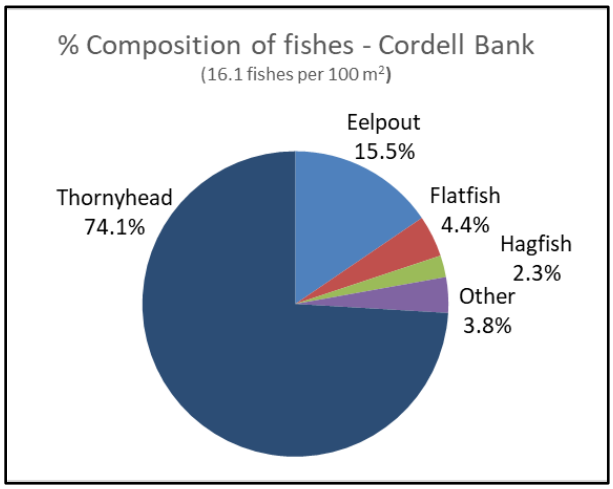

Colors in the pie diagram match colors in the list of sponge taxa (below).

| Scientific name | Common name | Number |
|---|---|---|
| *Poecillastra* spp. | fringed shelf sponge | 4 |
| Porifera #12 | unidentified sponge | 1 |
| Porifera #2 | unidentified upright flat sponges | 1 |
| Porifera #3 | unidentified barrel sponges | 1 |
| Porifera #4 | unidentified shelf sponges | 3 |
| Porifera #5 | unidentified vase sponges | 2 |
| Porifera #9 | unidentified puffball mound sponge | 1 |

Four sponge specimens were collected during Dive 0008-0009 at Cordell Bank National Marine Sanctuary and sent to experts for identification. Shipboard identifications were *Asbestopluma* spp. (one specimen), *Farrea* spp. (one specimen), a white vase sponge (one specimen), and globular sponge (one specimen). DNA barcodes have been successfully obtained for the sponges collected at this location, verifying identification of *Farrea* and *Asbestopluma* with additional analysis and identification ongoing. Verified identification from experts is still pending.

## BIOLOGICAL ENVIRONMENT: FISHES (Cordell Bank)

At least 16 taxa of fishes were identified from five quantitative transects conducted during Dives 0008-0009 within Cordell Bank National Marine Sanctuary off central California. A total of 478 individual fishes were enumerated, with an estimated overall density of 16.1 fishes per 100 $m^2$ of seafloor. Thornyheads dominated the fish assemblage (74.1%) followed by eelpouts (15.5%; mostly snakehead eelpouts), flatfishes (4.4%), other fishes (3.8%), and hagfishes (2.3%).



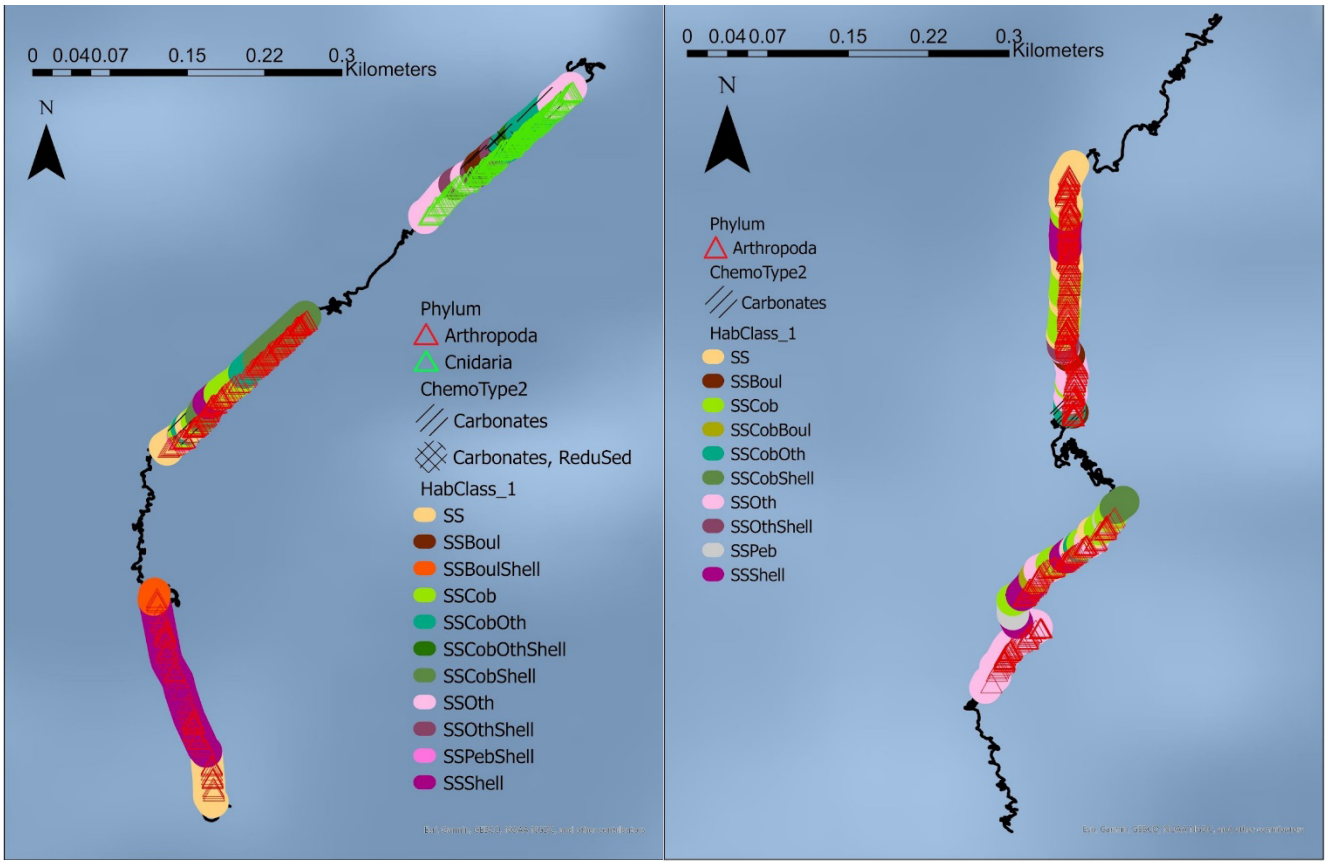

Colors in the pie diagram match colors in the list of fish taxa (below).

Nineteen of the 268 corals (7%) had a fish association (no sponges had associations). *Gersemia* spp. (6) had the most associations followed by thin sea pens (5), mushroom corals (4), *Bathypathes* spp. (3), and *Swiftia pacifica* (1). The most common fish taxa associated with the corals were thornyheads (12). Four roughtail skates, two hagfishes, and one Dover sole were also found within one body length of a coral.

| Scientific name | Common name | Number |
|---|---|---|
| *Alepocephalus tenebrosus* | California slickhead | 1 |
| *Anoplopoma fimbria* | sablefish | 1 |
| *Antimora microlepis* | Pacific flatnose | 3 |
| *Bathyraja trachura* | roughtail skate | 3 |
| *Cataetyx rubrirostris* | rubynose brotula | 1 |
| *Embassichthys bathybius* | deepsea sole | 11 |
| *Eptatretus* spp. | unidentified hagfish | 11 |
| Liparididae | unidentified snailfish | 2 |
| *Lycenchelys crotalinus* | snakehead eelpout | 40 |
| *Lycodes cortezianus* | bigfin eelpout | 2 |
| Macrouridae | unidentified grenadier | 6 |
| *Microstomus pacificus* | Dover sole | 10 |
| Myctophidae | unidentified lanternfish | 1 |
| *Sebastolobus alascanus* | shortspine thornyhead | 1 |
| *Sebastolobus altivelis* | longspine thornyhead | 45 |
| *Sebastolobus* spp. | unidentified thornyheads | 308 |
| Zoarcidae | unidentified eelpout | 32 |

## BIOLOGICAL ENVIRONMENT: OTHER FAUNA (Cordell Bank)

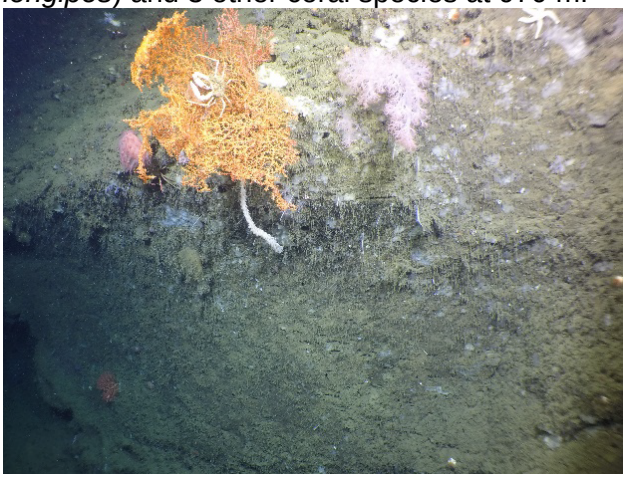
At least 24 taxa of fauna other than DSCS and fishes were identified from five quantitative transects conducted during Dives 0008-0009 within Cordell Bank National Marine Sanctuary off central California. The dominant phyla were Arthropoda (mostly shrimp) and Cnidaria (mostly anemones). The map below shows habitat classification and dominant phyla for each transect. Habitat classifications include soft sediment (SS), boulders (Boul), cobbles (Cob), pebbles (Peb), rubble (Rub), clam shells (Shell), and other less common substrates (OTH). The other classification includes detritus, crevices, ledges, and trash. Chemosynthetic features were overlaid on the habitat classification and include carbonates and reduced sediments (ReduSed).



## IMAGE GALLERY (Cordell Bank)

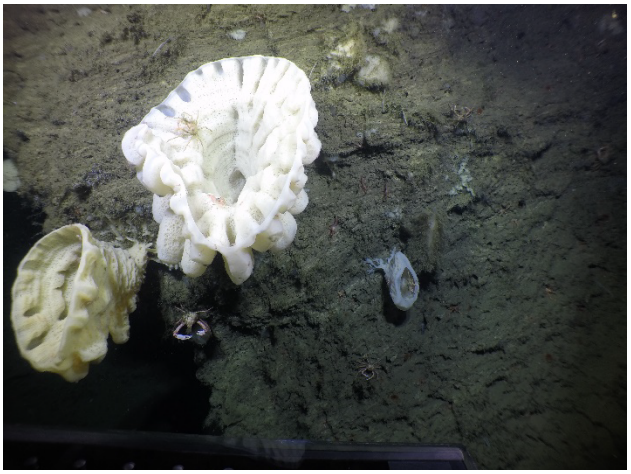
A tanner crab and a soft coral (*Gersemia* spp.) on a consolidated mud seafloor at 980 m.

A large *Swiftia pacifica* (with a crab, *Chorilia longipes*) and 3 other coral species at 970 m.



A sea pen (*Funiculina* cf*. quadrangularis*) at 1,015 m on a mud seafloor.

Sponges and crabs on a wall at 860 m.



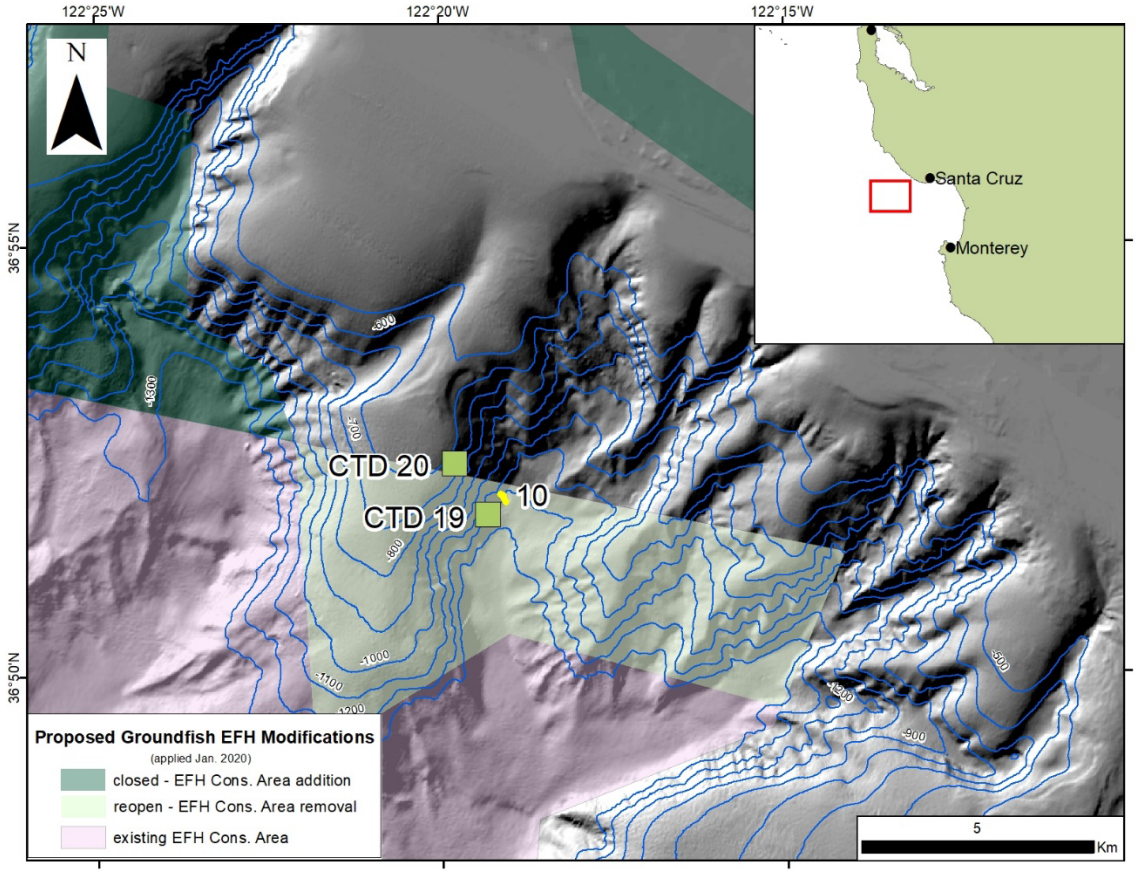
## ADDITIONAL COMMENTS (Cordell Bank)

One anthropogenic debris item was documented during dives at Cordell Bank NMS. The singular item was a gray PVC tube or pipe. It was located on a muddy seafloor but had anemones and other growth on it and was partially covered in sediment. Damage potentially caused by this item was not observed.

No corals or sponges were damaged and only two sea pens and no sponges were knocked over. Only one coral (*Bathypathes* spp.) was dying and only 1% of corals (one *Swiftia pacifica* and one Plexauridae #3) were dead, while 69% of sponges were dead or dying (9 out 14 sponges, mostly *Poecillastra* spp. and shelf sponges)

# STUDY AREA: Cabrillo Canyon
# DIVE NUMBER: ROV 0010

## GENERAL LOCATION AND DIVE TRACKS




## STATION OVERVIEW (Cabrillo Canyon)

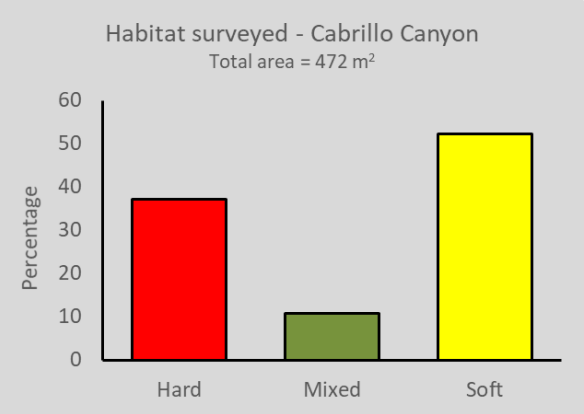
| | |
|---|---|
| **Project** | EXPRESS 2019 |
| **Chief Scientists** | Tom Laidig, Elizabeth Clarke, Chris Caldow |
| **Contact Information** | NMFS, SWFSC, tom.laidig@noaa.gov |
| **Purpose** | Survey deep-sea coral communities along the West Coast |
| **Vessel** | NOAA Ship *Reuben Lasker*; ROV *Yogi* (GFOE) |
| **Science Observers** | Tom Laidig, Meredith Everett, Craig Stuart |
| **Digital Video** | 5.3 hours |
| **Digital Still Photos** | 4,112 images |
| **Positioning System** | Ship: GPS; ROV: USBL |
| **CTD Sensors** | Yes |
| **$O_2$ Sensor (ship CTD only)** | Yes |
| **pH Sensor** | Yes |
| **Specimens collected** | 5 |
| **Water sample** | 2 eDNA; 14 water chemistry |
| **Other** | Logbook, SQL server database |
| **Report Analyst** | Tom Laidig |
| **Date Compiled** | 15 Jun 2022 |

## DIVE DATA (Cabrillo Canyon)

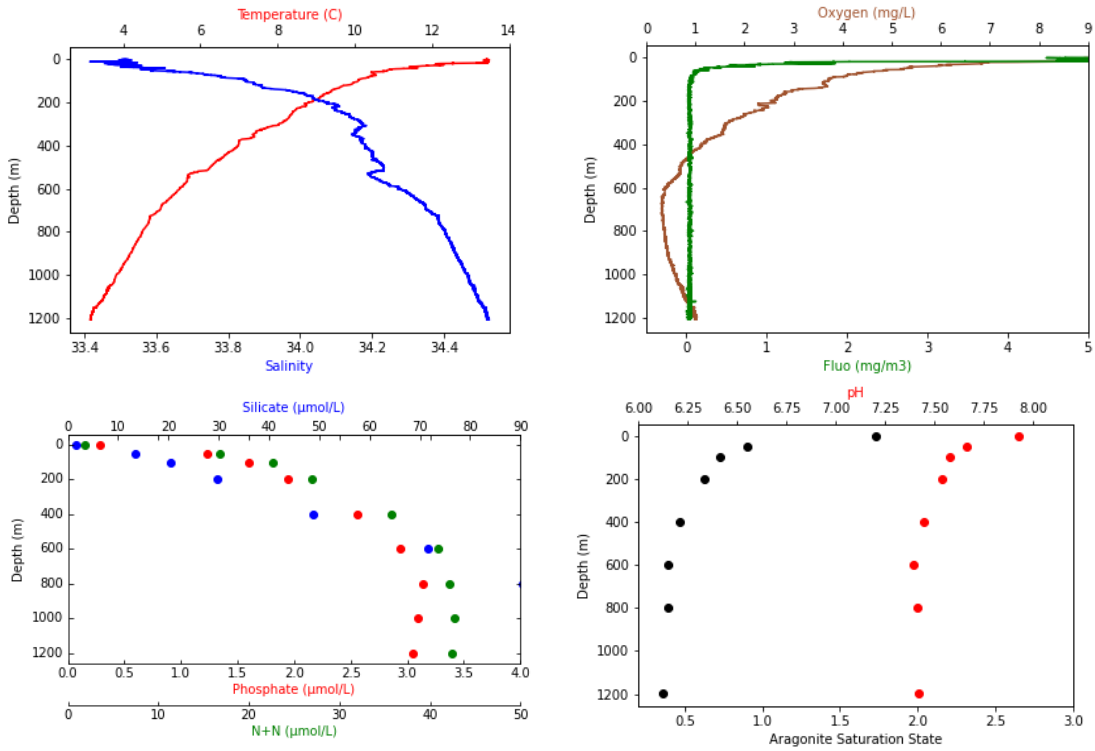
| | | | |
|---|---|---|---|
| Date | 27 Oct 2019 | Starting Latitude (N) | 36° 52.010’ |
| Minimum Bottom Depth (m) | 1,162 | Starting Longitude (W) | 122° 19.073’ |
| Maximum Bottom Depth (m) | 1,246 | Ending Latitude (N) | 36° 52.105’ |
| Start Bottom Time (UTC) | 5:41:20 | Ending Longitude (W) | 122° 19.144’ |
| End Bottom Time (UTC) | 7:59:18 | Surface Current | n/a |
| Number 15-min Transects | 1 | Bottom Current | n/a |

## PHYSICAL ENVIRONMENT (Cabrillo Canyon)

In total, 472 $m^2$ of seafloor were surveyed during one quantitative transect conducted during Dive 0010 in Cabrillo Canyon off central California. Habitat types were classified as (1) hard (37% of the total area surveyed), which consisted entirely of rock outcrops of various sizes; (2) mixed (11%), including a combination of mud with rock outcrops; and (3) soft (52%) which consisted entirely of mud.

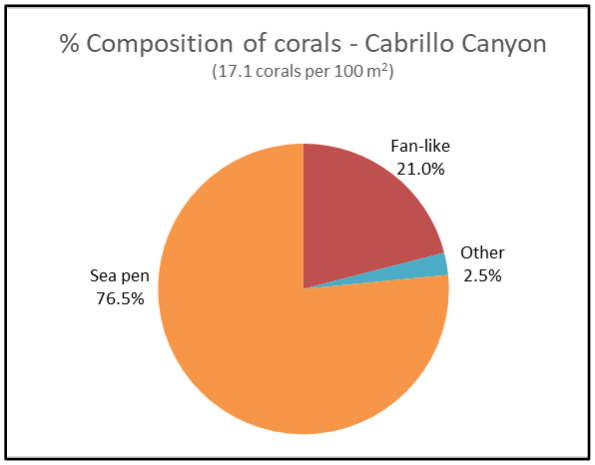



There was no thermocline (as measured from the shipboard CTD) and temperature decreased slowly with depth. Salinity increased quickly until ~200 m and slowed thereafter. Oxygen decreased with depth with a minimum zone occurring between 600-900 m. Fluorescence decreased to 0 around 100 m. Nutrient load (phosphate, silicate, and nitrate [N+N]) gradually increased with depth until about 800 m where it remained constant. Saturation of pH and aragonite saturation decreased with depth until 600 m, where it remained constant.



## BIOLOGICAL ENVIRONMENT: CORALS (Cabrillo Canyon)

A total of 81 individual coral colonies, comprising at least six taxa, were enumerated from one quantitative transect conducted during Dive 0010 at Cabrillo Canyon off central California. Overall coral density was 17.1 corals per 100 $m^2$ of seafloor. Sea pens dominated the coral assemblage (76.5% of all corals). Fan-like corals (21%) and other corals (2.5%) were also abundant.



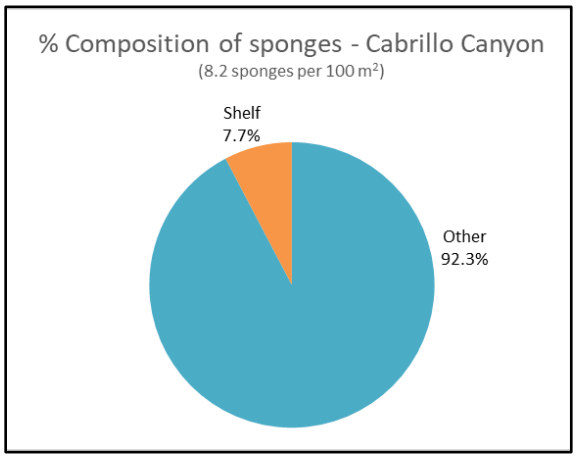

Colors in the pie diagram match colors in the list of coral taxa (below).

| Scientific name | Common name | Number |
|---|---|---|
| *Acanthogorgia* spp. | gold coral | 1 |
| Alcyonacea | unidentified sea fan | 1 |
| Hexacorallia/Octocorallia | unidentified coral | 2 |
| *Parastenella ramosa* | primnoid | 10 |
| Pennatulacea #1 | sea pen (thin) | 62 |
| *Swiftia pacifica* | sea fan (red with yellow polyps) | 5 |

Three coral specimens were collected during Dive 0010 at Cabrillo Canyon and sent to experts for identification. Shipboard identifications were a pink plexaurid (one specimen), an unknown gorgonian (one specimen), and a dead bamboo coral (one specimen). DNA barcoding identified the pink plexaurid as *Swiftia kofoidi*. Additional DNA barcoding is ongoing and verified identifications are still pending. Three eDNA samples from this location were successfully sequenced for octocorals with analysis ongoing.

## BIOLOGICAL ENVIRONMENT: SPONGES (Cabrillo Canyon)

A total of 39 individual sponges from at least three different taxa were enumerated from one quantitative transect conducted during Dive 0010 in Cabrillo Canyon off central California. An overall density of 8.2 sponges per 100 $m^2$ of seafloor was calculated. The most abundant taxon was other sponges accounting for 92% of all sponges. These were mostly the predatory pipecleaner sponge, *Asbestopluma* spp. #1. The only other group were unidentified shelf sponges (8%).



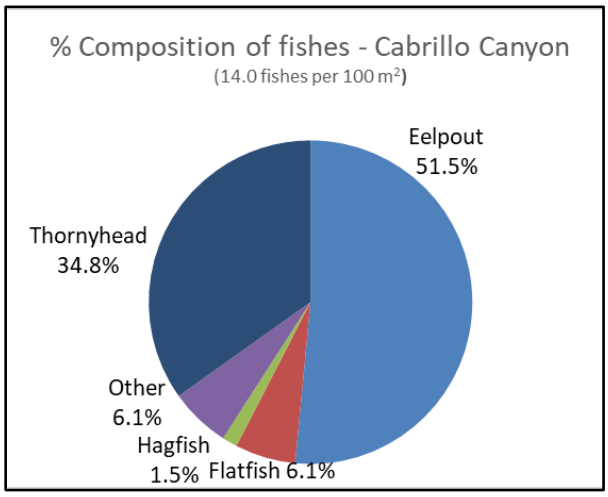

Colors in the pie diagram match colors in the list of sponge taxa (below).

| Scientific name | Common name | Number |
|---|---|---|
| *Asbestopluma* spp. #1 | predatory pipecleaner sponge | 30 |
| Porifera #12 | unidentified sponge | 6 |
| Porifera #4 | unidentified shelf sponges | 3 |

Two sponge specimens were collected during Dive 0010 in Cabrillo Canyon and sent to experts for identification. Shipboard identifications were a branched *Asbestopluma* spp. (one specimen) and a tube sponge (one specimen). DNA barcodes have been successfully sequenced from both sponge specimens. Verified identification from experts is still pending.

## BIOLOGICAL ENVIRONMENT: FISHES (Cabrillo Canyon)

At least 10 taxa of fishes were identified from one quantitative transect conducted during Dive 0010 in Cabrillo Canyon off central California. A total of 66 individual fishes were enumerated, with an estimated overall density of 14.0 fishes per 100 $m^2$ of seafloor. Eelpouts (51.5%; mostly snakehead eelpouts) and thornyheads (34.8%) accounted for >85% of all fishes. The remainder of the fish assemblage included other (6.1%), flatfishes (6.1%), and hagfishes (1.5%). A blob sculpin was observed in Cabrillo Canyon and was the only one observed on transect during the entire cruise.



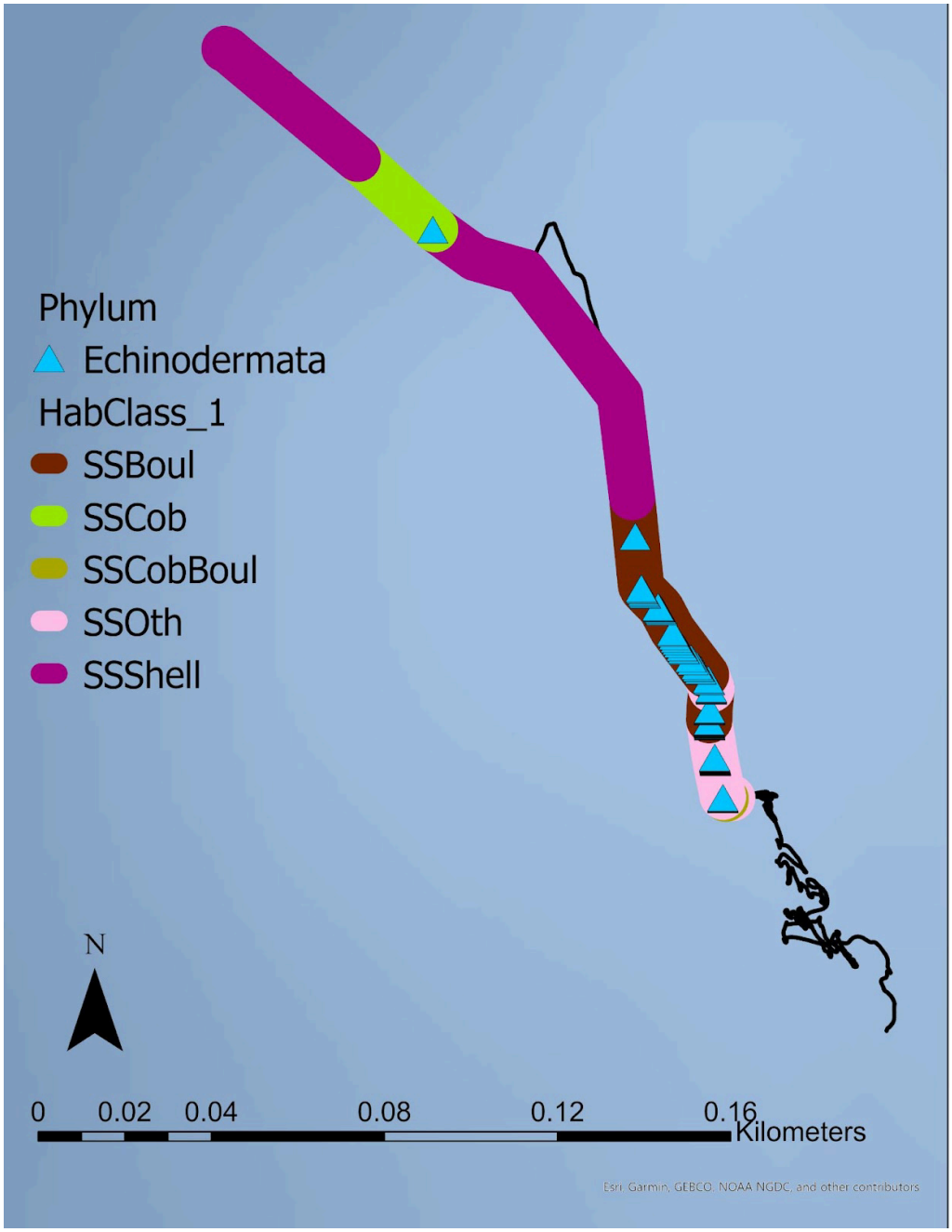

Colors in the pie diagram match colors in the list of fish taxa (below).

Only one thin sea pen had an association (1% of all corals and sponges). This association was with a 35 cm Dover sole.

| Scientific name | Common name | Number |
|---|---|---|
| *Bathyraja trachura* | roughtail skate | 1 |
| *Embassichthys bathybius* | deepsea sole | 1 |
| *Eptatretus* spp. | unidentified hagfish | 1 |
| *Lycenchelys crotalinus* | snakehead eelpout | 33 |
| Macrouridae | unidentified grenadier | 2 |
| *Microstomus pacificus* | Dover sole | 3 |
| *Psychrolutes phrictus* | blob sculpin | 1 |
| *Sebastolobus altivelis* | longspine thornyhead | 10 |
| *Sebastolobus* spp. | unidentified thornyheads | 13 |
| Zoarcidae | unidentified eelpout | 1 |

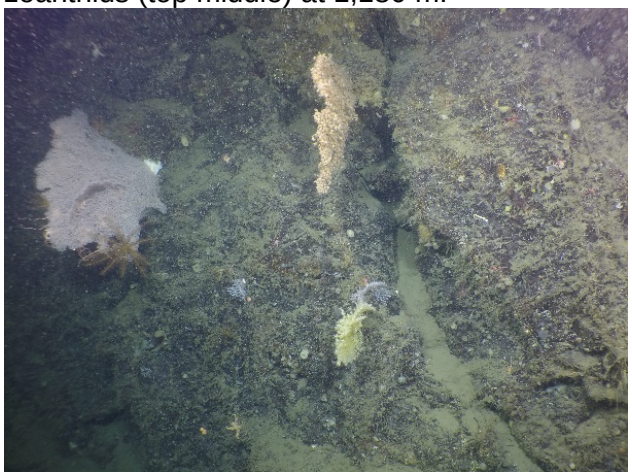
## BIOLOGICAL ENVIRONMENT: OTHER FAUNA (Cabrillo Canyon)

At least 15 taxa of fauna other than DSCS and fishes were identified from one quantitative transect conducted during Dive 0010 at Cabrillo Canyon off central California. The dominant phylum was Echinodermata (mostly Asteroidea sea stars and ophiuroids). The map below shows habitat classification and dominant phyla for each transect. Habitat classifications include soft sediment (SS), boulders (Boul), cobbles (Cob), clam shells (Shell), and other less common substrates (OTH). The other classification includes detritus, ridges, ledges, and trash. No chemosynthetic features were documented during this dive.

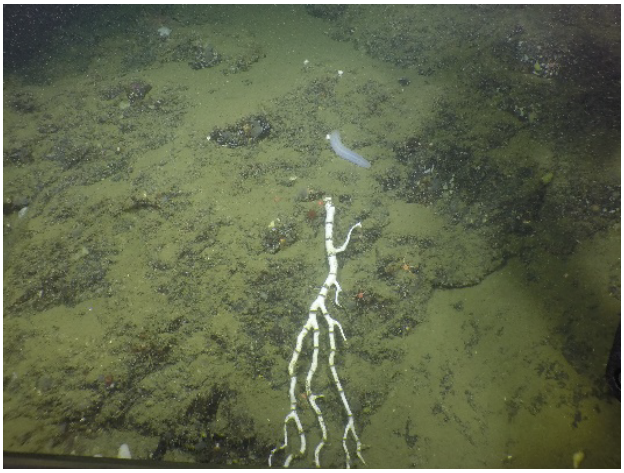


## IMAGE GALLERY (Cabrillo Canyon)

Multiple live corals and one dead covered in zoanthids (top middle) at 1,180 m.



A dead bamboo coral skeleton at 1,224 m.



A blob sculpin perched on a rocky slope at 1,220 m.

Two *Parastenella ramosa* on a rock wall at 1,215 m.

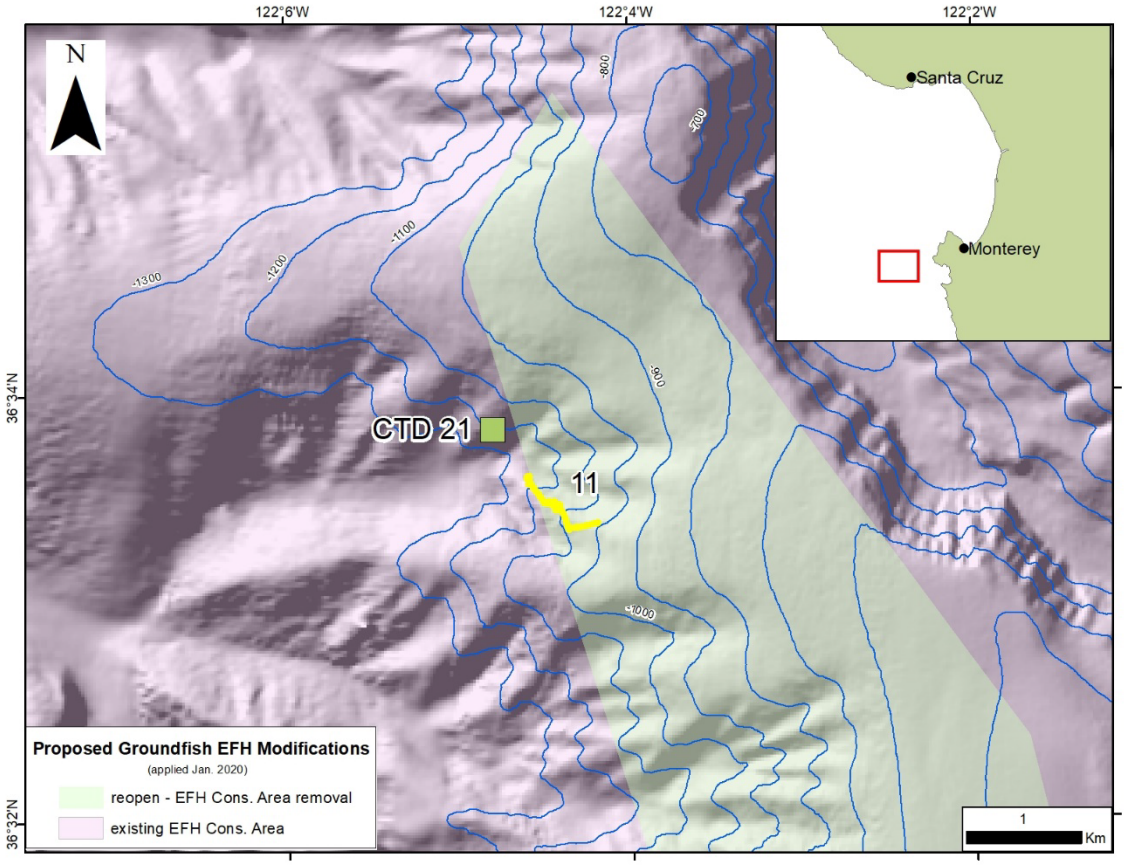
## ADDITIONAL COMMENTS (Cabrillo Canyon)

One anthropogenic debris item was documented during dives at Cabrillo Canyon. The item was a green bottle with no label resting on the seafloor next to a rock outcrop. It looked freshly littered with only minimal invertebrate growth and a small amount of sediment was on the bottle. Damage potentially caused by this item was not observed.

No corals or sponges were damaged and only one sea pen and no sponges were knocked over. One unidentified sea fan and one *Asbestopluma* spp. appearing to be dying and nine sponges (six unidentified and three shelf) and no corals were dead.

# STUDY AREA: West Carmel Canyon
# DIVE NUMBER: ROV 0011

## GENERAL LOCATION AND DIVE TRACKS




## STATION OVERVIEW (West Carmel Canyon)

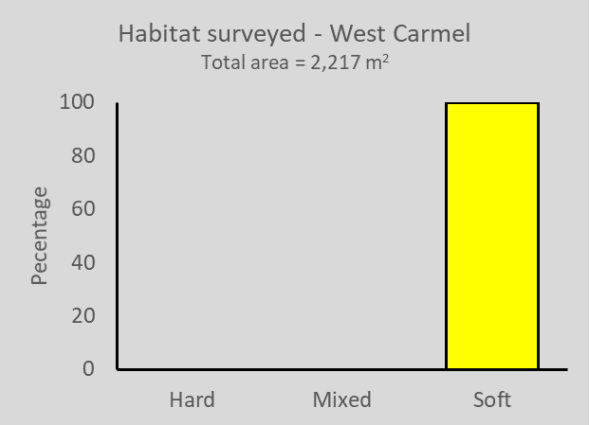
| | |
|---|---|
| **Project** | EXPRESS 2019 |
| **Chief Scientists** | Tom Laidig, Elizabeth Clarke, Chris Caldow |
| **Contact Information** | NMFS, SWFSC, tom.laidig@noaa.gov |
| **Purpose** | Survey deep-sea coral communities along the West Coast |
| **Vessel** | NOAA Ship *Reuben Lasker*; ROV *Yogi* (GFOE) |
| **Science Observers** | Tom Laidig, Meredith Everett, Craig Stuart |
| **Digital Video** | 7.5 hours |
| **Digital Still Photos** | 5,684 images |
| **Positioning System** | Ship: GPS; ROV: USBL |
| **CTD Sensors** | Yes |
| **$O_2$ Sensor (ship CTD only)** | Yes |
| **pH Sensor** | Yes |
| **Specimens collected** | 3 |
| **Water sample** | 2 eDNA; 12 water chemistry |
| **Other** | Logbook, SQL server database |
| **Report Analyst** | Tom Laidig |
| **Date Compiled** | 15 Jun 2022 |

## DIVE DATA (West Carmel Canyon)

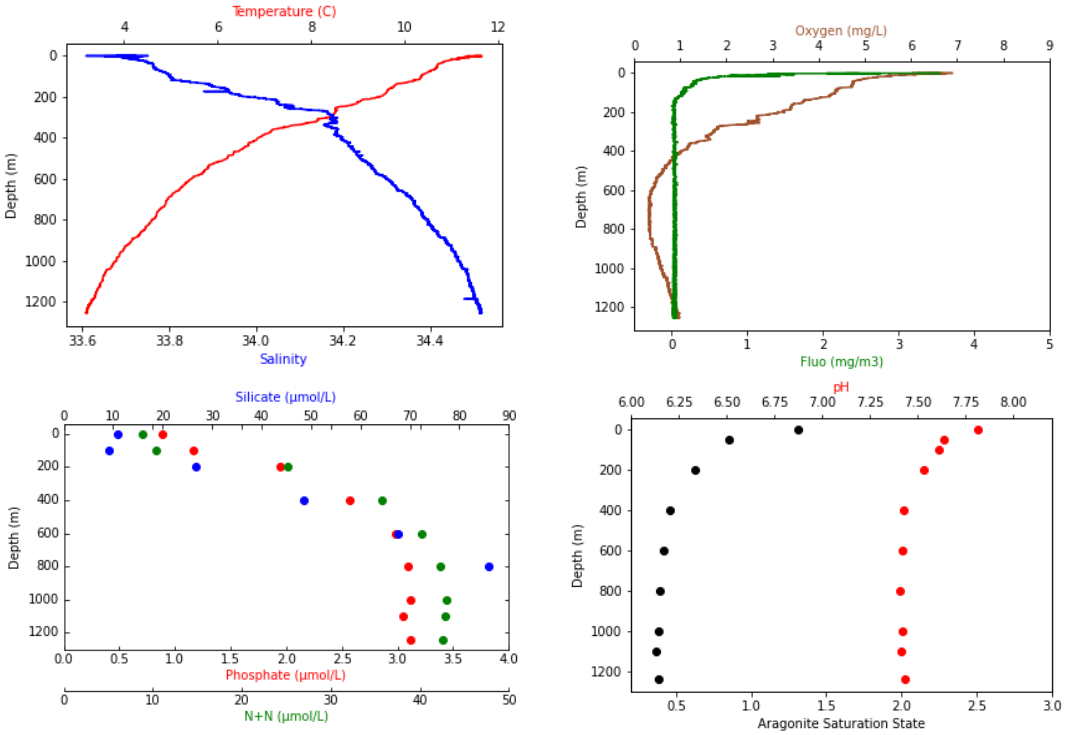
| | | | |
|---|---|---|---|
| Date | 28 Oct 2019 | Starting Latitude (N) | 36° 33.612’ |
| Minimum Bottom Depth (m) | 1,008 | Starting Longitude (W) | 122° 04.590’ |
| Maximum Bottom Depth (m) | 1,245 | Ending Latitude (N) | 36° 33.390’ |
| Start Bottom Time (UTC) | 2:41:42 | Ending Longitude (W) | 122° 04.212’ |
| End Bottom Time (UTC) | 7:09:54 | Surface Current | n/a |
| Number 15-min Transects | 3 | Bottom Current | n/a |

## PHYSICAL ENVIRONMENT (West Carmel Canyon)

In total, 2,217 $m^2$ of seafloor were surveyed during three quantitative transects conducted during Dive 0011 in West Carmel Canyon off central California. The only habitat type observed on this dive was soft (100%), which consisted entirely of mud.

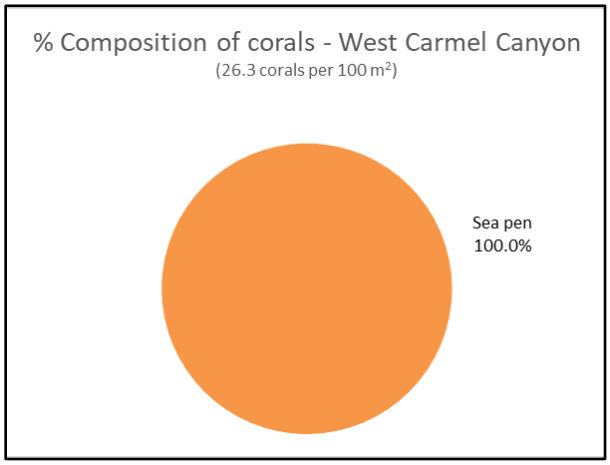



There was no thermocline (as measured from the shipboard CTD) and temperature decreased slowly with depth. Salinity increased quickly until ~300 m and slowed thereafter. Oxygen decreased with depth with a minimum zone occurring between 600 – 800 m. Fluorescence decreased to 0 around 150 m. Nutrient load (phosphate, silicate, and nitrate [N+N]) gradually increased with depth until about 800 m where it remained constant. Saturation of pH and aragonite decreased with depth until 600 m, where it remained constant.



## BIOLOGICAL ENVIRONMENT: CORALS (West Carmel Canyon)

A total of 583 individual coral colonies, comprising at least four taxa, were enumerated from three quantitative transects during Dive 0011 in West Carmel Canyon off central California. Overall coral density was 26.3 corals per 100 $m^2$ of seafloor. Sea pens were the only corals observed (100%).




Colors in the pie diagram match colors in the list of coral taxa (below).

| Scientific name | Common name | Number |
|---|---|---|
| *Halipteris californica* | sea pen | 2 |
| Pennatulacea #1 | sea pen (thin) | 568 |
| Pennatulidae | sea pen (thick) | 11 |
| *Umbellula lindahli* | droopy sea pen | 2 |

Three coral specimens were collected during Dive 0011 in West Carmel Canyon and sent to experts for identification. Shipboard identifications were a small *Funiculina* spp. (one specimen), a small *Pennatula* spp. (one specimen), and a *Stachyptilum*/*Protoptilum* spp. (one specimen). DNA barcoding has been completed for the three specimens, identifying them as *Virgularia sp., Funiculina quadrangularis,* and *Stachyptilum* sp., respectively. Verified morphological identifications are still pending. Several eDNA samples were successfully sequenced from this location with analysis ongoing.

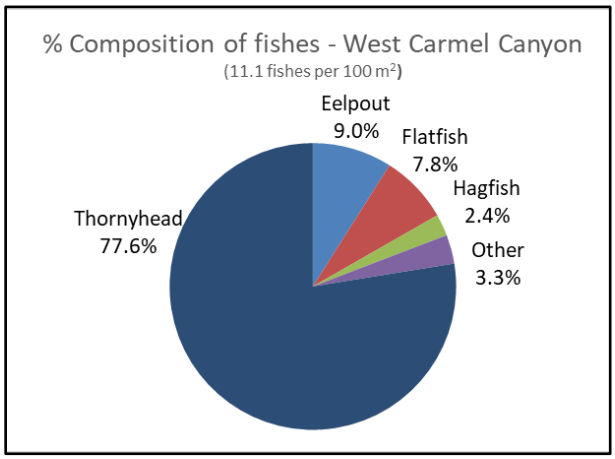
## BIOLOGICAL ENVIRONMENT: SPONGES (West Carmel Canyon)

No sponges were enumerated from three quantitative transects conducted during Dive 0011 in West Carmel Canyon off central California.

No sponges were collected on this dive.

## BIOLOGICAL ENVIRONMENT: FISHES (West Carmel Canyon)

At least 12 taxa of fishes were identified from three quantitative transects conducted during Dive 0011 in West Carmel Canyon off central California. A total of 245 individual fishes were enumerated, with an estimated overall density of 11.1 fishes per 100 $m^2$ of seafloor. Thornyheads dominated the fish assemblage (77.6%). The remainder of the fish assemblage included eelpouts (9.0%), flatfishes (7.8%), other fishes (3.3%), and hagfishes (2.4%).



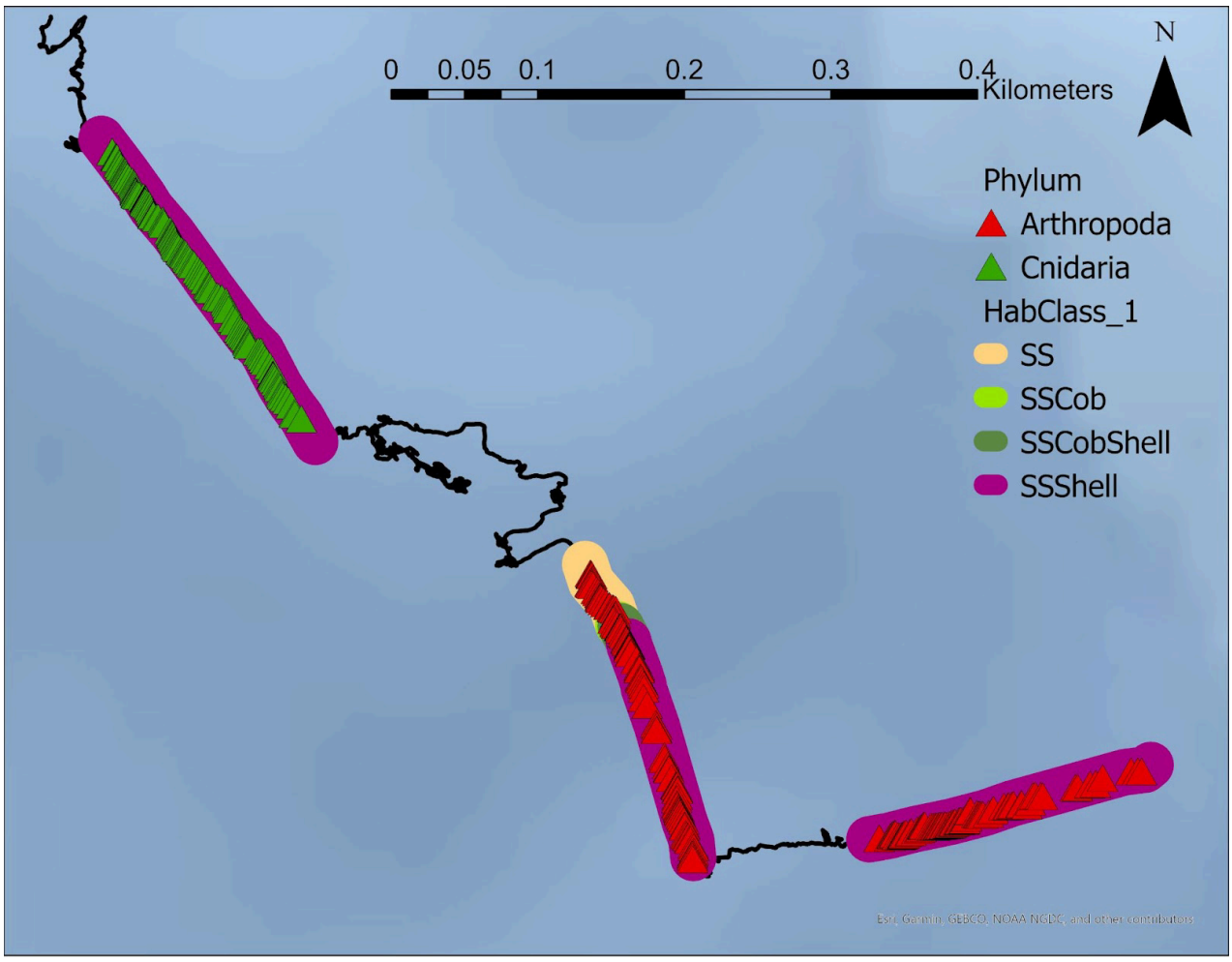

Colors in the pie diagram match colors in the list of fish taxa (below).

A total of 33 thin sea pens had a fish association within one body length, which equated to 6% of the 583 corals counted on transect. Thornyheads had the most sea pen associations (24) with five Dover sole, one hagfish, one Pacific flatnose, one sablefish, and one deepsea sole also having associations with sea pens.

| Scientific name | Common name | Number |
|---|---|---|
| *Anoplopoma fimbria* | sablefish | 2 |
| *Antimora microlepis* | Pacific flatnose | 1 |
| *Embassichthys bathybius* | deepsea sole | 5 |
| *Eptatretus* spp. | unidentified hagfish | 6 |
| *Lycenchelys crotalinus* | snakehead eelpout | 7 |
| Macrouridae | unidentified grenadier | 4 |
| *Microstomus pacificus* | Dover sole | 14 |
| Myctophidae | unidentified lanternfish | 1 |
| *Sebastolobus alascanus* | shortspine thornyhead | 2 |
| *Sebastolobus altivelis* | longspine thornyhead | 17 |
| *Sebastolobus* spp. | unidentified thornyheads | 171 |
| Zoarcidae | unidentified eelpout | 15 |

## BIOLOGICAL ENVIRONMENT: OTHER FAUNA (West Carmel Canyon)

At least 13 taxa of fauna other than DSCS and fishes were identified from three quantitative transects conducted during Dive 0011 in West Carmel Canyon off central California. The dominant phyla were Arthropoda (mostly shrimp) and Cnidaria (mostly anemones). The map below shows habitat classification and dominant phyla for each transect. Habitat classifications include soft sediment (SS), cobbles (Cob), and clam shells (Shell). No chemosynthetic features were documented during this dive.

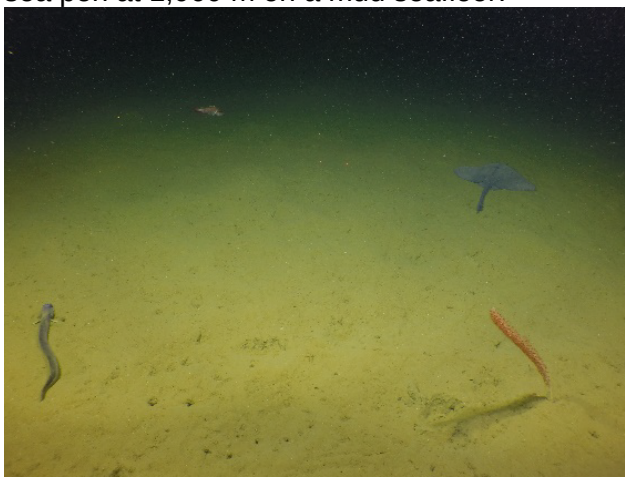


## IMAGE GALLERY (West Carmel Canyon)

A sablefish and two small sea pens at 1,120 m on a mud seafloor.

A tanner crab and two thornyheads on a mud seafloor at 1,070 m.

A snakehead eelpout, roughtail skate, and a sea pen at 1,060 m on a mud seafloor.



A juvenile longspine thornyhead (identified by the black in its fins) at 1,147 m.

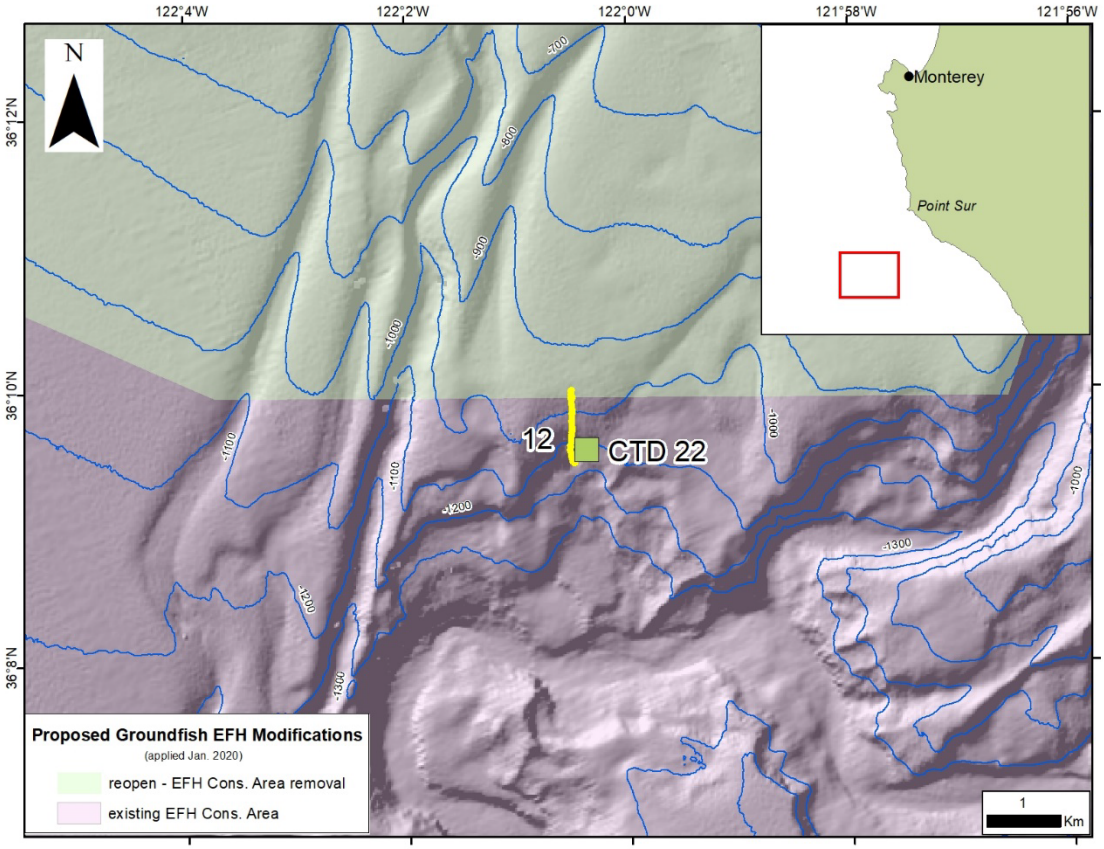
## ADDITIONAL COMMENTS (West Carmel Canyon)

No anthropogenic debris items were documented during dives at West Carmel Canyon.

Fifteen sea pens were damaged. Six of the damaged sea pens were also knocked over. One of the knocked over sea pens was also dead.

# STUDY AREA: Point Sur Slot Canyons
# DIVE NUMBER: ROV 0012

## GENERAL LOCATION AND DIVE TRACKS




## STATION OVERVIEW (Point Sur Slot Canyons)

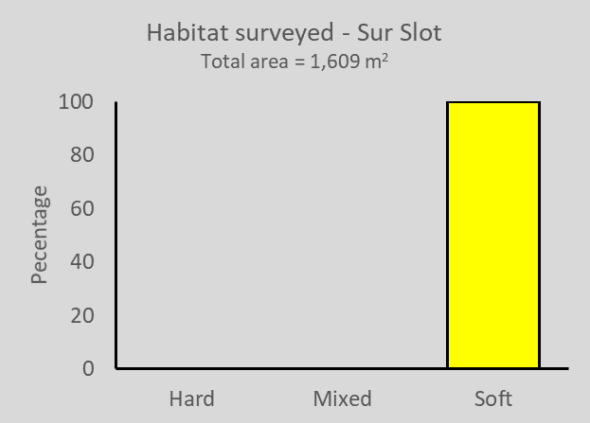
| | |
|---|---|
| **Project** | EXPRESS 2019 |
| **Chief Scientists** | Tom Laidig, Elizabeth Clarke, Chris Caldow |
| **Contact Information** | NMFS, SWFSC, tom.laidig@noaa.gov |
| **Purpose** | Survey deep-sea coral communities along the West Coast |
| **Vessel** | NOAA Ship *Reuben Lasker*; ROV *Yogi* (GFOE) |
| **Science Observers** | Tom Laidig, Meredith Everett, Craig Stuart |
| **Digital Video** | 6.5 hours |
| **Digital Still Photos** | 4,974 images |
| **Positioning System** | Ship: GPS; ROV: USBL |
| **CTD Sensors** | Yes |
| **$O_2$ Sensor (ship CTD only)** | Yes |
| **pH Sensor** | Yes |
| **Specimens collected** | 1 |
| **Water sample** | 2 eDNA; 9 water chemistry |
| **Other** | Logbook, SQL server database |
| **Report Analyst** | Tom Laidig |
| **Date Compiled** | 15 Jun 2022 |

## DIVE DATA (Point Sur Slot Canyons)

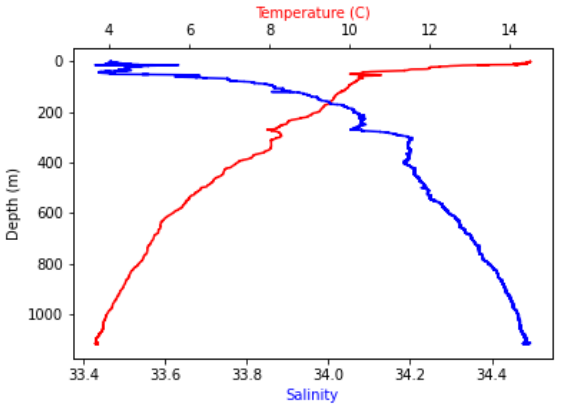
| | | | |
|---|---|---|---|
| Date | 29 Oct 2019 | Starting Latitude (N) | 36° 38.121’ |
| Minimum Bottom Depth (m) | 953 | Starting Longitude (W) | 122° 44.246’ |
| Maximum Bottom Depth (m) | 1,190 | Ending Latitude (N) | 36° 39.918’ |
| Start Bottom Time (UTC) | 2:31:05 | Ending Longitude (W) | 122° 48.477’ |
| End Bottom Time (UTC) | 6:07:03 | Surface Current | n/a |
| Number 15-min Transects | 3 | Bottom Current | n/a |

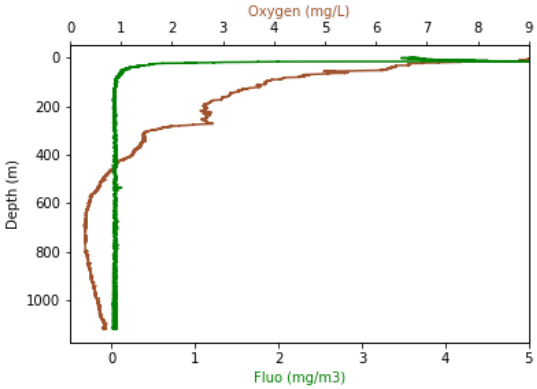
## PHYSICAL ENVIRONMENT (Point Sur Slot Canyons)

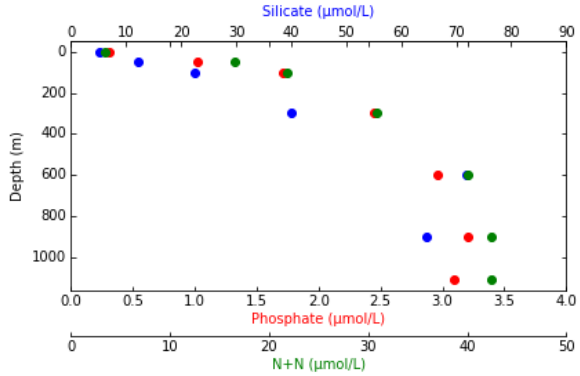
In total, 1,609 $m^2$ of seafloor were surveyed during three quantitative transects conducted during Dive 0012 in Point Sur Slot Canyons off central California. The only habitat type observed on this dive was soft (100%), which consisted entirely of mud.

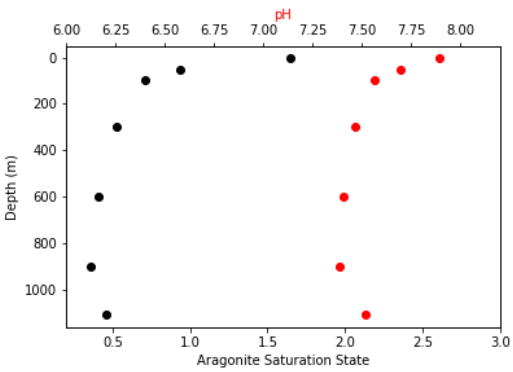



There was a thermocline (as measured from the shipboard CTD) for the first 50 m, and temperature decreased slowly with depth thereafter. Salinity increased quickly until about 200 m and slowly thereafter. Oxygen decreased with depth with a minimum zone occurring between 600 – 800 m. Fluorescence decreased to 0 around 100 m. Nutrient load (phosphate, silicate, and nitrate [N+N]) gradually increased with depth until about 800 m where it remained constant. Saturation of pH and aragonite decreased with depth until 600 m, with an increase at the deepest depths.



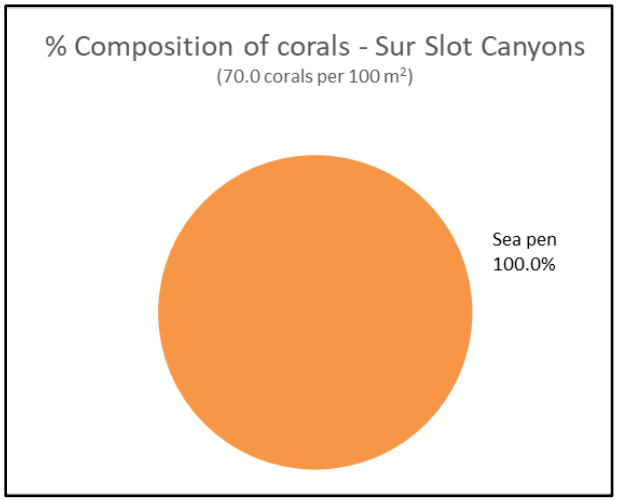



## BIOLOGICAL ENVIRONMENT: CORALS (Point Sur Slot Canyons)

A total of 1,127 individual coral colonies, comprising at least five taxa, were enumerated from three quantitative transects during Dive 0012 in Point Sur Slot Canyons off central California. Overall coral density was 70.0 corals per 100 $m^2$ of seafloor. Sea pens were the only corals observed (100%).




Colors in the pie diagram match colors in the list of coral taxa (below).

| Scientific name | Common name | Number |
|---|---|---|
| *Anthoptilum grandiflorum* | feather boa sea pen | 1 |
| *Halipteris californica* | sea pen | 1 |
| Pennatulacea #1 | sea pen (thin) | 669 |
| Pennatulidae | sea pen (thick) | 268 |
| *Umbellula lindahli* | droopy sea pen | 188 |

One coral specimen was collected during Dive 0012 in Point Sur Slot Canyons and sent to experts for identification. Shipboard identification was *Funiculina quadrangularis* (one specimen), which has been verified by both morphological identification and DNA barcoding. One eDNA sample from this location has been successfully sequenced.

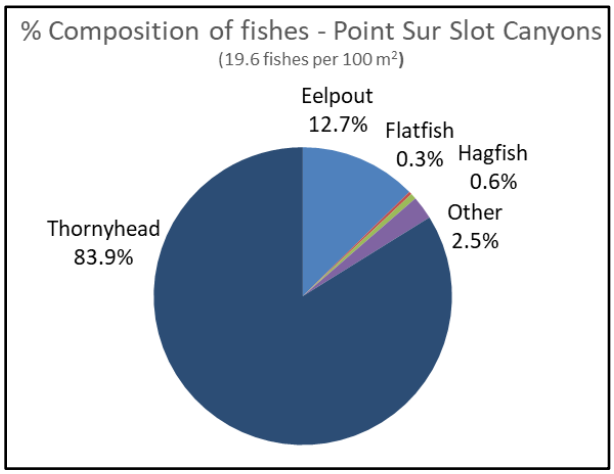
## BIOLOGICAL ENVIRONMENT: SPONGES (Point Sur Slot Canyons)

No sponges were enumerated from three quantitative transects conducted during Dive 0012 in Point Sur Slot Canyons off central California.

No sponges were collected during this dive.

## BIOLOGICAL ENVIRONMENT: FISHES (Point Sur Slot Canyons)

At least 11 taxa of fishes were identified from three quantitative transects conducted during Dive 0012 in Point Sur Slot Canyons off central California. A total of 316 individual fishes were enumerated, with an estimated overall density of 19.6 fishes per 100 $m^2$ of seafloor. As with the other deep areas surveyed, thornyheads (83.9%) and eelpouts (12.7%; mostly snakehead eelpouts) dominated the fish assemblage. The remainder of the fish assemblage included other fishes (2.5%), hagfishes (0.6%) and flatfishes (0.3%). A twoline eelpout was observed in Point Sur Slot Canyons, one of only two observations during the cruise



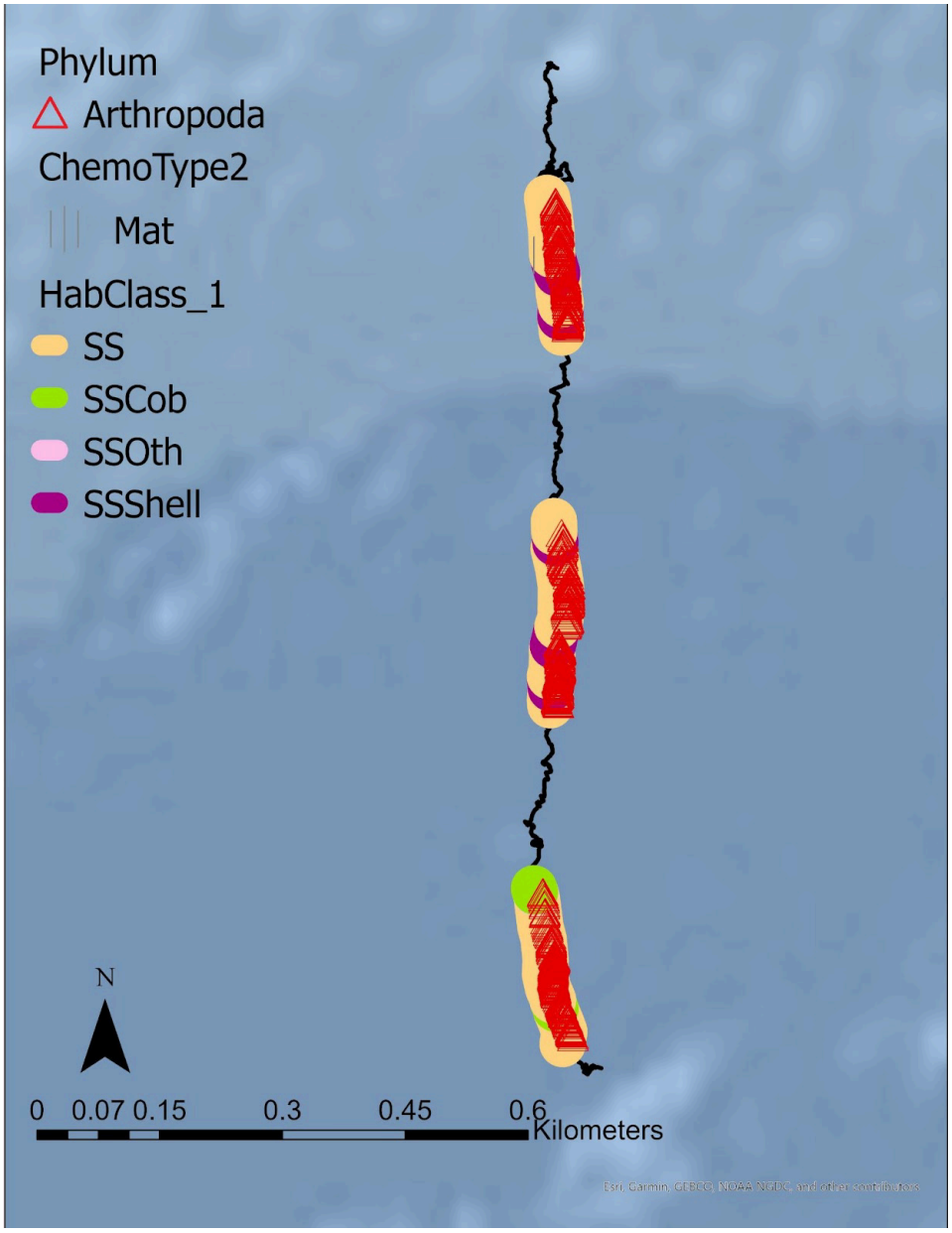

Colors in the pie diagram match colors in the list of fish taxa (below).

Four percent of the 1,127 corals (46 individuals) had a fish association within one body length. All fish associations were with sea pens, with 27 thin sea pens, 13 thick sea pens, and six droopy sea pens. The fish associates were dominated by thornyheads (41), followed by grenadiers (4), and one Dover sole.

| Scientific name | Common name | Number |
|---|---|---|
| *Alepocephalus tenebrosus* | California slickhead | 2 |
| *Anoplopoma fimbria* | sablefish | 1 |
| *Bathyraja trachura* | roughtail skate | 1 |
| *Bothrocara brunneum* | twoline eelpout | 1 |
| *Embassichthys bathybius* | deepsea sole | 1 |
| *Eptatretus* spp. | unidentified hagfish | 2 |
| *Lycenchelys crotalinus* | snakehead eelpout | 20 |
| Macrouridae | unidentified grenadier | 4 |
| *Sebastolobus altivelis* | longspine thornyhead | 33 |
| *Sebastolobus* spp. | unidentified thornyheads | 232 |
| Zoarcidae | unidentified eelpout | 19 |

## BIOLOGICAL ENVIRONMENT: OTHER FAUNA (Point Sur Slot Canyons)

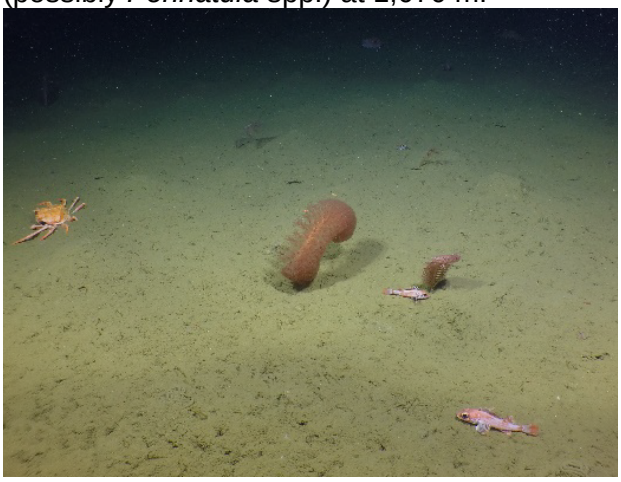
At least 13 taxa of fauna other than DSCS and fishes were identified from three quantitative transects conducted during Dive 0012 in Point Sur Slot Canyons off central California. The dominant phylum was Arthropoda (mostly shrimp [1489 individuals]). The map below shows habitat classification and dominant phyla for each transect. Habitat classifications include soft sediment (SS), cobbles (Cob), clam shells (Shell), and other less common substrates (OTH). The other classification includes detritus, and ledges. Chemosynthetic features were overlaid on the habitat classification and included bacterial mats.



## IMAGE GALLERY (Point Sur Slot Canyons)

Many sea pens (droopy and *Funiculina* cf. *quadrangularis*) at 960 m on a mud seafloor.

A feather boa sea pen and a thick sea pen (possibly *Pennatula* spp.) at 1,070 m.



A sea pen (*Funiculina* cf. *quadrangularis*) and a *Solaste*r *exiguous* sea star at 1,033 m on a mud seafloor, with small unidentified benthic shrimps spread out along the benthos.

A deep-sea sea star (*Solaster exiguous*) on a mud seafloor at 1,070 m.

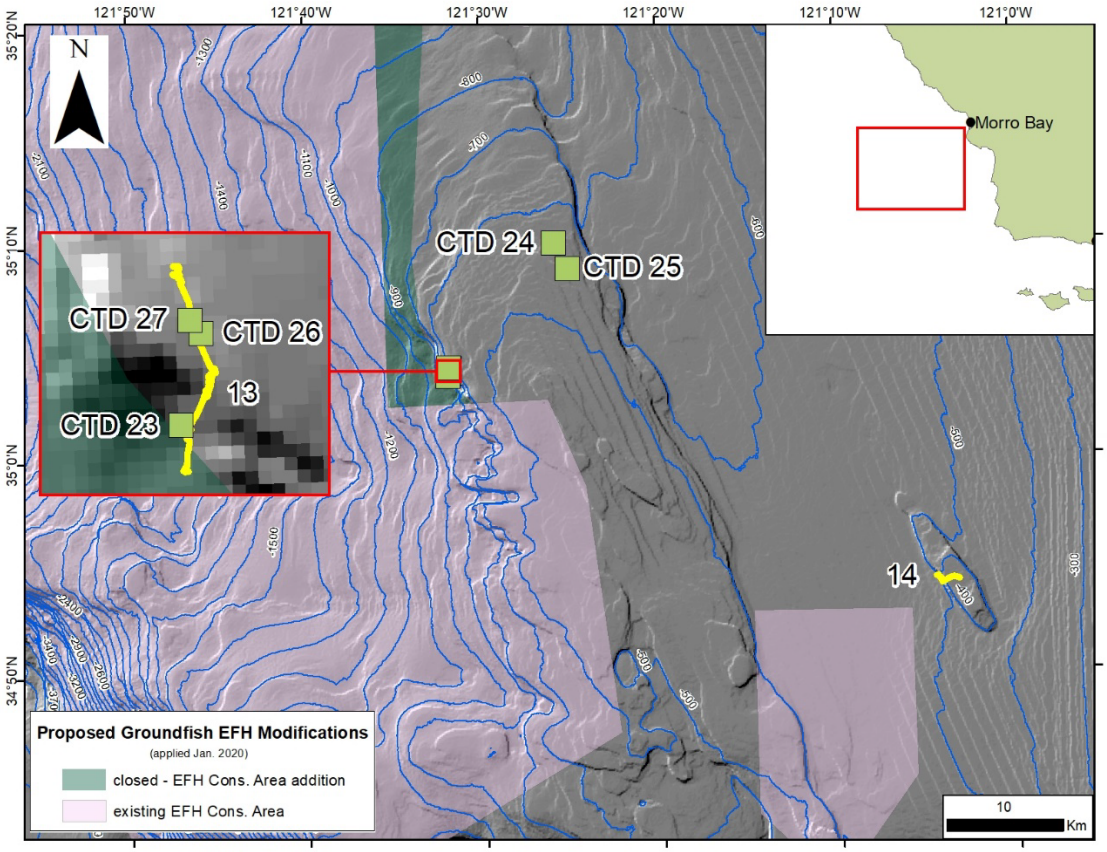
## ADDITIONAL COMMENTS (Point Sur Slot Canyons)

No anthropogenic debris items were documented during dives at Point Sur Slot Canyons.

Thirteen sea pens (10 thin and three thick) were damaged, and 6 of the 10 thin sea pens were also knocked over. However, even with being damaged and knocked over, none of the sea pens appeared dead or dying.

# STUDY AREA: Santa Lucia Bank
# DIVE NUMBER: ROV 0013-0014

## GENERAL LOCATION AND DIVE TRACKS




## STATION OVERVIEW (Santa Lucia Bank)

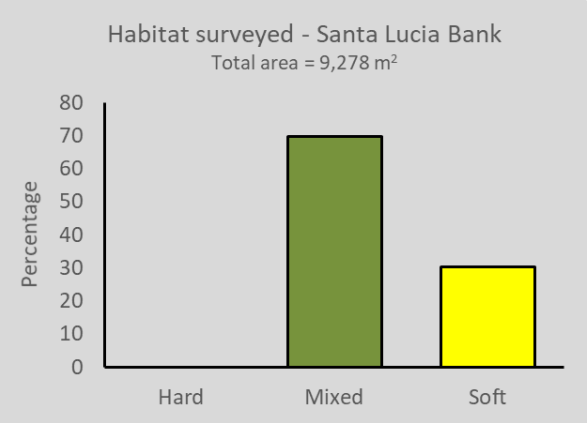
| | |
|---|---|
| **Project** | EXPRESS 2019 |
| **Chief Scientists** | Tom Laidig, Elizabeth Clarke, Chris Caldow |
| **Contact Information** | NMFS, SWFSC, tom.laidig@noaa.gov |
| **Purpose** | Survey deep-sea coral communities along the West Coast |
| **Vessel** | NOAA Ship *Reuben Lasker*; ROV *Yogi* (GFOE) |
| **Science Observers** | Tom Laidig, Meredith Everett, Craig Stuart |
| **Digital Video** | 18.5 hours |
| **Digital Still Photos** | 13,802 images |
| **Positioning System** | Ship: GPS; ROV: USBL |
| **CTD Sensors** | Yes |
| **$O_2$ Sensor (ship CTD only)** | Yes |
| **pH Sensor** | Yes |
| **Specimens collected** | 21 |
| **Water sample** | 3 eDNA; 17 water chemistry |
| **Other** | Logbook, SQL server database |
| **Report Analyst** | Tom Laidig |
| **Date Compiled** | 15 Jun 2022 |

## DIVE DATA (Santa Lucia Bank)

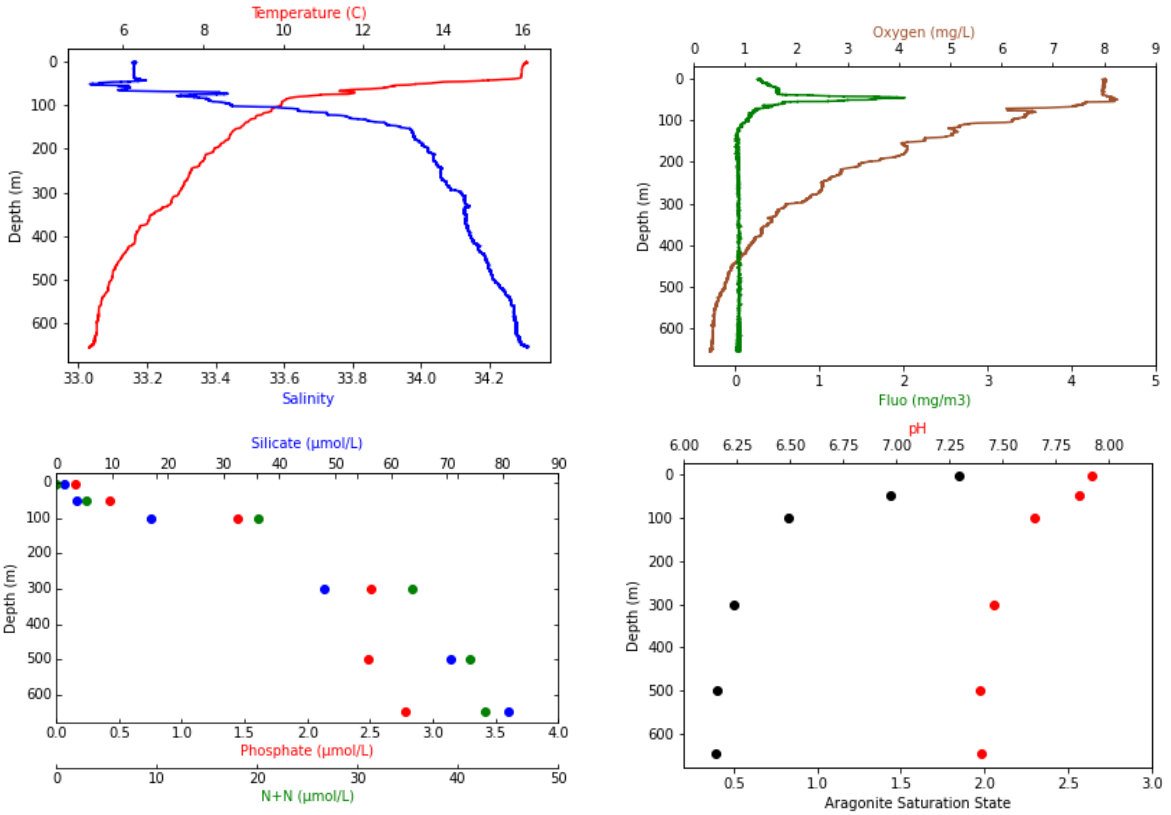
| | | | |
|---|---|---|---|
| Date | 30 Oct-2 Nov 2019 | Starting Latitude (N) | 35° 03.739’ |
| Minimum Bottom Depth (m) | 380 | Starting Longitude (W) | 121° 31.919’ |
| Maximum Bottom Depth (m) | 603 | Ending Latitude (N) | 34° 54.156’ |
| Start Bottom Time (UTC) | 23:40:52 | Ending Longitude (W) | 121° 03.231’ |
| End Bottom Time (UTC) | 7:33:39 | Surface Current | n/a |
| Number 15-min Transects | 11 | Bottom Current | n/a |

## PHYSICAL ENVIRONMENT (Santa Lucia Bank)

In total, 9,278 $m^2$ of seafloor were surveyed during 11 quantitative transects conducted during Dives 0013-0014 on Santa Lucia Bank off central California. Habitat types were classified as (1) mixed (70%), including a combination of mud with boulders and cobbles; and (2) soft (30%) which consisted entirely of mud. No hard habitat was observed.

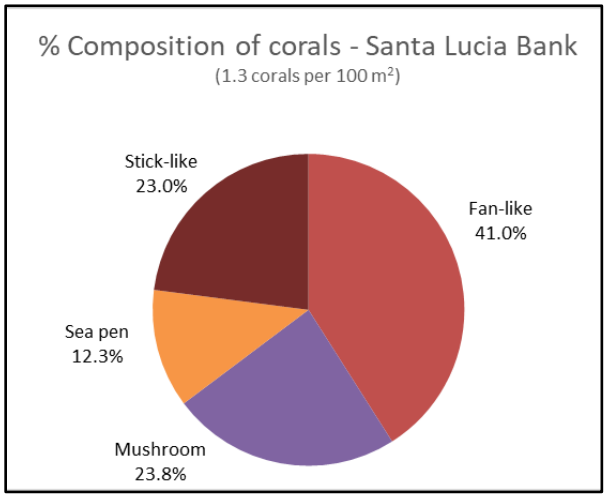



There was a thermocline (as measured from the shipboard CTD) from 20-80 m, and temperature decreased slowly with depth thereafter. Salinity increased quickly after about 50 m and increased slowly thereafter. Oxygen decreased with depth. Fluorescence spiked around 50 m and decreased to 0 around 120 m. Nutrient load (phosphate, silicate, and nitrate [N+N]) gradually increased with depth. Saturation of pH and aragonite decreased until 500 m, and then remained constant.



## BIOLOGICAL ENVIRONMENT: CORALS (Santa Lucia Bank)

A total of 122 individual coral colonies, comprising at least 10 taxa, were enumerated from 11 quantitative transects during Dives 0013-0014 on Santa Lucia Bank off central California. Overall coral density was 1.3 corals per 100 $m^2$ of seafloor. Fan-like corals were the most abundant coral (41%) with most from the genus *Paragorgia*. The remaining groups were mushroom corals (24%), stick-like corals (23%), and sea pens (12%).



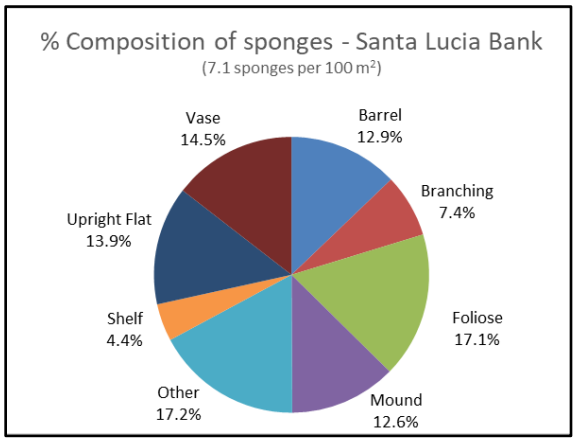

Colors in the pie diagram match colors in the list of coral taxa (below).

| Scientific name | Common name | Number |
|---|---|---|
| *Anthoptilum grandiflorum* | feather boa sea pen | 6 |
| *Heteropolypus ritteri* | mushroom coral | 29 |
| *Paragorgia pacifica* | bubblegum coral | 1 |
| *Paragorgia* spp. | sea fan (white with red polyps) | 40 |
| *Parastenella ramosa* | primnoid | 1 |
| Pennatulacea #1 | sea pen (thin) | 7 |
| Plexauridae #1 | *Swiftia* type (red w/ white polyps) | 2 |
| Plexauridae #3 | *Swiftia* type (red w/ unknown polyps) | 26 |
| *Swiftia pacifica* | sea fan (red with yellow polyps) | 8 |
| *Umbellula lindahli* | droopy sea pen | 2 |

Six coral specimens were collected during Dives 0013-0014 on Santa Lucia Bank and sent to experts for identification. Shipboard identifications were *Paragorgia* spp. (two specimens), *Swiftia spauldingi* (one specimen), *Swiftia* cf. *pacifica* (one specimen), stoloniferan coral (one specimen), and *Halipteris willemosi* (one specimen). Morphological and genetic information confirmed the identification of the sea pen as *H. willemosi*, one *Swiftia* as a member of the *Swiftia spauldingi/Chromoplexaura marki* complex and the other as *Swiftia* cf. *pacifica.* DNA barcoding suggests one stoloniferan coral is a species of *Anthothela.* Additional verified morphological identifications are still pending.

## BIOLOGICAL ENVIRONMENT: SPONGES (Santa Lucia Bank)

A total of 661 individual sponges from at least 22 different taxa were enumerated from 11 quantitative transects conducted during Dives 0013-0014 on Santa Lucia Bank off central California. An overall density of 7.1 sponges per 100 $m^2$ of seafloor was calculated. The sponge groups were represented fairly equally with a wide variety of sponges. Other sponges accounted for 17.2% (mostly the genus *Asbestopluma*), followed by foliose (17.1%), vase (14.5%), upright flat (13.9%), barrel (12.9%), mound (12.6%), branching (7.4%), and shelf (4.4%).



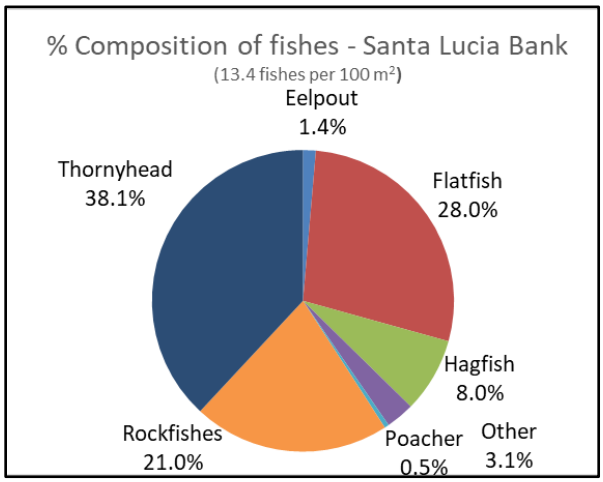

Colors in the pie diagram match colors in the list of coral taxa (below).

| Scientific name | Common name | Number |
|---|---|---|
| *Asbestopluma* spp. #1 | predatory pipecleaner sponge | 88 |
| *Asbestopluma* spp. #2 | predatory sponge (clear) | 7 |
| *Farrea occa* | lace (or cloud) foliose sponge | 8 |
| *Heterochone calyx* | fingered goblet vase sponge | 9 |
| *Latrunculia* spp. | purple moon sponge | 9 |
| *Mycale* spp. | upright flat sponge (yellow) | 85 |
| *Poecillastra* spp. | fringed shelf sponge | 9 |
| Porifera #1 | unidentified foliose sponges | 97 |
| Porifera #12 | unidentified sponge | 9 |
| Porifera #14 | Valentines sponge | 5 |
| Porifera #16 | crumpet sponge | 15 |
| Porifera #2 | unidentified upright flat sponges | 7 |
| Porifera #3 | unidentified barrel sponges | 84 |
| Porifera #4 | unidentified shelf sponges | 5 |
| Porifera #5 | unidentified vase sponges | 85 |
| Porifera #6 | unidentified mound sponges | 35 |
| Porifera #7 | unidentified branching sponge | 44 |
| Porifera #8 | unidentified tube sponge | 10 |
| Porifera #9 | unidentified puffball mound sponge | 39 |
| *Rhabdocalyptus dawsoni* | brown barrel sponge | 1 |
| *Staurocalyptus* spp. #1 | Picasso sponge | 2 |
| *Thenea muricata* | foliose sponge (clear) | 8 |

Eleven sponge specimens were collected during Dives 0013-0014 on Santa Lucia Bank and sent to experts for identification. Shipboard identifications were *Thenea* spp. (two specimens), white *Mycale* spp. (one specimen), *Staurocalyptus* spp. (two specimens), ball sponge (one specimen), white complex sponge (one specimen), spaceball sponge (one specimen), purple moon sponge (one specimen), tube sponge (one specimen), and a white cushion sponge (one specimen). DNA barcoding and morphological identification have confirmed the identification of the *Mycale* specimen as *Mycale loveni*. Verified identification from experts is still pending.

## BIOLOGICAL ENVIRONMENT: FISHES (Santa Lucia Bank)

At least 29 taxa of fishes were identified from 11 quantitative transects conducted during Dives 0013-0014 on Santa Lucia Bank off central California. A total of 1,245 individual fishes were enumerated, with an estimated overall density of 13.4 fishes per 100 $m^2$ of seafloor. Thornyheads (38.1%), flatfishes (28.0%; mostly Dover sole), and rockfishes (21.0%; mostly splitnose and blackgill rockfishes) were the most abundant groups. The remainder of the fish assemblage included hagfishes (8.0%), other fishes (3.1%), eelpouts (1.4%), and poachers (0.5%).




Colors in the pie diagram match colors in the list of fish taxa (below).

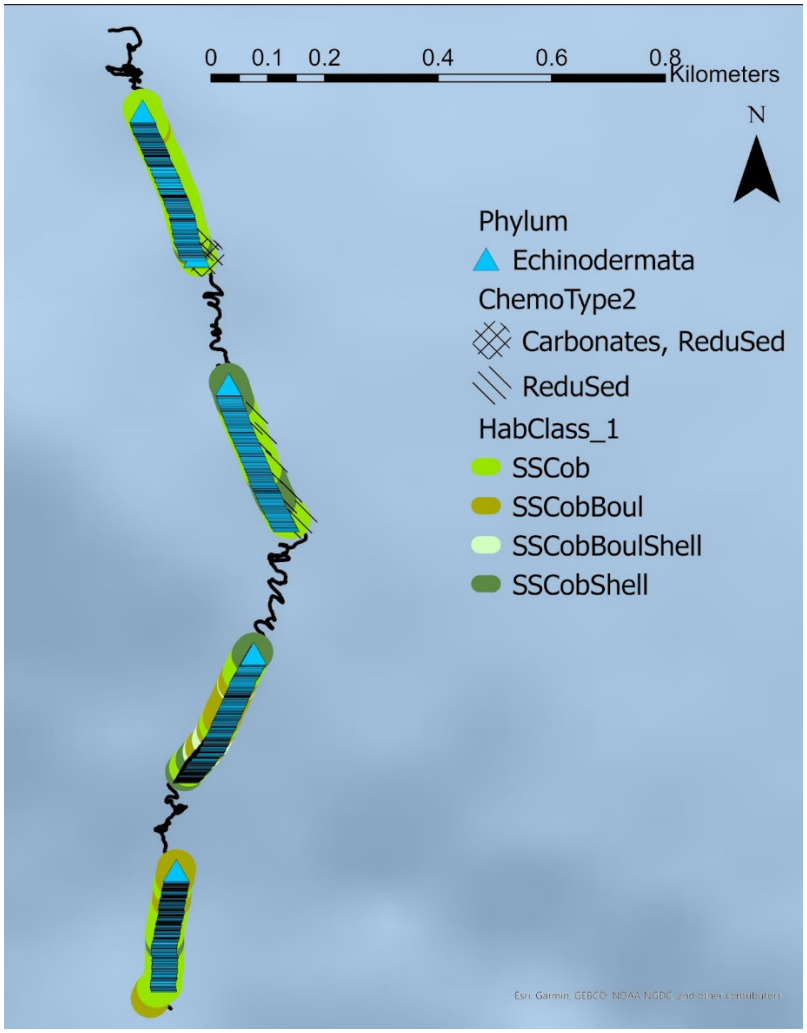
Nine percent (74 individuals) of the 783 corals and sponges had a fish association within one body length. Sponges had the most fish associations (58). Foliose sponges (12 individuals), barrel sponges (8), and *Mycale* spp. (7) were the three most abundant taxa out of the 16 sponge taxa with fish associations. Sixteen corals had fish associations with *Clavularia* spp. (seven individuals) and *Swiftia* type with unknown polyps (five individuals) as the most abundant taxa. Thornyheads (30 fish), Dover sole (26), and blackgill rockfish (10) accounted for most of the associations.

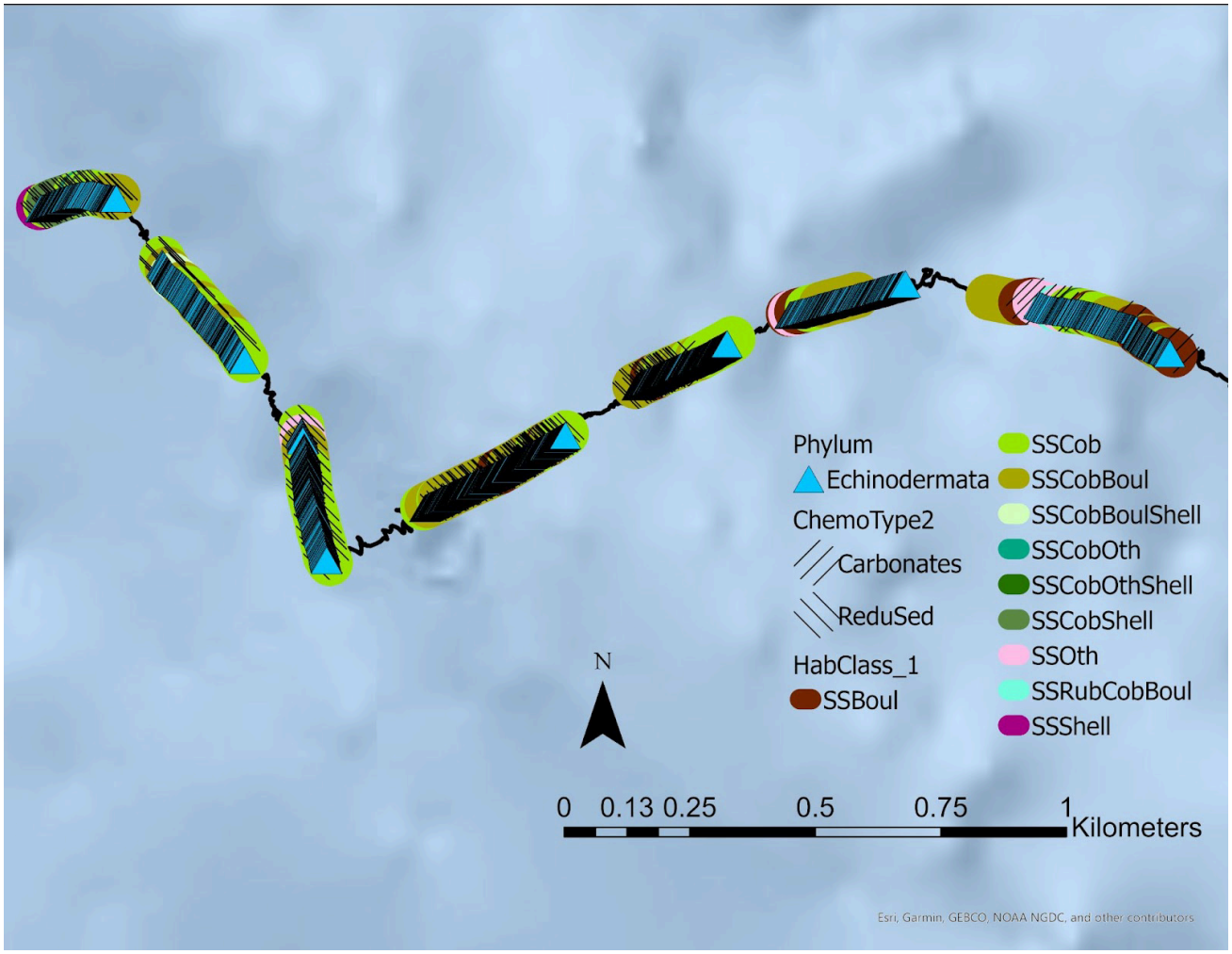
| Scientific name | Common name | Number |
|---|---|---|
| Agonidae | unidentified poachers | 5 |
| *Anoplopoma fimbria* | sablefish | 5 |
| *Cataetyx rubrirostris* | rubynose brotula | 10 |
| *Embassichthys bathybius* | deepsea sole | 5 |
| *Eptatretus* spp. | unidentified hagfish | 100 |
| *Glytocephalus zachirus* | rex sole | 50 |
| *Hydrolagus colliei* | spotted ratfish | 4 |
| *Lycenchelys crotalinus* | snakehead eelpout | 10 |
| *Lycodes diapterus* | black eelpout | 2 |
| *Lyopsetta exilis* | slender sole | 1 |
| Macrouridae | unidentified grenadier | 1 |
| *Merluccius productus* | Pacific hake | 6 |
| *Microstomus pacificus* | Dover sole | 292 |
| Myctophidae | unidentified lanternfish | 2 |
| *Nezumia stelgidolepis* | California grenadier | 1 |
| *Raja rhina* | longnose skate | 3 |
| Scyliorhinidae | unidentified cat shark | 6 |
| *Sebastes aurora* | aurora rockfish | 15 |
| *Sebastes crameri* | darkblotched rockfish | 24 |
| *Sebastes diploproa* | splitnose rockfish | 139 |
| *Sebastes entomelas* | widow rockfish | 1 |
| *Sebastes melanostomus* | blackgill rockfish | 76 |
| *Sebastes rufus* | bank rockfish | 5 |
| *Sebastolobus alascanus* | shortspine thornyhead | 11 |

| Scientific name | Common name | Number |
|---|---|---|
| *Sebastolobus altivelis* | longspine thornyhead | 40 |
| *Sebastolobus* spp. | unidentified thornyheads | 423 |
| *Sebastomus* | unidentified *Sebastomus* | 2 |
| *Xeneretmus leiops* | smootheye poacher | 1 |
| Zoarcidae | unidentified eelpout | 5 |

## BIOLOGICAL ENVIRONMENT: OTHER FAUNA (Santa Lucia Bank)

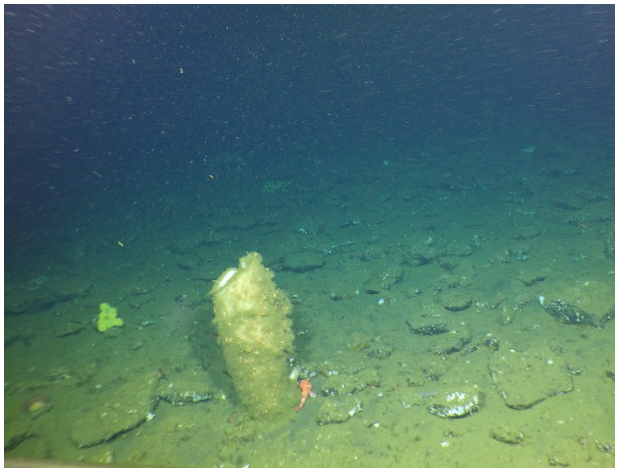
At least 24 taxa of fauna other than DSCS and fishes were identified from 11 quantitative transects conducted during Dives 0013-0014 on Santa Lucia Bank off central California. The dominant phylum was Echinodermata (mostly ophiuroids, urchins, and Asteroidea sea stars). The map below shows habitat classification and dominant phyla for each transect. Habitat classifications include soft sediment (SS), boulders (Boul), cobbles (Cob), rubble (Rub), clam shells (Shell), and other less common substrates (OTH). The other classification includes detritus, ridges, ledges, and trash. Chemosynthetic features were overlaid on the habitat classification and include carbonates and reduced sediments (ReduSed).



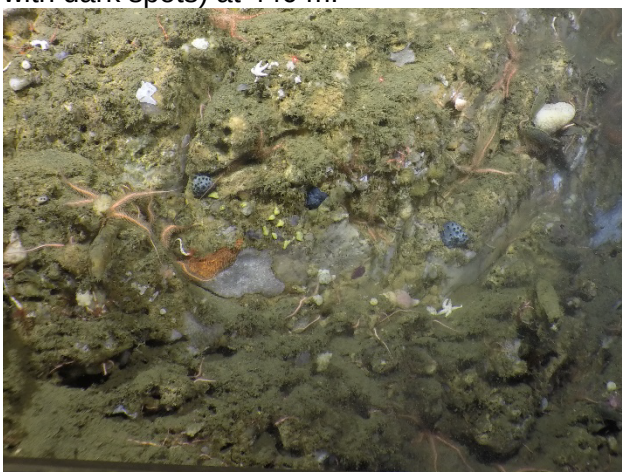

Phylum
Echinodermata
ChemoType2
Carbonates
ReduSed
HabClass_1
SSBoul
SSCob
SSCobBoul
SSCobBoulShell
SSCobOth
SSCobOthShell
SSCobShell
SSOth
SSRubCobBoul
SSShell
N
0 0.13 0.25 0.5 0.75 1
Kilometers
Esri, Garmin, GEBCO, NOAA NGDC, and other contributors

## IMAGE GALLERY (Santa Lucia Bank)

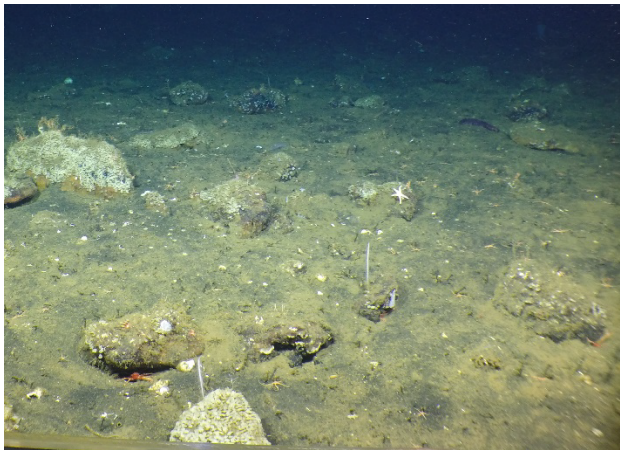
A barrel sponge and thornyhead at 660 m.



Three moldy Swiss cheese sponges (light blue with dark spots) at 440 m.



Gastropod eggs (light colored spots on rocks) and two *Asbestopluma* spp. (white sticks) at 592 m.



A Pacific sleeper shark at 448 m.

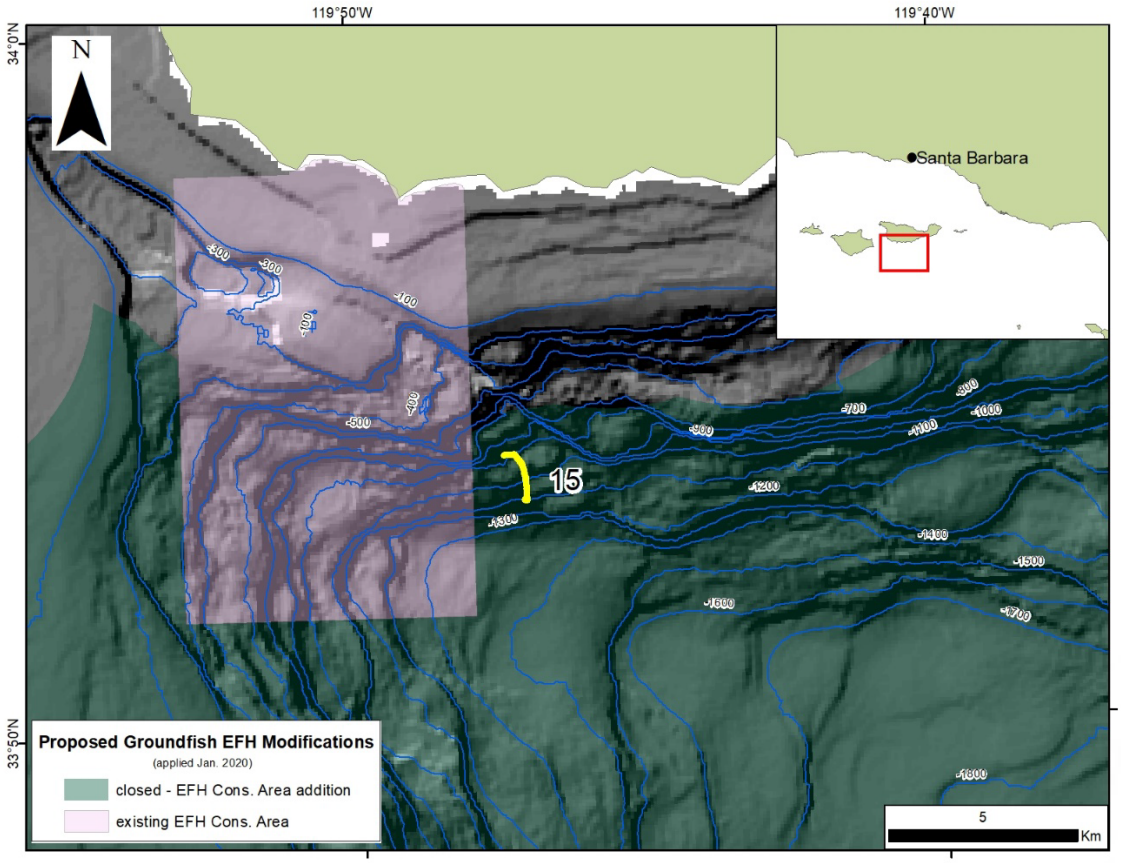
## ADDITIONAL COMMENTS (Santa Lucia Bank)

Two anthropogenic debris items were documented during dives at Santa Lucia Bank. One piece of plastic mesh was caught on the side of a boulder. It was covered in sediment and had many small sponges growing on the exposed sections. One large basket star was on the top of the mesh. One small, white plastic tarp was laying on the seafloor half covered in sediment. Damage potentially caused by these items was not observed.

No corals were damaged or knocked over and no sponges were damaged, but two were knocked over (a *Heterochone calyx* and an unidentified barrel sponge). Only one coral was dying (0.8%; a *Paragorgia* spp.) and one was dead (0.8%; a *Swiftia pacifica*), while 152 sponges (23%; most abundant taxon was unidentified vase sponges with 63 individuals) were dying and 23 sponges (3.5%; mostly unidentified vase and barrel sponges) were dead.

# STUDY AREA: Santa Cruz Island South
# DIVE NUMBER: ROV 0015

## GENERAL LOCATION AND DIVE TRACKS




## STATION OVERVIEW (Santa Cruz Island South)

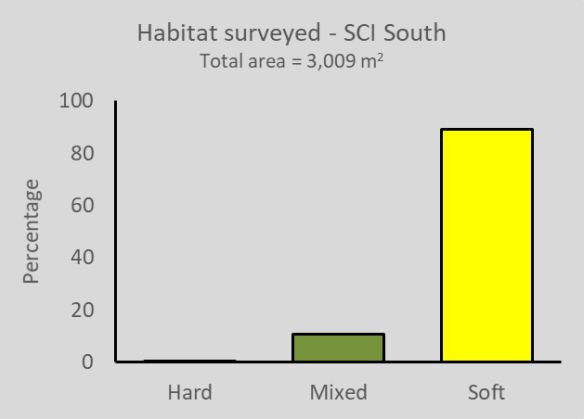
| | |
|---|---|
| **Project** | EXPRESS 2019 |
| **Chief Scientists** | Tom Laidig, Elizabeth Clarke, Chris Caldow |
| **Contact Information** | NMFS, SWFSC, tom.laidig@noaa.gov |
| **Purpose** | Survey deep-sea coral communities along the West Coast |
| **Vessel** | NOAA Ship *Reuben Lasker*; ROV *Yogi* (GFOE) |
| **Science Observers** | Tom Laidig, Meredith Everett, Craig Stuart |
| **Digital Video** | 8.3 hours |
| **Digital Still Photos** | 6,232 images |
| **Positioning System** | Ship: GPS; ROV: USBL |
| **CTD Sensors** | Yes (CTD not used at this location) |
| **$O_2$ Sensor (ship CTD only)** | Yes (CTD not used at this location) |
| **pH Sensor** | Yes (CTD not used at this location) |
| **Specimens collected** | 7 |
| **Water sample** | 2 eDNA; 2 water chemistry |
| **Other** | Logbook, SQL server database |
| **Report Analyst** | Tom Laidig |
| **Date Compiled** | 15 Jun 2022 |

## DIVE DATA (Santa Cruz Island South)

| | | | |
|---|---|---|---|
| Date | 3 Nov 2019 | Starting Latitude (N) | 33° 53.290’ |
| Minimum Bottom Depth (m) | 715 | Starting Longitude (W) | 119° 47.114’ |
| Maximum Bottom Depth (m) | 1,216 | Ending Latitude (N) | 33° 53.917’ |
| Start Bottom Time (UTC) | 01:58:22 | Ending Longitude (W) | 119° 47.459’ |
| End Bottom Time (UTC) | 7:59:30 | Surface Current | n/a |
| Number 15-min Transects | 6 | Bottom Current | n/a |

## PHYSICAL ENVIRONMENT (Santa Cruz Island South)

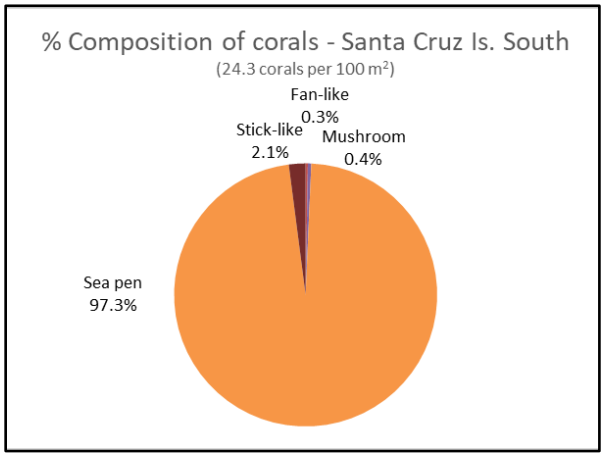
In total, 3,009 $m^2$ of seafloor were surveyed during six quantitative transects conducted during Dive 0015 along the south side of Santa Cruz Island off southern California. Habitat types were classified as (1) hard (0.5% of the total area surveyed), which was consisted entirely of rock outcrops of various sizes; (2) mixed (10.5%), including a combination of mud with boulders, rock outcrops, and cobbles; and (3) soft (89%) which consisted entirely of mud.




The ship’s CTD was not deployed here and no water chemistry was completed for this dive.

## BIOLOGICAL ENVIRONMENT: CORALS (Santa Cruz Island South)

A total of 731 individual coral colonies, comprising at least 10 taxa, were enumerated from six quantitative transects during Dive 0015 along the south side of Santa Cruz Island off southern California. Overall coral density was 24.3 corals per 100 $m^2$ of seafloor. Sea pens were the dominant corals (97.3%). The remaining groups were stick-like corals (2.1%), mushroom corals (0.4%), and fan-like corals (0.3%), all with a total of 15 or less individuals.



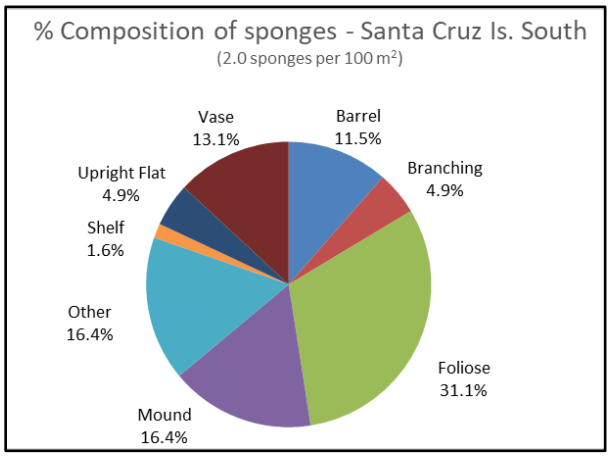

Colors in the pie diagram match colors in the list of coral taxa (below).

| Scientific name | Common name | Number |
|---|---|---|
| *Heteropolypus ritteri* | mushroom coral | 3 |
| *Paragorgia pacifica* | bubblegum coral | 2 |
| Pennatulacea #1 | sea pen (thin) | 692 |
| Pennatulidae | sea pen (thick) | 19 |
| Plexauridae #3 | *Swiftia* type (red w/ unknown polyps) | 15 |

Two coral specimens were collected during Dive 0015 along the south side of Santa Cruz Island and sent to experts for identification. Shipboard identifications were *Swiftia simplex* (one specimen) and a sea pen, *Stachyptilum/Protoptilum* (one specimen). DNA barcoding and morphological identification have been completed for *Swiftia simplex*. Verified identification on the sea pen is still pending.

## BIOLOGICAL ENVIRONMENT: SPONGES (Santa Cruz Island South)

A total of 61 individual sponges from at least 19 different taxa were enumerated from six quantitative transects conducted during Dive 0015 along the south side of Santa Cruz Island off southern California. An overall density of 2.0 sponges per 100 $m^2$ of seafloor was calculated. Foliose sponges were the most abundant group (31.1%), followed by mound (16.4%), other (16.4%), vase (13.1%), barrel (11.5%), branching (4.9%), upright flat (4.9%), and shelf (1.6%) sponges.



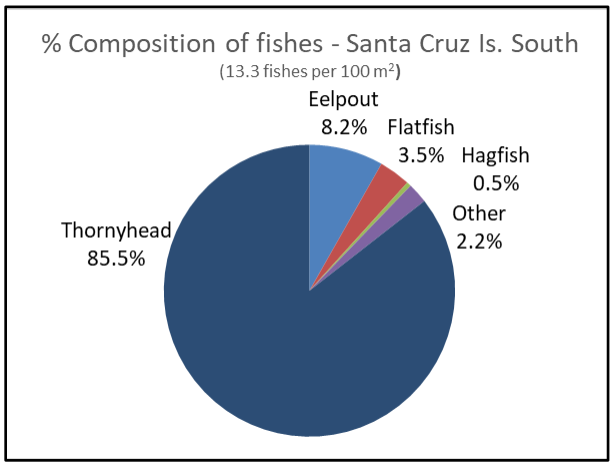

Colors in the pie diagram match colors in the list of coral taxa (below).

| Scientific name | Common name | Number |
|---|---|---|
| *Asbestopluma* spp. #1 | predatory pipecleaner sponge | 1 |
| *Farrea occa* | lace (or cloud) foliose sponge | 2 |
| *Heterochone calyx* | fingered goblet vase sponge | 2 |
| *Hexactinella* spp. | sponge (white) | 6 |
| *Hyalonema populiferum* | fiber optic sponge | 3 |
| *Mycale* spp. | upright flat sponge (yellow) | 1 |
| *Poecillastra* spp. | fringed shelf sponge | 1 |
| Porifera #1 | unidentified foliose sponges | 2 |
| Porifera #14 | Valentines sponge | 2 |
| Porifera #15 | green moon sponge | 2 |
| Porifera #2 | unidentified upright flat sponges | 2 |
| Porifera #3 | unidentified barrel sponges | 5 |
| Porifera #5 | unidentified vase sponges | 5 |
| Porifera #6 | unidentified mound sponges | 4 |
| Porifera #7 | unidentified branching sponge | 1 |
| Porifera #9 | unidentified puffball mound sponge | 4 |
| *Rhabdocalyptus dawsoni* | brown barrel sponge | 2 |
| *Staurocalyptus* spp. #1 | Picasso sponge | 1 |
| *Thenea muricata* | foliose sponge (clear) | 15 |

Five sponge specimens were collected during Dive 0015 along the south side of Santa Cruz Island and sent to experts for identification. Shipboard identifications were *Staurocalyptus* spp. (two specimens), lightbulb sponge (one specimen), *Farrea* spp. (one specimen), and *Hyalonema populiferum* (one specimen). DNA barcodes have been obtained for a number of the sponges but additional analysis is ongoing.

## BIOLOGICAL ENVIRONMENT: FISHES (Santa Cruz Island South)

At least 13 taxa of fishes were identified from six quantitative transects conducted during Dive 0015 along the south side of Santa Cruz Island off southern California. A total of 401 individual fishes were enumerated, with an estimated overall density of 13.3 fishes per 100 $m^2$ of seafloor. Thornyheads dominated the fish assemblage (85.5%). The remainder of the fish assemblage included eelpouts (8.2%), flatfishes (3.5%), other fishes (2.2%), and hagfishes (0.5%). A twoline eelpout and a Pacific electric ray were two of the more unusual species encountered at this site.



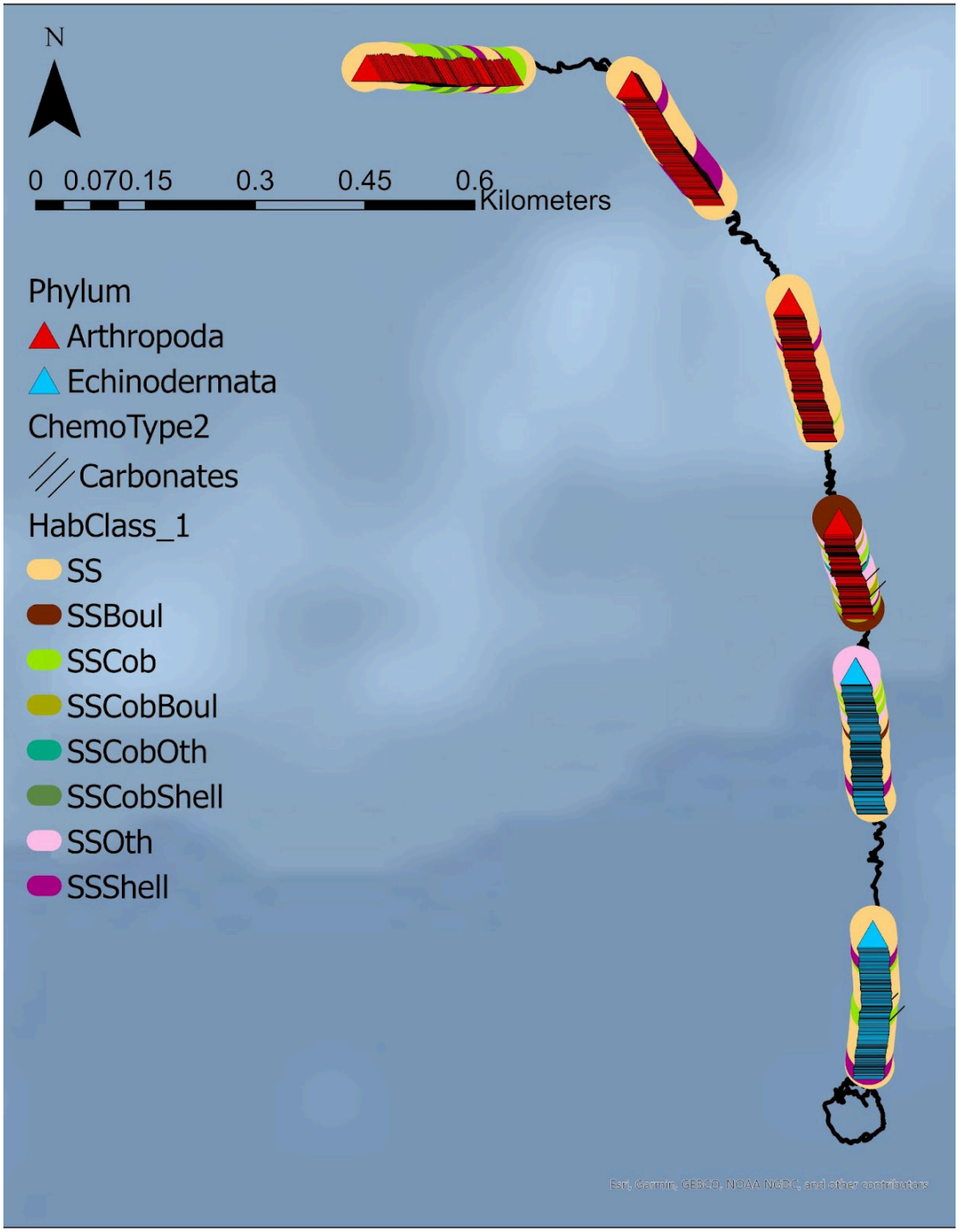

Colors in the pie diagram match colors in the list of fish taxa (below).

Eight percent (61 individuals) of the 792 corals and sponges had a fish association within one body length. Corals accounted for 74% of the associations (thin sea pens were the most abundant taxa). Thornyheads had the most associations (81%). Other fish species with associations were three deepsea sole, one twoline eelpout, and one snakehead eelpout.

| Scientific name | Common name | Number |
|---|---|---|
| *Alepocephalus tenebrosus* | California slickhead | 4 |
| *Bothrocara brunneum* | twoline eelpout | 1 |
| *Embassichthys bathybius* | deepsea sole | 2 |
| *Eptatretus* spp. | unidentified hagfish | 2 |
| *Lycenchelys crotalinus* | snakehead eelpout | 25 |
| Macrouridae | unidentified grenadier | 2 |
| *Microstomus pacificus* | Dover sole | 12 |
| Myctophidae | unidentified lanternfish | 2 |
| *Sebastolobus alascanus* | shortspine thornyhead | 6 |
| *Sebastolobus altivelis* | longspine thornyhead | 49 |
| *Sebastolobus* spp. | unidentified thornyheads | 288 |
| *Tetronarce californica* | Pacific electric ray | 1 |
| Zoarcidae | unidentified eelpout | 7 |

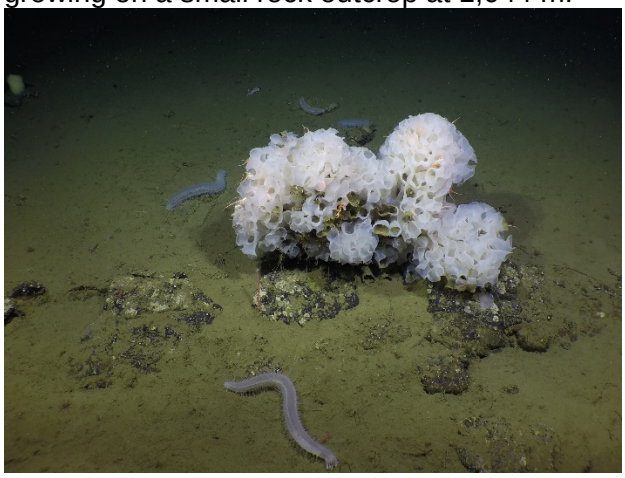
## BIOLOGICAL ENVIRONMENT: OTHER FAUNA (Santa Cruz Island South)

At least 16 taxa of fauna other than DSCS and fishes were identified from six quantitative transects conducted during Dive 0015 along the south side of Santa Cruz Island off southern California. The dominant phyla were Arthropoda (mostly shrimp) and Echinodermata (mostly ophiuroids). The map below shows habitat classification and dominant phyla for each transect. Habitat classifications include soft sediment (SS), boulders (Boul), cobbles (Cob), clam shells (Shell), and other less common substrates (OTH). The other classification includes detritus, dead sponge, ridges, and ledges. Chemosynthetic features were overlaid on the habitat classification and include carbonates.

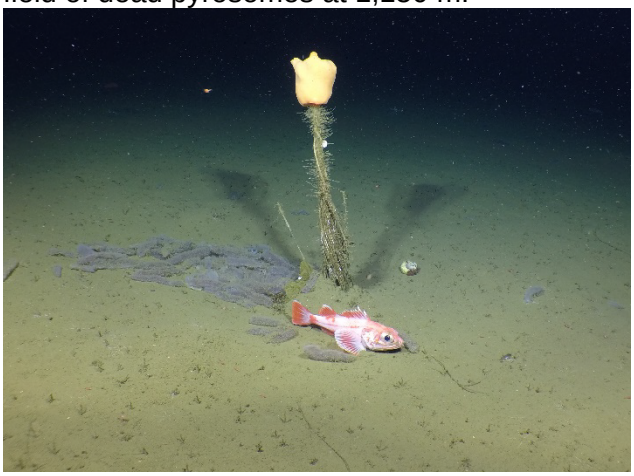


## IMAGE GALLERY (Santa Cruz Island South)

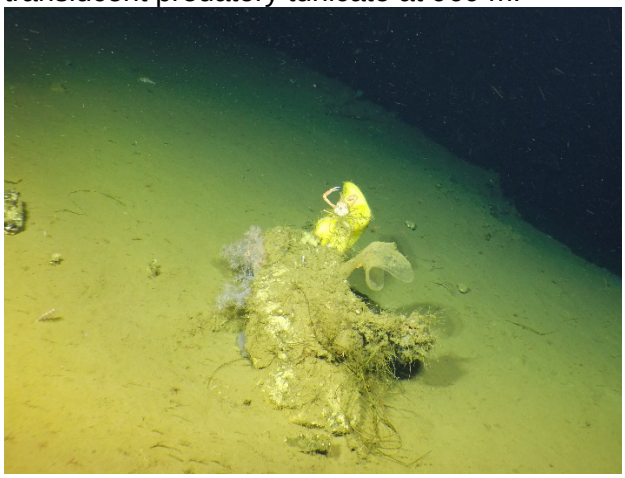
Two sea cucumbers and a large *Farrea occa* growing on a small rock outcrop at 1,044 m.



A fiber optic sponge and a thornyhead amid a field of dead pyrosomes at 1,150 m.



A yellow Picasso sponge, *Gersemia* spp., and a translucent predatory tunicate at 960 m.



A scarlet king crab (*Lithodes cousei*) crawling over a lightbulb sponge at 930 m.

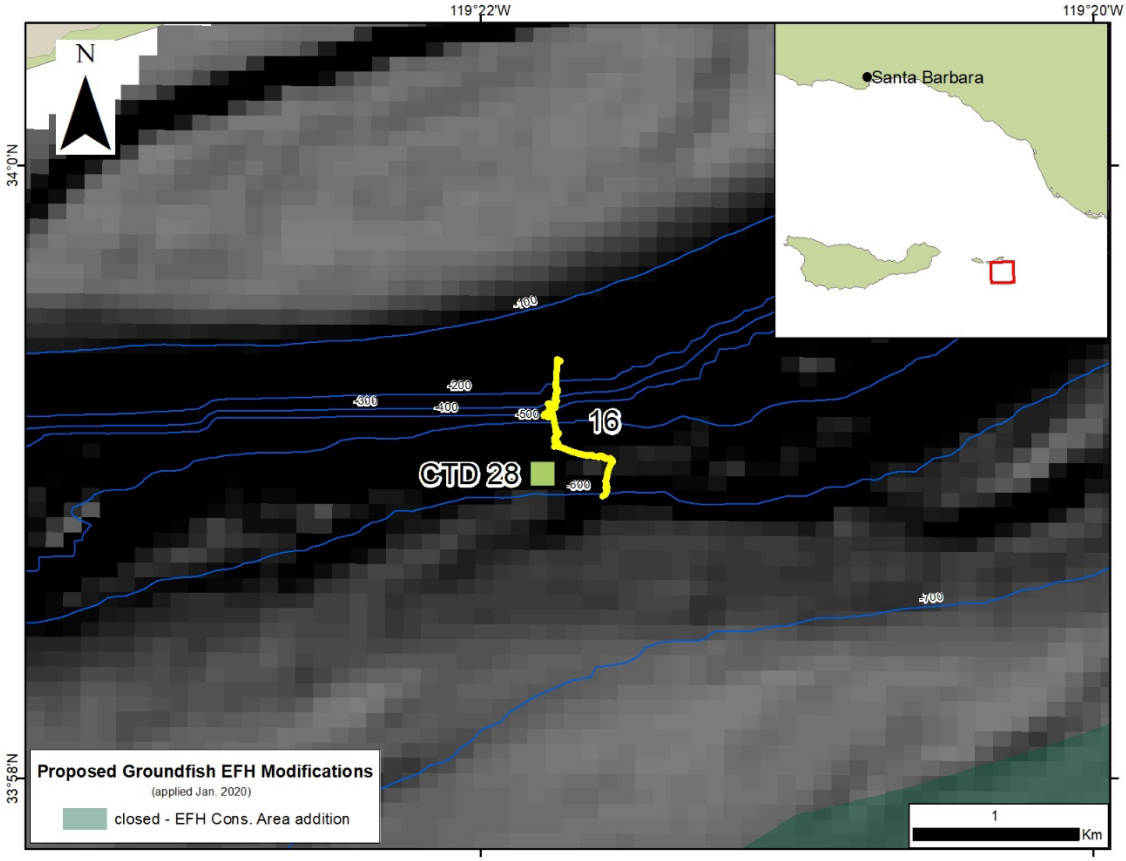
## ADDITIONAL COMMENTS (Santa Cruz Island South)

No anthropogenic debris items were documented during dives at Santa Cruz Island South.

One thin sea pen and two sponges (a *Heterochone calyx* and an unidentified vase) showed damage, while two sea pens and three sponges (two unidentified barrels and a *Heterochone calyx*) were knocked over. No corals were dying or dead and 21% of sponges (mostly unidentified vase sponges) were dying and seven percent were dead 92 unidentified barrels, and unidentified vase and a *Heterochone calyx*).

# STUDY AREA: Anacapa Island South
# DIVE NUMBER: ROV 0016

## GENERAL LOCATION AND DIVE TRACKS




## STATION OVERVIEW (Anacapa Island South)

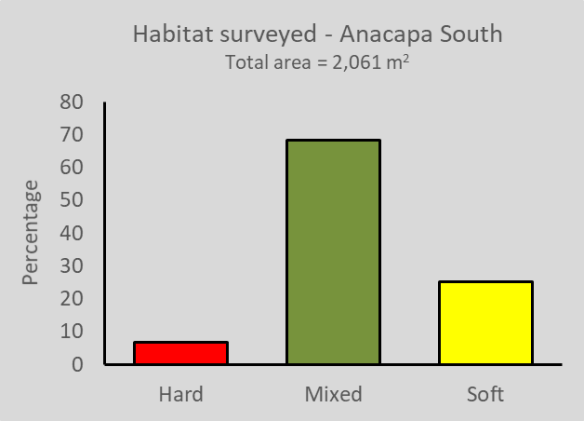
| | |
|---|---|
| **Project** | EXPRESS 2019 |
| **Chief Scientists** | Tom Laidig, Elizabeth Clarke, Chris Caldow |
| **Contact Information** | NMFS, SWFSC, tom.laidig@noaa.gov |
| **Purpose** | Survey deep-sea coral communities along the West Coast |
| **Vessel** | NOAA Ship *Reuben Lasker*; ROV *Yogi* (GFOE) |
| **Science Observers** | Tom Laidig, Meredith Everett, Craig Stuart |
| **Digital Video** | 7.7 hours |
| **Digital Still Photos** | 5,766 images |
| **Positioning System** | Ship: GPS; ROV: USBL |
| **CTD Sensors** | Yes |
| **$O_2$ Sensor (ship CTD only)** | Yes |
| **pH Sensor** | Yes |
| **Specimens collected** | 6 |
| **Water sample** | 2 eDNA; 10 water chemistry |
| **Other** | Logbook, SQL server database |
| **Report Analyst** | Tom Laidig |
| **Date Compiled** | 15 Jun 2022 |

## DIVE DATA (Anacapa Island South)

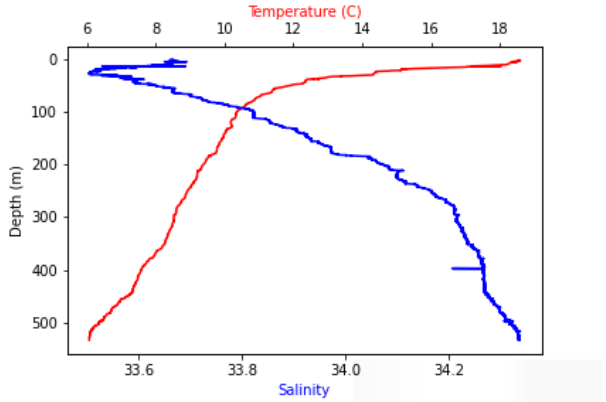
| | | | |
|---|---|---|---|
| Date | 4 Nov 2019 | Starting Latitude (N) | 33° 58.921’ |
| Minimum Bottom Depth (m) | 190 | Starting Longitude (W) | 119° 21.603’ |
| Maximum Bottom Depth (m) | 601 | Ending Latitude (N) | 33° 59.363’ |
| Start Bottom Time (UTC) | 1:30:42 | Ending Longitude (W) | 119° 21.751’ |
| End Bottom Time (UTC) | 8:07:31 | Surface Current | n/a |
| Number 15-min Transects | 4 | Bottom Current | n/a |

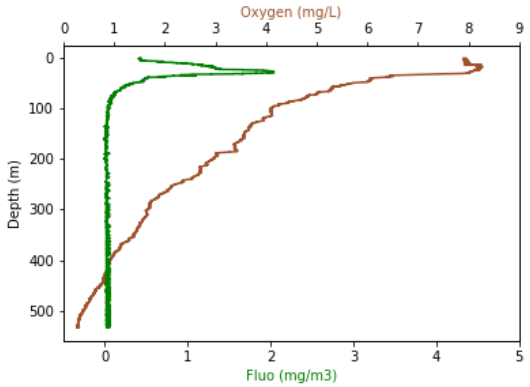
## PHYSICAL ENVIRONMENT (Anacapa Island South)

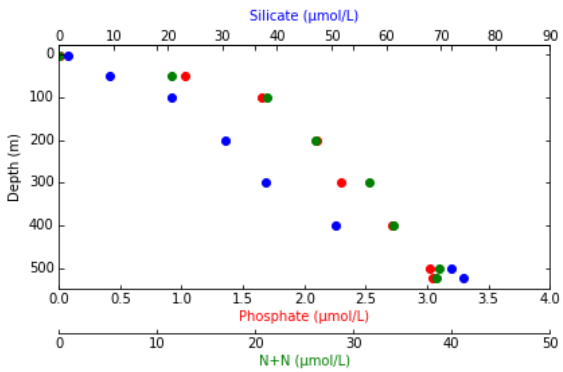
In total, 2,061 m$^2$ of seafloor were surveyed during four quantitative transects conducted during Dive 0016 along the south side of Anacapa Island off southern California. Habitat types were classified as (1) hard (7% of the total area surveyed), which included rock outcrops, boulders, and cobbles; (2) mixed (68%), including a combination of mud with boulders, rock outcrops, and cobbles; and (3) soft (25%) which consisted entirely of mud.

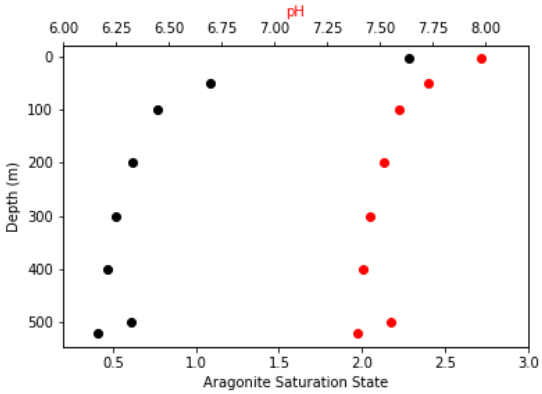



There was a thermocline (as measured from the shipboard CTD) from the surface to about 60 m and temperature decreased slowly with depth thereafter. Salinity was varied at the top 30 m, and increased slowly with depth thereafter. Oxygen decreased with depth. Fluorescence spiked around 40 m and decreased to 0 around 80 m. Nutrient load (phosphate, silicate, and nitrate [N+N]) gradually increased with depth. Saturation of pH and aragonite decreased with depth.



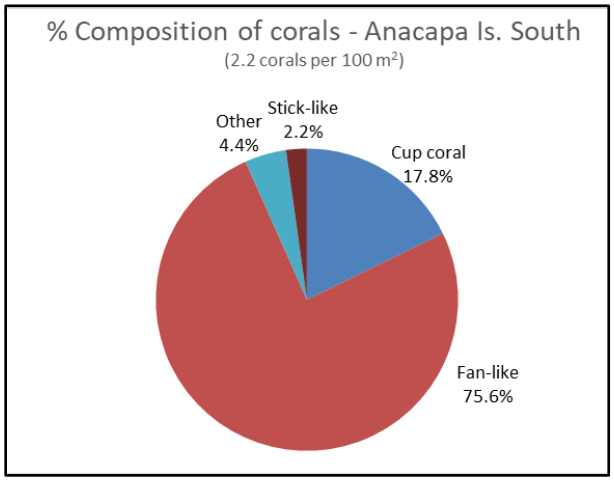



## BIOLOGICAL ENVIRONMENT: CORALS (Anacapa Island South)

A total of 45 individual coral colonies, comprising at least 11 taxa, were enumerated from four quantitative transects during Dive 0016 along the south side of Anacapa Island off southern California. Overall coral density was 2.2 corals per 100 $m^2$ of seafloor. Fan-like corals were the dominant corals (75.6%), and Christmas tree black corals were the most abundant species. The remaining groups were cup corals (*Desmophyllum dianthus*; 17.8), stick-like corals (2.2%), and other corals (4.4%).



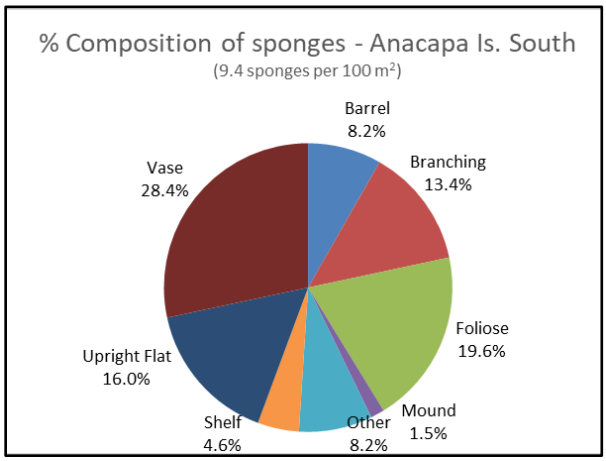

Colors in the pie diagram match colors in the list of coral taxa (below).

| Scientific name | Common name | Number |
|---|---|---|
| *Acanthogorgia gracillima* | golden coral | 3 |
| *Antipathes dendrochristos* | Christmas tree black coral | 12 |
| *Chromoplexura cordellbankensis* | yellow stick coral | 1 |
| *Desmophyllum dianthus* | cockscomb cup coral | 8 |
| Hexacorallia/Octocorallia | unidentified coral | 2 |
| *Narella* spp. | white coral | 5 |
| *Paragorgia pacifica* | bubblegum coral | 7 |
| *Paragorgia stephencairnsi* | peppermint coral | 3 |
| *Placogorgia* sp. | brown coral | 1 |
| Plexauridae #3 | *Swiftia* type (red w/ unknown polyps) | 1 |
| *Swiftia pacifica* | sea fan (red with yellow polyps) | 2 |

Three coral specimens were collected during Dive 0016 along the south side of Anacapa Island and sent to experts for identification. Shipboard identifications were *Paragorgia* spp. (one specimen), *Callogorgia* spp. (one specimen), and a stoloniferan coral (possibly *Anthothela*; one specimen). DNA barcoding and morphological identification have confirmed the identification of *Callogorgia kinoshitae.* DNA barcoding has identified the unknown stoloniferan as a species of *Anthothela*. Additional verified identifications are still pending.

## BIOLOGICAL ENVIRONMENT: SPONGES (Anacapa Island South)

A total of 194 individual sponges from at least 19 different taxa were enumerated from four quantitative transects conducted during Dive 0016 along the south side of Anacapa Island off southern California. An overall density of 9.4 sponges per 100 $m^2$ of seafloor was calculated. Unidentified vase sponges were the most abundant group (28.4%), followed by foliose (19.6%), upright flat (16.0%), branching (13.4%), barrel (8.2%), other (8.2%), shelf (4.6%), and mound (1.5%) sponges.



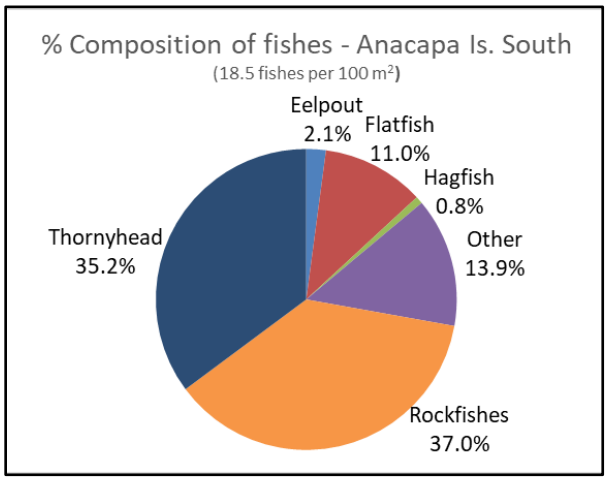

Colors in the pie diagram match colors in the list of coral taxa (below).

| Scientific name | Common name | Number |
|---|---|---|
| *Asbestopluma* spp. #1 | predatory pipecleaner sponge | 12 |
| *Farrea occa* | lace (or cloud) foliose sponge | 1 |
| *Hexactinella* spp. | sponge (white) | 1 |
| *Poecillastra* spp. | fringed shelf sponge | 2 |
| Porifera #1 | unidentified foliose sponges | 27 |
| Porifera #12 | unidentified sponge | 2 |
| Porifera #14 | Valentines sponge | 1 |
| Porifera #16 | crumpet sponge | 4 |
| Porifera #2 | unidentified upright flat sponges | 31 |
| Porifera #3 | unidentified barrel sponges | 15 |
| Porifera #4 | unidentified shelf sponges | 3 |
| Porifera #5 | unidentified vase sponges | 49 |
| Porifera #6 | unidentified mound sponges | 3 |
| Porifera #7 | unidentified branching sponge | 22 |
| Porifera #8 | unidentified tube sponge | 1 |
| *Rhabdocalyptus dawsoni* | brown barrel sponge | 1 |
| *Rhizaxinella gadus* | club sponge | 3 |
| *Staurocalyptus* spp. #1 | Picasso sponge | 6 |
| *Thenea muricata* | foliose sponge (clear) | 10 |

Two sponge specimens were collected during Dive 0016 along the south side of Anacapa Island and sent to experts for identification. Shipboard identifications were unidentified sponge (one specimen) and white vase sponge (one specimen). Verified identification from experts is still pending. DNA barcodes have been obtained from the two green sponges and analysis and additional sequencing is ongoing.

## BIOLOGICAL ENVIRONMENT: FISHES (Anacapa Island South)

At least 29 taxa of fishes were identified from four quantitative transects conducted during Dive 0016 along the south side of Anacapa Island off southern California. A total of 381 individual fishes were enumerated, with an estimated overall density of 18.5 fishes per 100 $m^2$ of seafloor. Rockfishes (37.0%; mostly splitnose rockfish) and thornyheads (35.2%) dominated the fish assemblage. The remainder of the fish assemblage included other (13.9%), flatfishes (11.0%; mostly Dover sole), eelpouts (2.1%), and hagfishes (0.8%).




Colors in the pie diagram match colors in the list of fish taxa (below).

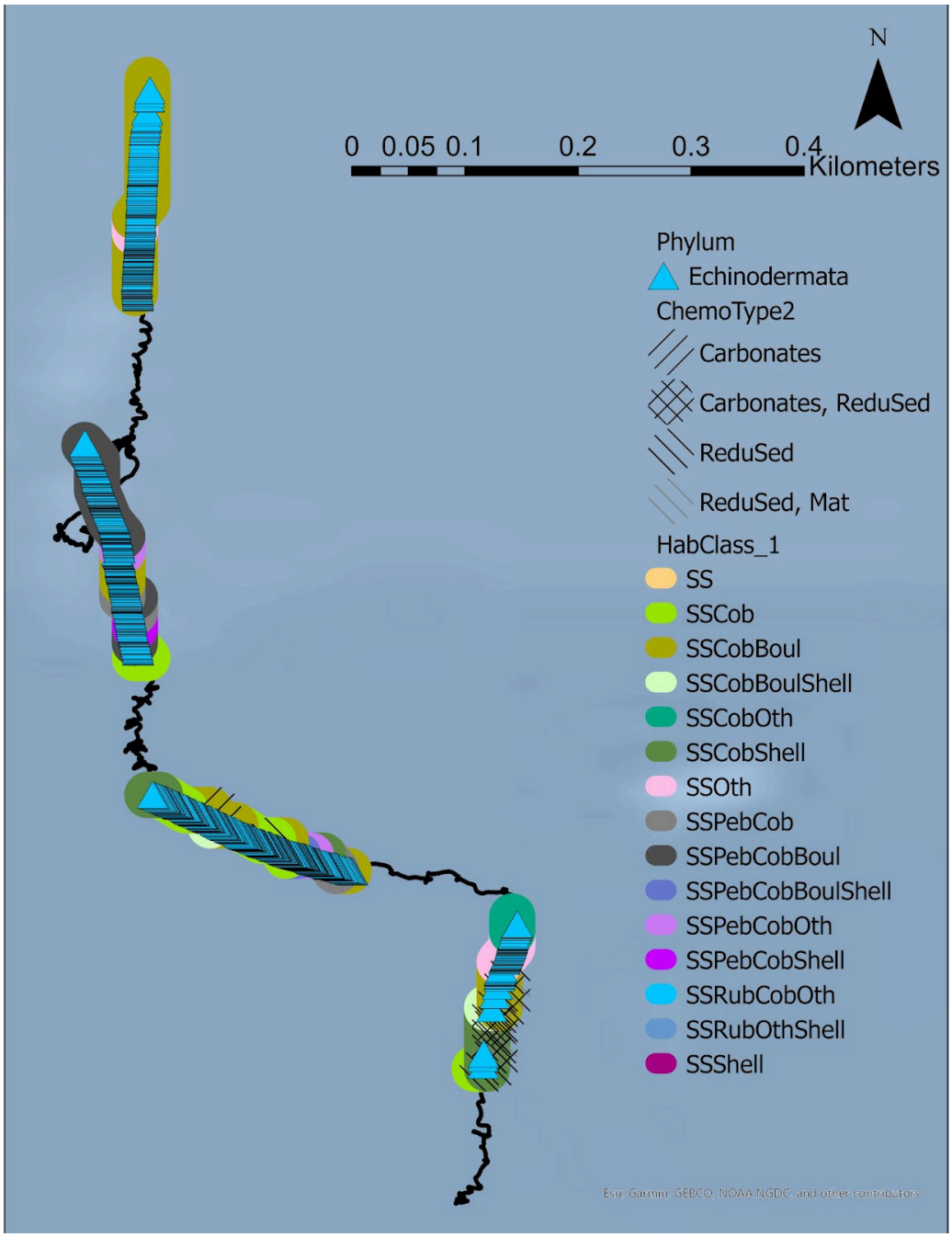
Nine percent (21 individuals) of the 239 corals and sponges had a fish association within one body length. Sponges had the most associations at 81% with vase (7) and branching (3) sponges accounting for over half of all fish and sponge associations. Four corals had fish associations (two Christmas tree black corals, one *Swiftia* type with unknown polyps, and one bubblegum coral). *Sebastomus* were the most common fish taxa associated with corals and sponges (62%). Other fish taxa associated with corals and sponges were thornyheads, combfishes, dogface witch eels, and greenspotted and splitnose rockfishes.

| Scientific name | Common name | Number |
|---|---|---|
| *Cataetyx rubrirostris* | rubynose brotula | 17 |
| *Eptatretus* spp. | unidentified hagfish | 3 |
| *Facciolella equatorialis* | dogface witch eel | 4 |
| *Glytocephalus zachirus* | rex sole | 4 |
| *Icelinus* spp. | *Icelinus* sculpins | 4 |
| *Lycodes cortezianus* | bigfin eelpout | 3 |
| *Lycodes diapterus* | black eelpout | 5 |
| Macrouridae | unidentified grenadier | 3 |
| *Merluccius productus* | Pacific hake | 9 |
| *Microstomus pacificus* | Dover sole | 38 |
| Myctophidae | unidentified lanternfish | 6 |
| *Nezumia stelgidolepis* | California grenadier | 2 |
| *Raja rhina* | longnose skate | 1 |
| *Raja stellulata* | starry skate | 1 |
| Scyliorhinidae | unidentified cat shark | 1 |
| *Sebastes aurora* | aurora rockfish | 5 |
| *Sebastes chlorostictus* | greenspotted rockfish | 1 |
| *Sebastes diploproa* | splitnose rockfish | 67 |
| *Sebastes elongatus* | greenstriped rockfish | 3 |
| *Sebastes paucispinis* | bocaccio | 1 |
| *Sebastes phillipsi* | chameleon rockfish | 5 |
| *Sebastes rubrivinctus* | flag rockfish | 1 |
| *Sebastes rufus* | bank rockfish | 4 |
| *Sebastes simulator* | pinkrose rockfish | 3 |

| Scientific name | Common name | Number |
|---|---|---|
| *Sebastolobus alascanus* | shortspine thornyhead | 2 |
| *Sebastolobus altivelis* | longspine thornyhead | 27 |
| *Sebastolobus* spp. | unidentified thornyheads | 105 |
| *Sebastomus* | unidentified *Sebastomus* | 51 |
| *Zaniolepis frenata* | shortspine combfish | 5 |

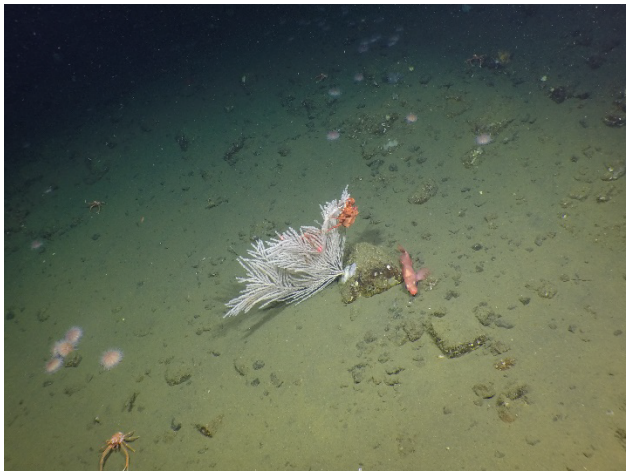
## BIOLOGICAL ENVIRONMENT: OTHER FAUNA (Anacapa Island South)

At least 25 taxa of fauna other than DSCS and fishes were identified from four quantitative transects conducted during Dive 0016 along the south side of Anacapa Island off southern California. The dominant phylum was Echinodermata (mostly urchins). The map below shows habitat classification and dominant phyla for each transect. Habitat classifications include soft sediment (SS), boulders (Boul), cobbles (Cob), pebbles (Peb), rubble (Rub), clam shells (Shell), and other less common substrates (OTH). The other classification includes detritus, mounds, and trash. Chemosynthetic features were overlaid on the habitat classification and include carbonates, reduced sediments (ReduSed), and bacterial mats (Mat).



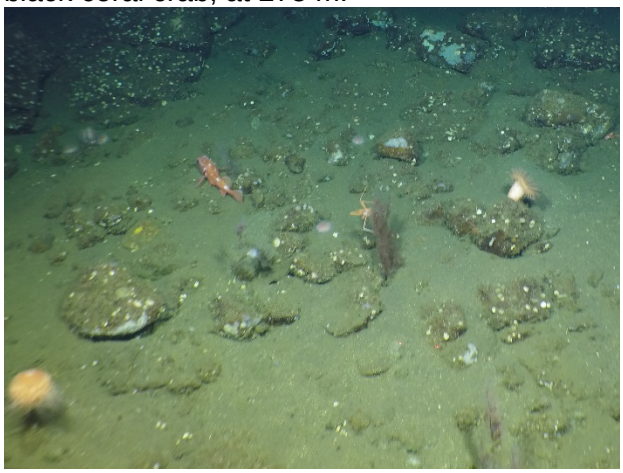
## IMAGE GALLERY (Anacapa Island South)

A *Callogorgia* spp. with crab and a splitnose rockfish at 450 m.

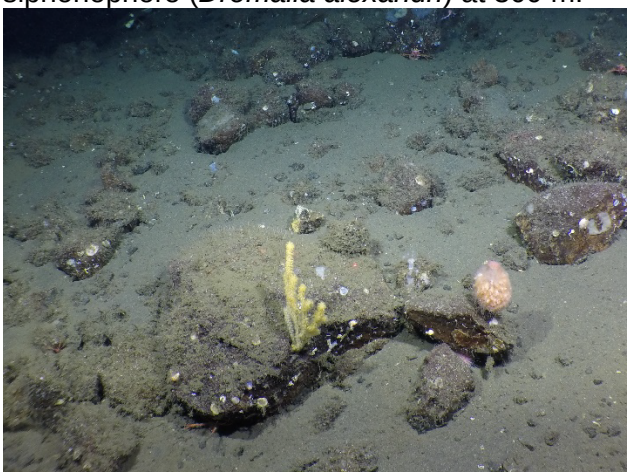


An unidentified sponge and anemone on a mud seafloor at 460 m.

Two Christmas tree black corals, one with a black coral crab, at 275 m.



A small *Acanthogorgia gracillima* and a benthic siphonophore (*Dromalia alexandri*) at 300 m.



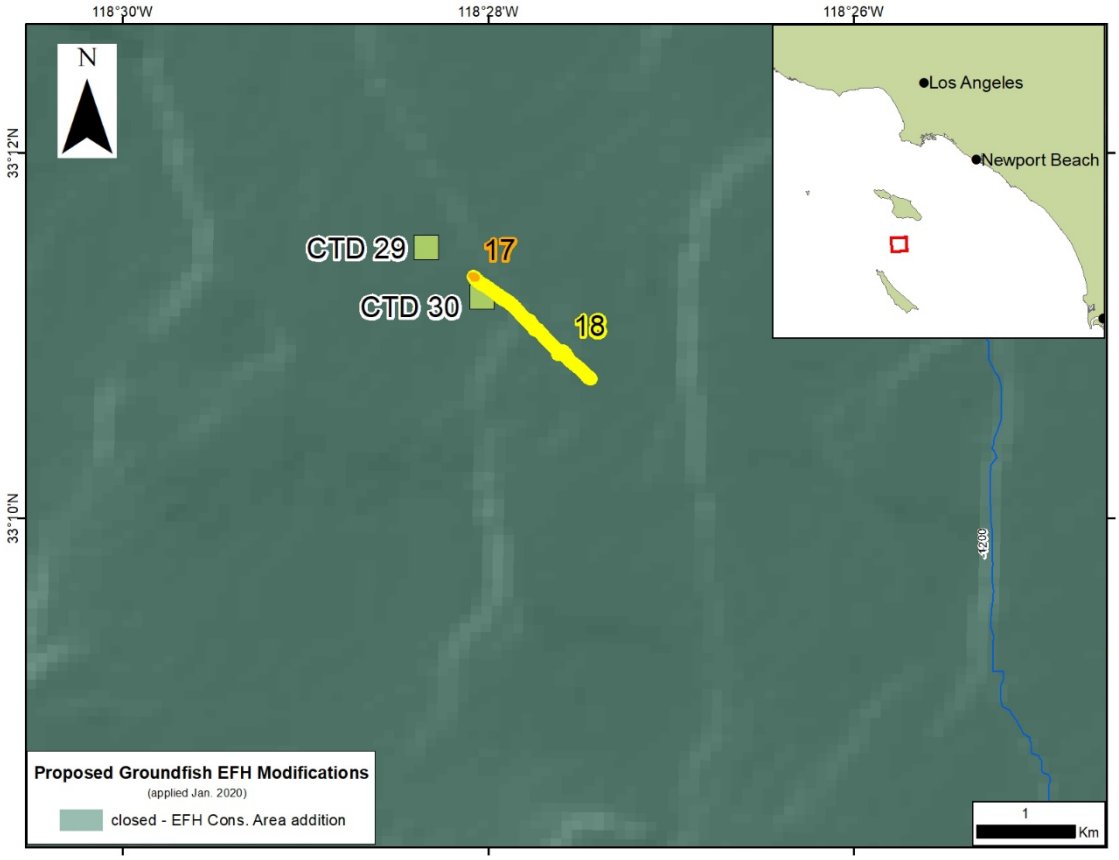
## ADDITIONAL COMMENTS (Anacapa Island South)

Three anthropogenic debris items were documented during dives at Anacapa Island South. One heavy rope line and one thin rope were draped across the seafloor and over boulders. Both were covered in sediment in places and had some invertebrate growth. The remaining debris item was a silver can slightly bigger than a cat food can. It was sitting on a mud seafloor and had a few small patches of sediment on the top, which suggested that it was not newly discarded. Damage potentially caused by these items was not observed.

No corals and four sponges (one foliose and three unidentified vase sponges) showed signs of damage with broken sections. One *Antipathes dendrochristos* and five sponges (one foliose [the same one that was damaged] and four unidentified vase sponges) were knocked over. Three percent of corals (one *Antipathes dendrochristos*) and 16% of sponges (32 individuals; mostly unidentified barrel and vase sponges) were dying and no corals and 11% of sponges (mostly unidentified vase and barrel sponges) were dead.

# STUDY AREA: Santa Catalina Basin
# DIVE NUMBER: ROV 0017-0018

## GENERAL LOCATION AND DIVE TRACKS




## STATION OVERVIEW (Santa Catalina Basin)

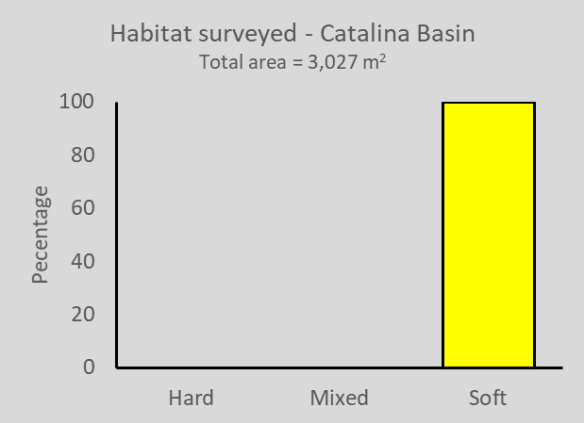
| | |
|---|---|
| **Project** | EXPRESS 2019 |
| **Chief Scientists** | Tom Laidig, Elizabeth Clarke, Chris Caldow |
| **Contact Information** | NMFS, SWFSC, tom.laidig@noaa.gov |
| **Purpose** | Survey deep-sea coral communities along the West Coast |
| **Vessel** | NOAA Ship *Reuben Lasker*; ROV *Yogi* (GFOE) |
| **Science Observers** | Tom Laidig, Meredith Everett, Craig Stuart |
| **Digital Video** | 12.2 hours |
| **Digital Still Photos** | 9,376 images |
| **Positioning System** | Ship: GPS; ROV: USBL |
| **CTD Sensors** | Yes |
| **$O_2$ Sensor** | Yes |
| **pH Sensor** | Yes |
| **Specimens collected** | 14 |
| **Water sample** | 0 eDNA; 4 water chemistry |
| **Other** | Logbook, SQL server database |
| **Report Analyst** | Tom Laidig |
| **Date Compiled** | 15 Jun 2022 |

## DIVE DATA (Santa Catalina Basin)

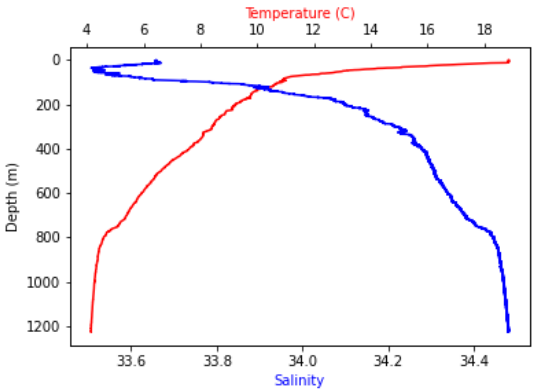
| | | | |
|---|---|---|---|
| Date | 5-6 Nov 2019 | Starting Latitude (N) | 33° 11.316’ |
| Minimum Bottom Depth (m) | 1,234 | Starting Longitude (W) | 118° 28.081’ |
| Maximum Bottom Depth (m) | 1,244 | Ending Latitude (N) | 33° 11.326’ |
| Start Bottom Time (UTC) | 2:41:39 | Ending Longitude (W) | 118° 28.092’ |
| End Bottom Time (UTC) | 3:14:20 | Surface Current | n/a |
| Number 15-min Transects | 4 | Bottom Current | n/a |

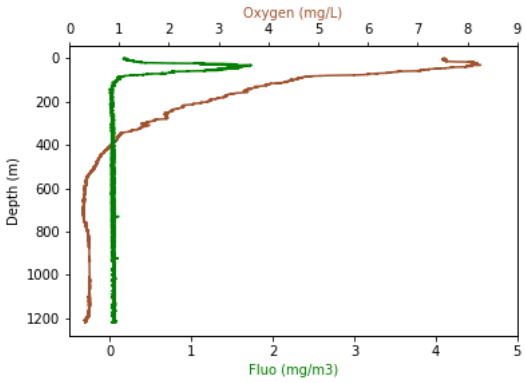
## PHYSICAL ENVIRONMENT (Santa Catalina Basin)

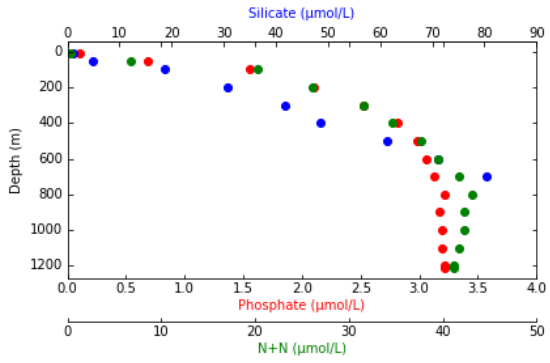
In total, 3,027 $m^2$ of seafloor were surveyed during four quantitative transects conducted during Dive 0017 in the Santa Catalina Basin off southern California. The only habitat type observed on this dive was soft (100%), which consisted entirely of mud.

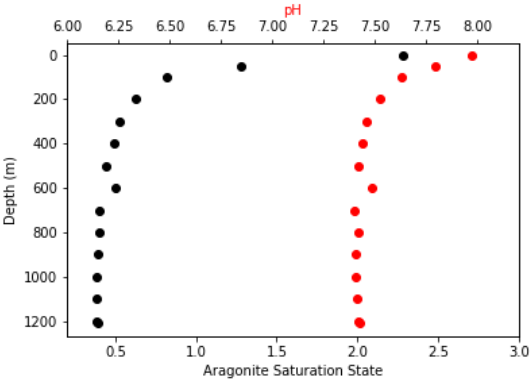



Temperature dropped quickly (as measured from the shipboard CTD) from the surface to 100 m and decreased slowly with depth thereafter. Salinity decreased for the first 50 m and slowly increased with depth thereafter. Oxygen increased for the first 30 m and then decreased with depth with an increase slightly from 800-1,150 m, before decreasing again. Fluorescence spiked around 40 m and decreased to 0 around 150 m. Nutrient load (phosphate, silicate, and nitrate [N+N]) gradually increased with depth and remained constant after 800 m. Saturation of pH and aragonite decreased with depth.



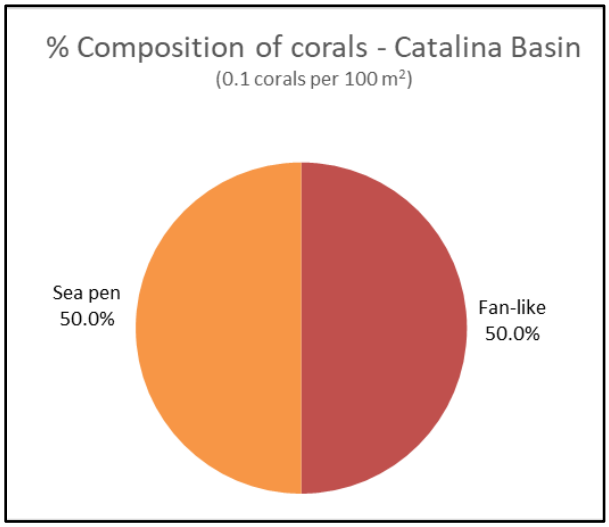



## BIOLOGICAL ENVIRONMENT: CORALS (Santa Catalina Basin)

A total of two individual coral colonies, comprising at least two taxa, were enumerated from four quantitative transects during Dive 0017 in the Santa Catalina Basin off southern California. Overall coral density was 0.1 corals per 100 $m^2$ of seafloor. One fan-like coral and one sea pen were observed on this muddy covered dive.



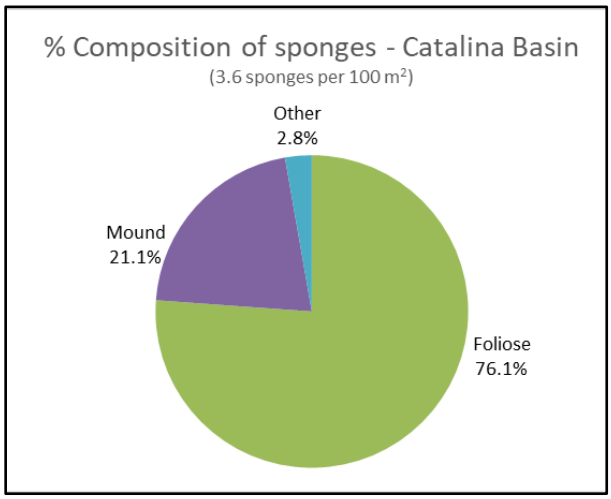

Colors in the pie diagram match colors in the list of coral taxa (below).

| Scientific name | Common name | Number |
|---|---|---|
| Antipatharia | unknown black coral | 1 |
| Pennatulacea #1 | sea pen (thin) | 1 |

No coral specimens were collected during Dive 0017-18 at Santa Catalina Basin.

## BIOLOGICAL ENVIRONMENT: SPONGES (Santa Catalina Basin)

A total of 109 individual sponges from at least five different taxa were enumerated from four quantitative transects conducted during Dive 0017 in the Santa Catalina Basin off southern California. An overall density of 3.6 sponges per 100 $m^2$ of seafloor was calculated. Foliose sponges (predominantly dead *Farrea occa*) dominated the sponge assemblage (76%), followed by mound (21%), and other (3%) sponges.



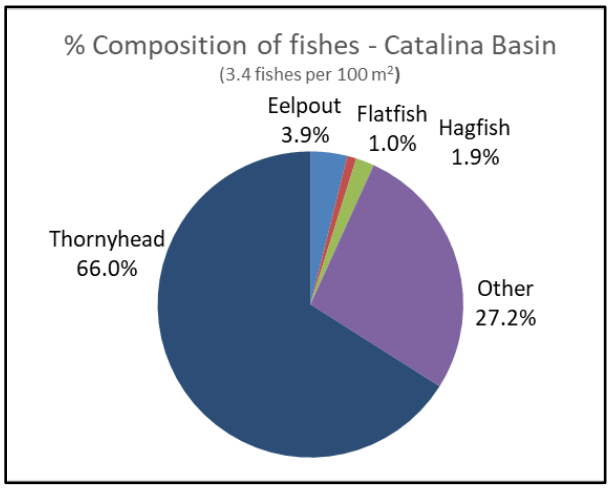

Colors in the pie diagram match colors in the list of coral taxa (below).

| Scientific name | Common name | Number |
|---|---|---|
| *Asbestopluma* spp. #1 | predatory pipecleaner sponge | 2 |
| *Farrea occa* | lace (or cloud) foliose sponge | 56 |
| *Hyalonema populiferum* | fiber optic sponge | 1 |
| Porifera #1 | unidentified foliose sponges | 27 |
| Porifera #15 | green moon sponge | 23 |

Eight sponge specimens were collected during Dive 0017 in the Santa Catalina Basin and sent to experts for identification. Shipboard identifications were dead sponge (possibly *Farrea* spp.; five specimens), green puffball sponge (two specimens), and puffball sponge (one specimen). Verified identification from experts is still pending.

## BIOLOGICAL ENVIRONMENT: FISHES (Santa Catalina Basin)

At least eight taxa of fishes were identified from four quantitative transects conducted during Dive 0017 in the Santa Catalina Basin off southern California. A total of 103 individual fishes were enumerated, with an estimated overall density of 3.4 fishes per 100 $m^2$ of seafloor. Thornyheads dominated the fish assemblage (66%). The remainder of the fish assemblage included other fishes (27.2%; mostly grenadiers), eelpouts (3.9%), hagfishes (1.9%), and flatfishes (1.0%).



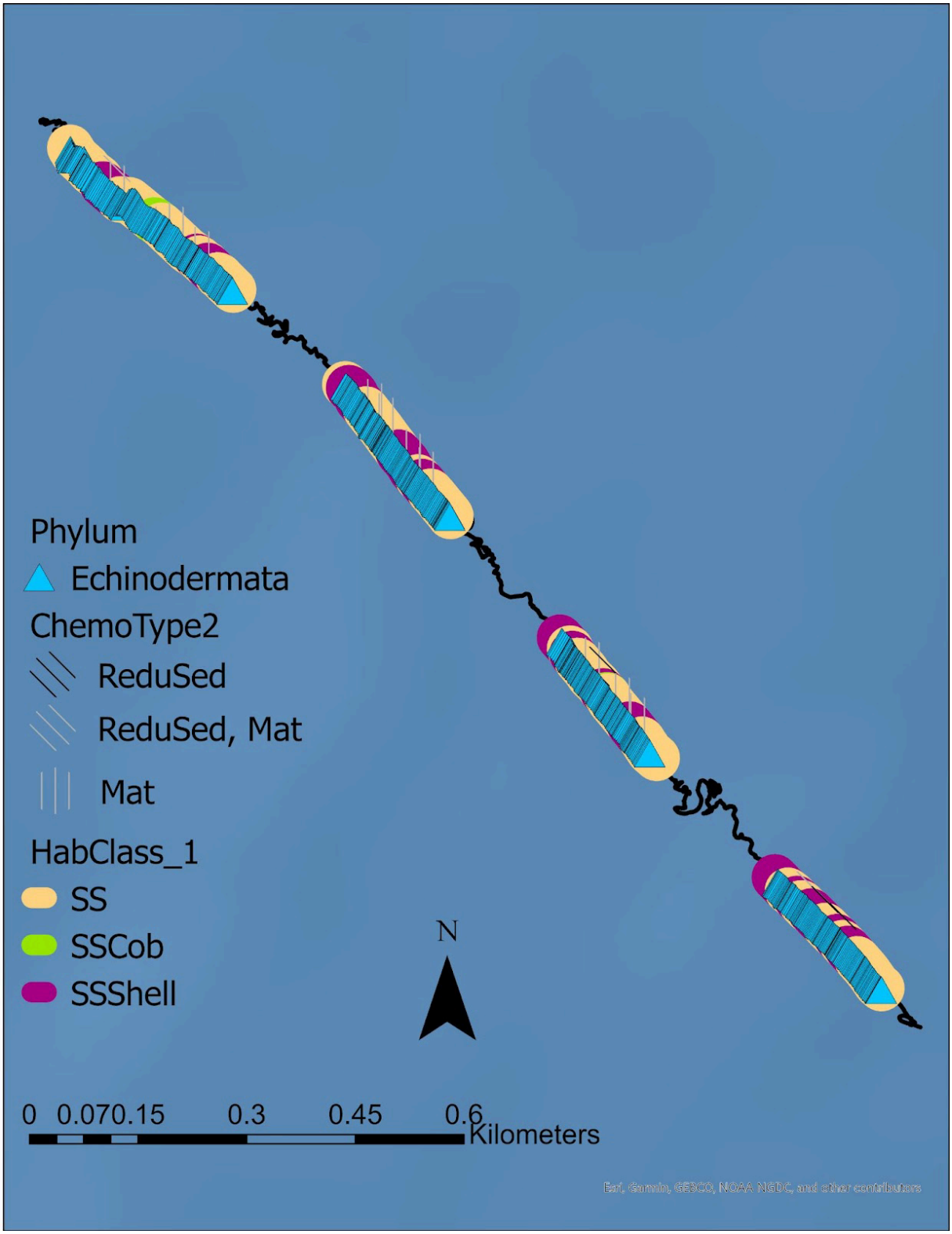

Colors in the pie diagram match colors in the list of fish taxa (below).

Four individuals (three longspine thornyheads and one grenadier) were associated with four dead *Farrea* spp. sponges (4% of all sponges) and no fish were associated with either of the two corals observed. The 30 cm grenadier was hovering near the sponge, while the three thornyheads (ranging from 15-20 cm) were sitting on the mud next to the sponges.

| Scientific name | Common name | Number |
|---|---|---|
| *Bathyraja trachura* | roughtail skate | 1 |
| *Eptatretus* spp. | unidentified hagfish | 2 |
| Macrouridae | unidentified grenadier | 19 |
| *Microstomus pacificus* | Dover sole | 1 |
| Myctophidae | unidentified lanternfish | 8 |
| *Sebastolobus altivelis* | longspine thornyhead | 5 |
| *Sebastolobus* spp. | unidentified thornyheads | 63 |
| Zoarcidae | unidentified eelpout | 4 |

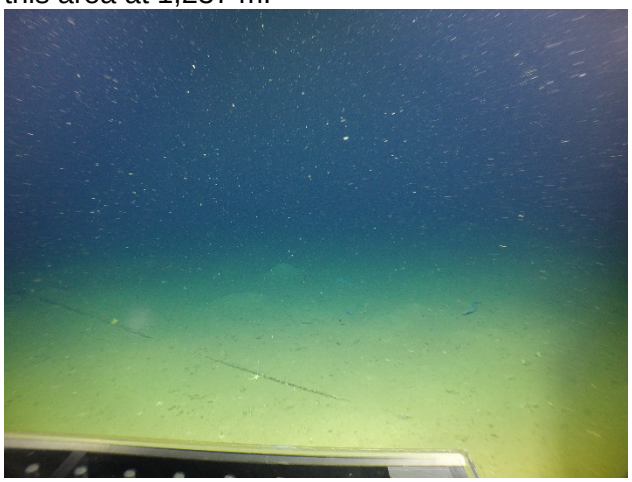
## BIOLOGICAL ENVIRONMENT: OTHER FAUNA (Santa Catalina Basin)

At least 14 taxa of fauna other than DSCS and fishes were identified from four quantitative transects conducted during Dive 0017 in the Santa Catalina Basin off southern California. The dominant phylum was Echinodermata (mostly ophiuroids [21,627 individuals]). The map below shows habitat classification and dominant phyla for each transect. Habitat classifications include soft sediment (SS), cobbles (Cob), and clam shells (Shell). Chemosynthetic features were overlaid on the habitat classification and include reduced sediments (ReduSed) and bacterial mats (Mat).

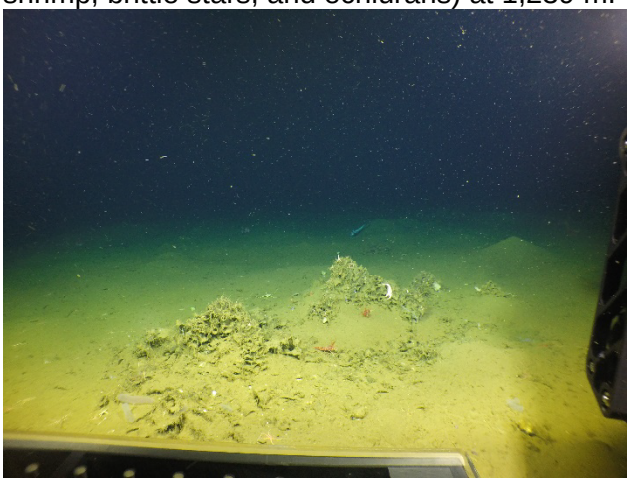


## IMAGE GALLERY (Santa Catalina Basin)

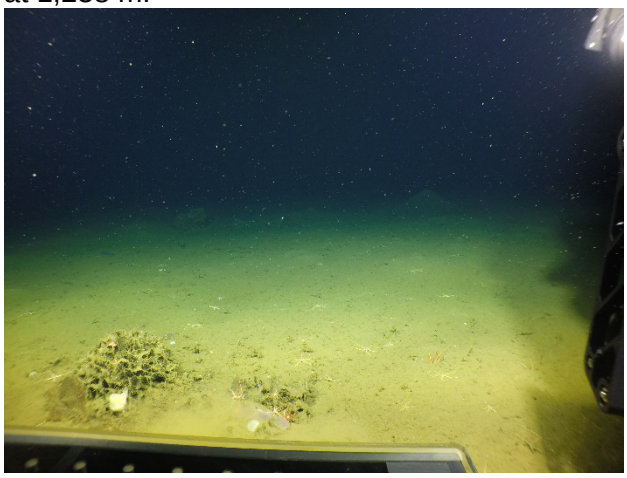
One of many lines crisscrossing the seafloor in this area at 1,237 m.



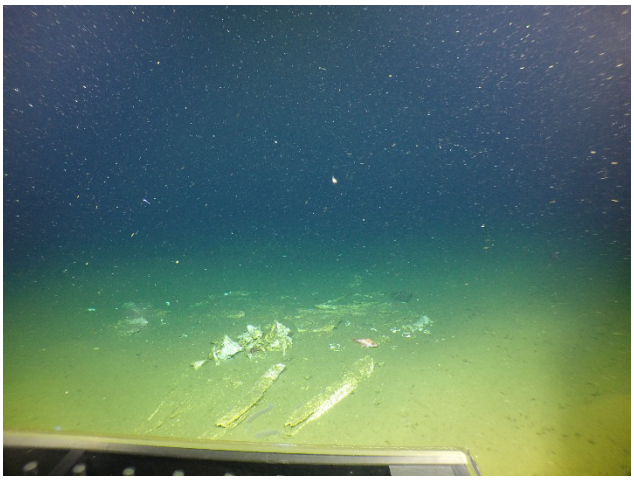
A dead sponge (possibly *Farrea* spp.) with many associated invertebrates (e.g., sea star, shrimp, brittle stars, and echiurans) at 1,239 m.



A dead sponge (possibly *Farrea* spp.) with brittle stars and small living sponges attached at 1,238 m.



Old whale bones covered in sediment on a mud seafloor at 1,236 m.



## ADDITIONAL COMMENTS (Santa Catalina Basin)

Many lines were crisscrossing the seafloor during this dive. They often crossed perpendicular to one another and had the appearance of gridlines. We researched this and could not find any scientific papers that used physical gridlines in this area. It is a mystery to us as to the origin of these lines. The lines were dark, but reflected the ROV lights and it was difficult to determine the exact material from which they were made. We counted at least 21 different lines crossing, and some of the lines stretched for tens of meters. All the lines looked old and had growth on them or were buried in the sediment. Although the lines traversed over sponges, they did not appear to have damaged any of them. The only other anthropogenic debris item was a black tube (looked like PVC pipe) laying on the sediment.

No corals were damaged or knocked over, and only one stalked sponge was damaged but none were knocked over. No corals were dying or dead. Most sponges were dead (71%) or dying (4%). The most common dead or dying sponges were *Farrea occa* (56 individuals) and unidentified foliose sponges (24 sponges). Of the remaining sponges, only one stalked sponge was dead and one green moon sponge appeared to be dying. This site had the highest number of dead sponges out of all the sites surveyed.

# CONCLUSIONS AND NEXT STEPS

In surveying from southern Washington to southern California, the 2019 EXPRESS cruise provided a unique opportunity to examine the distribution of deep-sea coral and sponges (DSCS) and fishes along roughly 1,000 miles of coastline. Altogether we surveyed 14 sites covering 35,253 $m^2$ of seafloor in 50 quantitative transects. In total, 29 coral taxa, 29 sponge taxa and 69 fish taxa were observed from the ROV video, with densities of DSCS and fishes varying along the coastline (Tables 5-7). During the 31-day cruise, we lost only one day to weather when no surveying or sampling could occur. Along with the good weather window, the EXPRESS partnerships allowed enormous amounts of data to be collected (CTD, eDNA, POM, etc.) than would have been collected by video surveys alone. These data will help answer a variety of research questions and will give us baseline information on many different EFHCAs. This 2019 EXPRESS mission is a great example of what can be accomplished when resources, technology, and expertise are strategically leveraged.

## Deep-Sea Corals and Sponges

Deep-sea corals were observed on all transects while sponges were more variable and were absent at two dives (Table 5, 6, and 8). Point Sur Slot Canyons had the highest density of corals (Table 8). These were all sea pens of various species. Santa Catalina Basin had the lowest density of corals (0.1 corals/100 $m^2$) with only two corals observed. The Sponge Bycatch area had the greatest diversity of corals with 14 taxa. Daisy Bank had the highest density and number of sponges with 6,415 sponges counted over four transects. Santa Catalina Basin was filled with many dead sponges, many of which had other healthy sponges attached.

## Range Observations and Range Extensions

Most corals were seen coastwide, and no surprises occurred in their distributions. Northern species like S*wiftia* cf. *beringi*, were only seen in the north while southern species were only seen in the south (*Adelogorgia* spp., *Placogorgia* sp., *Antipathes dendrochristos*). Most sponge taxa were observed coastwide; however, some taxa were only observed in the southernmost portion of our study area, including the moldy Swiss cheese sponge (only as far north as Santa Lucia Bank), purple and green moon sponge, and *Mycale* spp. while potato sponge was only seen in the north. Further work on sponge identification and distribution is needed to determine ranges for most species. The deep-living fish species (e.g., thornyheads, roughtail skates, slickheads, sablefish, and grenadiers) occurred throughout the coastal survey having a generally cosmopolitan distribution along the coast. No range extensions were observed in the few shallower sites, but a few notable fish distributions were observed. Darkblotched rockfish (a northern species) were prevalent on Santa Lucia Bank. This is similar to the 2018 expedition, which suggests that this is a stable population at this location. Many rubynose brotulas were observed at the Sponge Bycatch site. This species is common in southern and central California, and although not a range extension, this was a large number to see this far north.

Table 5. Densities of coral taxa (#/100 m) observed at each site surveyed (ordered from north to south) during the 2019 EXPRESS expedition.

| Coral taxa | Willapa Canyon | Daisy Bank | Sponge Bycatch | Humboldt Wind Energy | Cordell Bank NMS | Cabrillo Canyon | West Carmel Canyon | Point Sur Slot Canyons | Santa Lucia Bank | Santa Cruz Island South | Anacapa Island South | Santa Catalina Basin |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| *Acanthogorgia* spp. | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.21 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| *Acanthogorgia gracillima* | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.15 | 0.00 |
| Alcyonacea | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.21 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| *Anthoptilum grandiflorum* | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.06 | 0.06 | 0.00 | 0.00 | 0.00 |
| Antipatharia | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.03 |
| *Antipathes dendrochristos* | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.58 | 0.00 |
| *Bathypathes* spp. | 0.00 | 0.00 | 0.00 | 0.00 | 0.24 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| *Chromoplexura cordellbankensis* | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.05 | 0.00 |
| *Clavularia* spp. | 0.00 | 0.00 | 0.14 | 0.31 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| *Desmophyllum dianthus* | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.39 | 0.00 |
| *Funiculina* spp. | 0.00 | 0.00 | 0.17 | 0.00 | 0.27 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| *Gersemia* spp. | 0.00 | 0.00 | 0.63 | 0.00 | 2.56 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| *Halipteris californica* | 0.00 | 0.00 | 0.06 | 0.00 | 0.07 | 0.00 | 0.09 | 0.06 | 0.00 | 0.00 | 0.00 | 0.00 |
| *Heteropolypus ritteri* | 0.00 | 0.00 | 2.07 | 1.40 | 2.43 | 0.00 | 0.00 | 0.00 | 0.31 | 0.10 | 0.00 | 0.00 |
| Hexacorallia/Octocorallia | 0.00 | 0.00 | 0.03 | 0.00 | 0.00 | 0.42 | 0.00 | 0.00 | 0.00 | 0.00 | 0.10 | 0.00 |
| Isididae | 0.00 | 0.00 | 0.11 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| *Narella* spp. | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.24 | 0.00 |
| *Paragorgia pacifica* | 0.00 | 0.00 | 0.19 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.01 | 0.07 | 0.34 | 0.00 |
| *Paragorgia* spp. | 0.00 | 0.00 | 2.84 | 2.96 | 0.00 | 0.00 | 0.00 | 0.00 | 0.43 | 0.00 | 0.00 | 0.00 |
| *Paragorgia stephencairnsi* | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.15 | 0.00 |
| *Parastenella ramosa* | 0.00 | 0.00 | 0.08 | 0.78 | 0.00 | 2.12 | 0.00 | 0.00 | 0.01 | 0.00 | 0.00 | 0.00 |
| Pennatulacea #1 | 0.04 | 0.00 | 0.00 | 0.00 | 2.76 | 13.14 | 25.62 | 41.58 | 0.08 | 23.00 | 0.00 | 0.03 |
| Pennatulidae | 0.00 | 0.00 | 0.00 | 0.00 | 0.03 | 0.00 | 0.50 | 16.66 | 0.00 | 0.63 | 0.00 | 0.00 |
| *Placogorgia* sp. | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.05 | 0.00 |
| Plexauridae #1 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.02 | 0.00 | 0.00 | 0.00 |
| Plexauridae #3 | 0.00 | 0.00 | 1.71 | 0.62 | 0.07 | 0.00 | 0.00 | 0.00 | 0.28 | 0.50 | 0.05 | 0.00 |
| *Plumarella longispina* | 0.00 | 0.00 | 0.03 | 0.16 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| *Swiftia* cf. *beringi* | 0.00 | 2.91 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| *Swiftia pacifica* | 0.00 | 0.00 | 0.11 | 7.64 | 0.13 | 1.06 | 0.00 | 0.00 | 0.09 | 0.00 | 0.10 | 0.00 |
| *Umbellula lindahli* | 0.00 | 0.00 | 0.14 | 0.00 | 0.47 | 0.00 | 0.09 | 11.68 | 0.02 | 0.00 | 0.00 | 0.00 |

Table 6. Densities of sponge taxa observed at each site surveyed (ordered from north to south) during the 2019 EXPRESS expedition.

| Sponge taxa | Willapa Canyon | Daisy Bank | Sponge Bycatch | Humboldt Wind Energy | Cordell Bank NMS | Cabrillo Canyon | West Carmel Canyon | Point Sur Slot Canyons | Santa Lucia Bank | Santa Cruz Island South | Anacapa Island South | Santa Catalina Basin |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| *Asbestopluma* spp. #1 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 6.36 | 0.00 | 0.00 | 0.95 | 0.03 | 0.58 | 0.07 |
| *Asbestopluma* spp. #2 | 0.00 | 0.00 | 2.21 | 0.47 | 0.00 | 0.00 | 0.00 | 0.00 | 0.08 | 0.00 | 0.00 | 0.00 |
| *Farrea occa* | 0.00 | 0.00 | 0.36 | 0.78 | 0.00 | 0.00 | 0.00 | 0.00 | 0.09 | 0.07 | 0.05 | 1.85 |
| *Haliclona* (Gellius) spp. | 0.00 | 8.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| *Heterochone calyx* | 0.00 | 2.74 | 0.00 | 0.78 | 0.00 | 0.00 | 0.00 | 0.00 | 0.10 | 0.07 | 0.00 | 0.00 |
| *Hexactinella* spp. | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.20 | 0.05 | 0.00 |
| *Hyalonema populiferum* | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.10 | 0.00 | 0.03 |
| *Latrunculia* spp. | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.10 | 0.00 | 0.00 | 0.00 |
| *Mycale* spp. | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.92 | 0.03 | 0.00 | 0.00 |
| *Poecillastra* spp. | 0.00 | 0.00 | 0.00 | 0.00 | 0.13 | 0.00 | 0.00 | 0.00 | 0.10 | 0.03 | 0.10 | 0.00 |
| *Polymastia* spp. #1 | 0.00 | 0.00 | 0.00 | 42.43 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Porifera #1 | 0.00 | 2.05 | 0.19 | 0.16 | 0.00 | 0.00 | 0.00 | 0.00 | 1.05 | 0.07 | 1.31 | 0.89 |
| Porifera #2 | 0.00 | 0.00 | 0.00 | 0.00 | 0.03 | 0.00 | 0.00 | 0.00 | 0.08 | 0.07 | 1.50 | 0.00 |
| Porifera #3 | 0.00 | 92.30 | 0.14 | 1.25 | 0.03 | 0.00 | 0.00 | 0.00 | 0.91 | 0.17 | 0.73 | 0.00 |
| Porifera #4 | 0.00 | 0.17 | 0.03 | 0.00 | 0.10 | 0.64 | 0.00 | 0.00 | 0.05 | 0.00 | 0.15 | 0.00 |
| Porifera #5 | 0.00 | 36.25 | 0.36 | 1.72 | 0.07 | 0.00 | 0.00 | 0.00 | 0.92 | 0.17 | 2.38 | 0.00 |
| Porifera #6 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.38 | 0.13 | 0.15 | 0.00 |
| Porifera #7 | 0.17 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.47 | 0.03 | 1.07 | 0.00 |
| Porifera #8 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.11 | 0.00 | 0.05 | 0.00 |
| Porifera #9 | 0.00 | 0.00 | 0.44 | 0.00 | 0.03 | 0.00 | 0.00 | 0.00 | 0.42 | 0.13 | 0.00 | 0.00 |
| Porifera #12 | 0.00 | 0.77 | 0.47 | 1.72 | 0.03 | 1.27 | 0.00 | 0.00 | 0.10 | 0.00 | 0.10 | 0.00 |
| Porifera #14 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.05 | 0.07 | 0.05 | 0.00 |
| Porifera #15 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.07 | 0.00 | 0.76 |
| Porifera #16 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.16 | 0.00 | 0.19 | 0.00 |
| *Rhabdocalyptus dawsoni* | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.01 | 0.07 | 0.05 | 0.00 |
| *Rhizaxinella gadus* | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.15 | 0.00 |
| *Staurocalyptus* spp. #1 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.02 | 0.03 | 0.29 | 0.00 |
| *Staurocalyptus* spp. #2 | 0.00 | 16.12 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| *Thenea muricata* | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.09 | 0.50 | 0.49 | 0.00 |

Table 7. Densities of fish taxa observed at each site surveyed (ordered from north to south) during the 2019 EXPRESS expedition.

| Fish Taxa | Willapa Canyon | Daisy Bank | Sponge Bycatch | Humboldt Wind Energy | Cordell Bank NMS | Cabrillo Canyon | West Carmel Canyon | Point Sur Slot Canyons | Santa Lucia Bank | Santa Cruz Island South | Anacapa Island South | Santa Catalina Basin |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Agonidae | 1.87 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.05 | 0.00 | 0.00 | 0.00 |
| *Alepocephalus tenebrosus* | 0.00 | 0.00 | 0.00 | 0.00 | 0.03 | 0.00 | 0.00 | 0.12 | 0.00 | 0.13 | 0.00 | 0.00 |
| *Anarrhichthys ocellatus* | 0.00 | 0.02 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| *Anoplopoma fimbria* | 0.00 | 0.00 | 0.03 | 0.31 | 0.03 | 0.00 | 0.09 | 0.06 | 0.05 | 0.00 | 0.00 | 0.00 |
| *Antimora microlepis* | 0.00 | 0.00 | 0.00 | 0.00 | 0.10 | 0.00 | 0.05 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| *Bathyagonus nigripinnis* | 0.00 | 0.00 | 0.19 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| *Bathyraja interrupta* | 0.04 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| *Bathyraja trachura* | 0.00 | 0.00 | 0.00 | 0.00 | 0.10 | 0.21 | 0.00 | 0.06 | 0.00 | 0.00 | 0.00 | 0.03 |
| *Bothrocara brunneum* | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.06 | 0.00 | 0.03 | 0.00 | 0.00 |
| *Cataetyx rubrirostris* | 0.00 | 0.00 | 0.69 | 0.94 | 0.03 | 0.00 | 0.00 | 0.00 | 0.11 | 0.00 | 0.82 | 0.00 |
| *Embassichthys bathybius* | 0.00 | 0.00 | 1.05 | 0.78 | 0.37 | 0.21 | 0.23 | 0.06 | 0.05 | 0.07 | 0.00 | 0.00 |
| *Eptatretus* spp. | 0.04 | 0.20 | 0.69 | 1.25 | 0.37 | 0.21 | 0.27 | 0.12 | 1.08 | 0.07 | 0.15 | 0.07 |
| *Facciolella equatorialis* | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.19 | 0.00 |
| *Glytocephalus zachirus* | 0.78 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.54 | 0.00 | 0.19 | 0.00 |
| *Hydrolagus colliei* | 0.04 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.04 | 0.00 | 0.00 | 0.00 |
| *Icelinus* spp. | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.19 | 0.00 |
| *Idiacanthus antrostomus* | 0.00 | 0.00 | 0.03 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Liparididae | 0.00 | 0.00 | 0.11 | 0.00 | 0.07 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| *Lycenchelys crotalinus* | 0.00 | 0.00 | 0.03 | 0.00 | 1.35 | 6.99 | 0.32 | 1.24 | 0.11 | 0.83 | 0.00 | 0.00 |
| *Lycodes cortezianus* | 0.52 | 0.00 | 0.14 | 0.00 | 0.07 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.15 | 0.00 |
| *Lycodes diapterus* | 2.05 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.02 | 0.00 | 0.24 | 0.00 |
| *Lyopsetta exilis* | 0.13 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.01 | 0.00 | 0.00 | 0.00 |
| Macrouridae | 0.00 | 0.00 | 0.00 | 0.00 | 0.20 | 0.42 | 0.18 | 0.25 | 0.01 | 0.07 | 0.15 | 0.63 |
| *Merluccius productus* | 0.78 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.06 | 0.00 | 0.44 | 0.00 |
| *Microstomus pacificus* | 0.83 | 0.00 | 0.52 | 6.86 | 0.34 | 0.64 | 0.63 | 0.00 | 3.15 | 0.40 | 1.84 | 0.03 |
| Myctophidae | 0.00 | 0.00 | 0.03 | 0.16 | 0.03 | 0.00 | 0.05 | 0.00 | 0.02 | 0.07 | 0.29 | 0.26 |
| *Nezumia stelgidolepis* | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.01 | 0.00 | 0.10 | 0.00 |
| *Ophiodon elongatus* | 0.00 | 0.17 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Osteichthyes | 0.04 | 0.00 | 0.03 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |

| Fish Taxa | Willapa Canyon | Daisy Bank | Sponge Bycatch | Humboldt Wind Energy | Cordell Bank NMS | Cabrillo Canyon | West Carmel Canyon | Point Sur Slot Canyons | Santa Lucia Bank | Santa Cruz Island South | Anacapa Island South | Santa Catalina Basin |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| *Paricelinus hopliticus* | 0.00 | 0.02 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Pleuronectiformes | 0.44 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| *Psychrolutes phrictus* | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.21 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| *Raja rhina* | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.03 | 0.00 | 0.05 | 0.00 |
| *Raja stellulata* | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.05 | 0.00 |
| Rajidae | 0.04 | 0.00 | 0.03 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Rajiformes egg cases | 0.00 | 0.00 | 0.00 | 0.16 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Scyliorhinidae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.06 | 0.00 | 0.05 | 0.00 |
| *Sebastes alutus* | 0.04 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| *Sebastes aurora* | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.16 | 0.00 | 0.24 | 0.00 |
| *Sebastes brevispinis* | 0.00 | 0.10 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| *Sebastes chlorostictus* | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.05 | 0.00 |
| *Sebastes crameri* | 0.04 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.26 | 0.00 | 0.00 | 0.00 |
| *Sebastes diploproa* | 0.04 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 1.50 | 0.00 | 3.25 | 0.00 |
| *Sebastes elongatus* | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.15 | 0.00 |
| *Sebastes entomelas* | 0.00 | 0.02 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.01 | 0.00 | 0.00 | 0.00 |
| *Sebastes helvomaculatus* | 0.00 | 6.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| *Sebastes melanostomus* | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.82 | 0.00 | 0.00 | 0.00 |
| *Sebastes paucispinis* | 0.00 | 0.02 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.05 | 0.00 |
| *Sebastes phillipsi* | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.24 | 0.00 |
| *Sebastes pinniger* | 0.00 | 1.11 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| *Sebastes proriger* | 0.00 | 0.02 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| *Sebastes ruberrimus* | 0.00 | 0.12 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| *Sebastes rubrivinctus* | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.05 | 0.00 |
| *Sebastes rufus* | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.05 | 0.00 | 0.19 | 0.00 |
| *Sebastes simulator* | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.15 | 0.00 |
| *Sebastes* spp. | 0.17 | 0.07 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| *Sebastes* spp. YOY | 0.00 | 0.02 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| *Sebastes wilsoni* | 0.00 | 2.10 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| *Sebastes zacentrus* | 0.04 | 27.38 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| *Sebastolobus alascanus* | 0.09 | 0.00 | 0.22 | 0.62 | 0.03 | 0.00 | 0.09 | 0.00 | 0.12 | 0.20 | 0.10 | 0.00 |

| Fish Taxa | Willapa Canyon | Daisy Bank | Sponge Bycatch | Humboldt Wind Energy | Cordell Bank NMS | Cabrillo Canyon | West Carmel Canyon | Point Sur Slot Canyons | Santa Lucia Bank | Santa Cruz Island South | Anacapa Island South | Santa Catalina Basin |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| *Sebastolobus altivelis* | 0.04 | 0.00 | 3.12 | 1.40 | 1.52 | 2.12 | 0.77 | 2.05 | 0.43 | 1.63 | 1.31 | 0.17 |
| *Sebastolobus* spp. | 0.78 | 0.00 | 11.70 | 15.44 | 10.38 | 2.75 | 7.71 | 14.42 | 4.56 | 9.57 | 5.09 | 2.08 |
| *Sebastomus* | 0.00 | 1.23 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.02 | 0.00 | 2.47 | 0.00 |
| *Squalus suckleyi* | 0.17 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| *Tetronarce californica* | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.03 | 0.00 | 0.00 |
| *Xeneretmus leiops* | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.01 | 0.00 | 0.00 | 0.00 |
| *Zaniolepis frenata* | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.24 | 0.00 |
| Zoarcidae | 4.09 | 0.00 | 0.83 | 0.16 | 1.08 | 0.21 | 0.68 | 1.18 | 0.05 | 0.23 | 0.00 | 0.13 |

Table 8. Overall coral, sponge, and fish densities, the number and proportion of fish associations with corals and sponges, and depth range at each site on the 2019 EXPRESS cruise.

| | Density (#/100 $m^2$) | | | Fish Associations | Depth Range |
|---|---|---|---|---|---|
| Site | Coral | Sponge | Fish | Number (%) | |
| Willapa Canyon | 0.1 | 0.2 | 13.2 | 1 (20%) | 242-468 |
| Daisy Bank | 2.9 | 158.2 | 38.6 | 499 (8%) | 131-140 |
| Sponge Bycatch | 8.3 | 4.2 | 19.4 | 10 (2%) | 556-753 |
| Mud volcano | - | - | - | - | 459-483 |
| Brush Patch | - | - | - | - | - |
| Humboldt Wind Energy | 13.9 | 49.3 | 28.1 | 31 (8%) | 548-606 |
| Cordell Bank NMS | 9.0 | 0.4 | 16.1 | 19 (7%) | 854-1261 |
| Cabrillo Canyon | 17.1 | 8.2 | 14 | 1 (1%) | 1162-1246 |
| West Carmel Canyon | 26.3 | 0 | 11.1 | 33 (6%) | 1008-1245 |
| Point Sur Slot Canyons | 70.0 | 0 | 19.6 | 46 (4%) | 953-1190 |
| Santa Lucia Bank | 1.3 | 7.1 | 13.4 | 74 (9%) | 380-603 |
| Santa Cruz Island South | 24.3 | 2 | 13.3 | 61 (8%) | 715-1216 |
| Anacapa Island South | 2.2 | 9.4 | 18.5 | 21 (9%) | 190-601 |
| Santa Catalina Basin | 0.1 | 3.6 | 3.4 | 4 (4%) | 1234-1244 |

## Fishes

Many deepwater species were encountered during the 2019 EXPRESS cruise relative to that of 2018 due to the increased sampling depths (up to 1,246 m) from using GFOE's ROV. These include sablefish, grenadiers of multiple species, snakehead eelpouts, twoline eelpouts, roughtail skates, Pacific flatnoses, and California slickheads. A rare blob sculpin (*Psychrolutes phrictus*) was counted during a transect at the Cabrillo Canyon site. No latitudinal trend was evident in these deep-living species and densities were generally between 11-20 fish/100 $m^2$ (Tables 7 and 8). The lowest density of fishes for all sites was observed at Santa Catalina Basin, which was the deepest dive overall and was on a mud seafloor interspersed with dead sponges. It may be that the productivity of this area is low and it cannot support a large fish population. This basin had very low dissolved oxygen values and this may have contributed to the low numbers of fishes (and corals).

## EFH Surveys

Baseline surveys were conducted on DSCS and fish to assess densities, condition, and distribution in seven EFH areas that underwent fishing regulation changes as part of Amendment 28, implemented 1 January 2020 (four EFH areas were closed to bottom contact fishing gear and three were reopened to bottom contact fishing gear). The reopened areas (Cabrillo Canyon, West Carmel Canyon, and Point Sur Slot Canyons) consisted mostly of mud and had few sponges and the dominant corals were sea pens. This baseline information will allow researchers to track potential changes to benthic communities over time and will help resource managers better manage these important areas. In particular, the baseline information collected in newly closed EFH areas, like Santa Lucia Bank, can be compared to future surveys and provide data on the potential recovery speed of corals and sponges.

## Santa Catalina Basin

Surveys conducted in Santa Catalina Basin (~1,240 m) found numerous large, dead sponges (possibly *Farrea* spp.) with attached epifauna. Live DSCS densities were very low at this deep, mud bottom site and fish densities were the lowest of all surveyed sites. In the 1990's, surveys in this area found mostly dead sponges (with some living sponges growing on the dead sponges), and surveys since have found no large sponges alive. This suggests that the sponges that were observed in 2019 had not recently died, but had been dead since at least the 1990's. The reason for this mass die-off of sponges is being investigated with the leading theory of an underwater landslide on the side of the basin that covered the sponges with a layer of mud, ultimately smothering the sponges. Other ideas being considered are

wide spread disease, predation, or a decrease in oxygen levels within the basin sometime in the past. These sponges may have at one time formed a massive reef in the area and now we are left with the last of the skeletal remains.

## Coral, Sponge, and Fish Associations

No latitudinal trend in fish associations were evident from the surveys (Table 8). This may be due to the fact that most surveys were deep and the numbers of fishes and DSCS were low compared to 2018. Also, these deep species may not associate with DSCS as often as shallower-living species. Only Willapa Canyon had a fish association percentage >10, but this was for one individual out of only five DSCS observations. Daisy Bank had the most associations (499) but also had a high number of DSCS and fishes which reduced the percentage of associations to only 8%. Daisy Bank was the shallowest dive site. Other shallow dive sites (<600 m) had similar percent associations (Santa Lucia Bank, Anacapa Island, and Humboldt Wind Energy sites) except the Sponge Bycatch area which only had 2% associations.

## Observations of Marine Debris

Instances of marine debris were low throughout the study, except for in the Santa Catalina Basin. In this basin, many lines crisscrossed the seafloor and looked to have been purposely placed on the seafloor (for what purpose remains unknown). At the remaining sites, only 13 instances of marine debris were observed, with most being trash (bottles, cans, a tarp, and two plastic tubes). The only fishing gear observed were at Daisy Bank (two old fishing nets and two old longlines). Most other sites surveyed were deeper than the normal commercial fishing depths, which is the most probable reason for the low number of fishing debris observed throughout the cruise.

## Management Implications

Coastwide surveys like those conducted on this 31-day EXPRESS cruise provide opportunities to conduct distribution and population connectivity studies on DSCS across the West Coast. Visual surveys, eDNA samples, and biological samples of the same or similar species were collected over depths ranging from 131–1246 m and covering 1,600 km (1,000 mi) of coastline for the study area. DSCS, fish, and habitat records generated from the visual survey data were submitted to the Deep-Sea Coral Research and Technology Program's National Database (https://www.ncei.noaa.gov/maps/deep-sea-corals/mapSites.htm), a publicly accessible and global inventory of DSCS records. The data generated from this cruise will improve our understanding of these valuable and vulnerable DSCS communities and identify areas in need of further research and protection. For example, this information collected in areas currently under evaluation for offshore wind energy development (southern Oregon, Humboldt, and Morro Bay) will help guide decisions made by BOEM as to where seabed construction would least impact important DSCS assemblages and habitat. NMFS may use these data to evaluate the effectiveness of regulatory actions, such as protecting DSCS and fish habitats through either EFH or discretionary authorities. To date, two presentations on findings from this cruise have been given to the Habitat Committee of the PFMC. Survey results will also contribute to the understanding of how species distributions change over large latitudinal and depth gradients, in response to environmental changes such as climate change and ocean acidification. Data from these surveys are important for NMFS's ecosystem-based approach to management because they include densities of all fishes, corals, sponges along with their related habitats. In addition, West Coast NMS benefit from these data as much of the deeper portions of the sanctuaries visited have yet to be explored or thoroughly characterized. NMS are mandated to characterize and monitor the status and health of living and non-living resources within their boundaries, including DSCS habitats. Thus, this work is, and will continue to be, critical for the ability of sanctuaries to fulfill their Congressional mandates and generate periodic condition reports that track changes to deep-sea benthic communities and evaluate the extent to which sanctuaries provide necessary protection.

## Outreach

Two forms of outreach were conducted during this cruise: livestreaming video and a dock-side open house. The testing of GFOE's "flyaway" telepresence system gave us the rare opportunity to connect live with the public and other scientists on a NOAA fisheries research vessel. ROV dives were live-

streamed to GFOE's YouTube site and homepage. During the video broadcasts, researchers explained the science behind the surveys, the scientific objectives, described the species encountered, and answered questions from the audience (during specified times). The shipboard researchers used a Slack channel for scientists ashore to comment and ask questions in near real time. This live broadcast capability allowed the general public onshore to hear our live commentary, ask questions, and experience each dive as if they were on the ship. Also, several remote video interactions were broadcast with San Francisco's Exploratorium and Pierpont Elementary School in Ventura, CA.

The ship's crew and scientists hosted an informational event about the cruise and the EXPRESS campaign at the Exploratorium in San Francisco with approximately 40 representatives from federal and state agencies, private firms, and academia. After the behind-the-scenes tour of the Exploratorium, the group moved to the *Reuben Lasker* to learn about the ship, survey vehicles, and science operations from scientists and the ROV crew.

## Data disposition

Disposition and contact information for data collected during this expedition.

| Data type | Contact | Institution | Email |
|---|---|---|---|
| Fish/coral/sponge counts | Tom Laidig | NMFS - SWFSC | tom.laidig@noaa.gov |
| Water chemistry and CTD | Nancy Prouty | USGS | nprouty@usgs.gov |
| Transect and mapping | Diana Watters | NMFS - SWFSC | diana.watters@noaa.gov |
| DNA/eDNA | Meredith Everett | NMFS - NWFSC | meredith.everett@noaa.gov |
| Isotope data and non-fish/DSCS counts | Amanda Demopoulos | USGS | ademopoulos@usgs.gov |

## Comparison to 2018

Surveys were generally conducted at deeper depths in 2019 than in 2018 (mean maximum depth for all dives combined was 851 m in 2019 and 470 m in 2018) most likely contributing to the lower total number and diversity of fishes observed. Fish densities from these deeper surveys in 2019 (>600 m) varied little (13.3-19.6 fish/100 $m^2$) except in the deepest survey at Santa Catalina Basin where low oxygen levels likely contributed to the low numbers of living DSC and fishes observed. Deeper living fishes were common at most sites in 2019, including thornyheads, grenadiers, deepsea soles, and eelpouts. In contrast, our shallowest site in 2019, Daisy Bank, had none of these taxa. In 2018, many shallow fish taxa and few deep-living taxa were observed, except for an occasional thornyhead. For corals, many deeper species (including bamboo and black corals) were encountered in 2019 compared to few observations of these taxa in 2018. Even with these differences, the 2019 and 2018 surveys had a large overlap in taxa observed for DSCS and fishes. Daisy Bank and Santa Lucia Bank were surveyed in both 2019 and 2018. Fishes were observed in similar densities in both years at both sites (Table 9). At Daisy Bank, corals were more abundant in 2018 and sponges had higher densities in 2019. In 2019, only the top of the bank was surveyed which is a sponge garden. The corals were more abundant on the deeper flanks of the bank. At Santa Lucia Bank, corals and sponges were more abundant in 2018. This difference may be explained by depth differences between years with 2019 surveys occurring approximately 100 m deeper than 2018 surveys.

Table 9. Overall coral, sponge, and fish densities for Daisy Bank and Santa Lucia Bank in 2018 and 2019.

| Year | Site | Density (#/100 $m^2$) | | |
|---|---|---|---|---|
| | | Coral | Sponge | Fish |
| 2018 | Daisy Bank | 15.3 | 102 | 47.5 |
| 2019 | Daisy Bank | 2.9 | 158.2 | 38.6 |
| | | | | |
| 2018 | Santa Lucia Bank | 2.7 | 22.4 | 16.6 |
| 2019 | Santa Lucia Bank | 1.3 | 7.1 | 13.4 |

The deeper depths surveyed in 2019 increased the deployment and retrieval times for the ROV, thus reducing the overall dive time for conducting transects. This was evident in the reduced number of transects (50 in 2019 vs 150 in 2018) and amount of seafloor surveyed (35,253 $m^2$ in 2019 compared to 83,322 $m^2$ in 2018). A higher percentage of soft habitat was surveyed in 2019 (53%) compared to 2018 (27%), likely contributing to the higher number of sea pens observed in 2019 (2,619 individuals) compared to 2018 (737 individuals).

Almost 200 tissue, water, and sediment samples were collected, processed, and analyzed for stable carbon ($\delta^{13}C$) and nitrogen isotope ($\delta^{15}N$) analyses in 2019. Results indicate isotopically distinct faunal groups, consistent with their feeding ecology. Suspension feeding corals and sponges were distinct from deposit feeding gastropods and mixed feeders, ophiuroids (aka brittle stars), all likely relying on photosynthetically fixed carbon deposited from surface waters. In contrast, chemosynthetic clams represented a discrete isotopic niche, consistent with their reliance on thiotrophic, endosymbiotic bacteria.

Isotope data exhibited between-year differences across taxa and sites (Figure 1). In general, isotope values for particulate organic matter (POM, green symbols) were similar between years, but all other taxa from 2018 were depleted in both isotopes relative to fauna analyzed from 2019, with chemosynthetic bivalves being the only exception (see below). There are several reasons for these between-year differences, including site-specific differences in isotopic baselines (food sources), small scale and temporal variability in food availability and associated isotopic composition, depth-driven isotope changes associated with microbial processing of organic matter, as well as the higher diversity of taxa analyzed in 2019. Given $\delta^{13}C$ and $\delta^{15}N$ values for POM were consistent across years, and isotope values did not correlate with depth, between year differences may be a result of among-site variability in isotopic baselines and possible temporal differences in their associated isotopic composition. In other words, while the isotopic composition of POM was consistent between 2018 and 2019, it may vary throughout the year, due to seasonal changes in surface production, and faunal isotope values represent a time-integrated record of this variability.

Sponges were among the most isotopically variable and distinct from other suspension feeders (corals) in both years. For 2019, unknown sponges from Santa Catalina Basin yielded the highest $\delta^{15}N$ values (29.8‰), corresponding to an unidentified puffball sponge. High $\delta^{15}N$ values are notable for sponges and have been documented elsewhere in the deep sea. These values may reflect feeding on isotopically enriched, recycled pools of dissolved nitrogen and/or utilization of various nitrogen species by sponge symbionts.

Lastly, in both years, vesicomyid clams, known to house chemosynthetic endosymbiotic bacteria, had the lowest $\delta^{15}N$ and $\delta^{13}C$ values, reflecting energy derived from their thiotrophic endosymbionts. Low $\delta^{15}N$ values may reflect utilization of local nitrogen sources rather than particulate organic nitrogen.

Ultimately, restrictions on laboratory use as a result of the COVID-19 pandemic delayed many of the lab-based analyses. Once restrictions ease, results from eDNA, genetics, and population connectivity studies will soon become available.

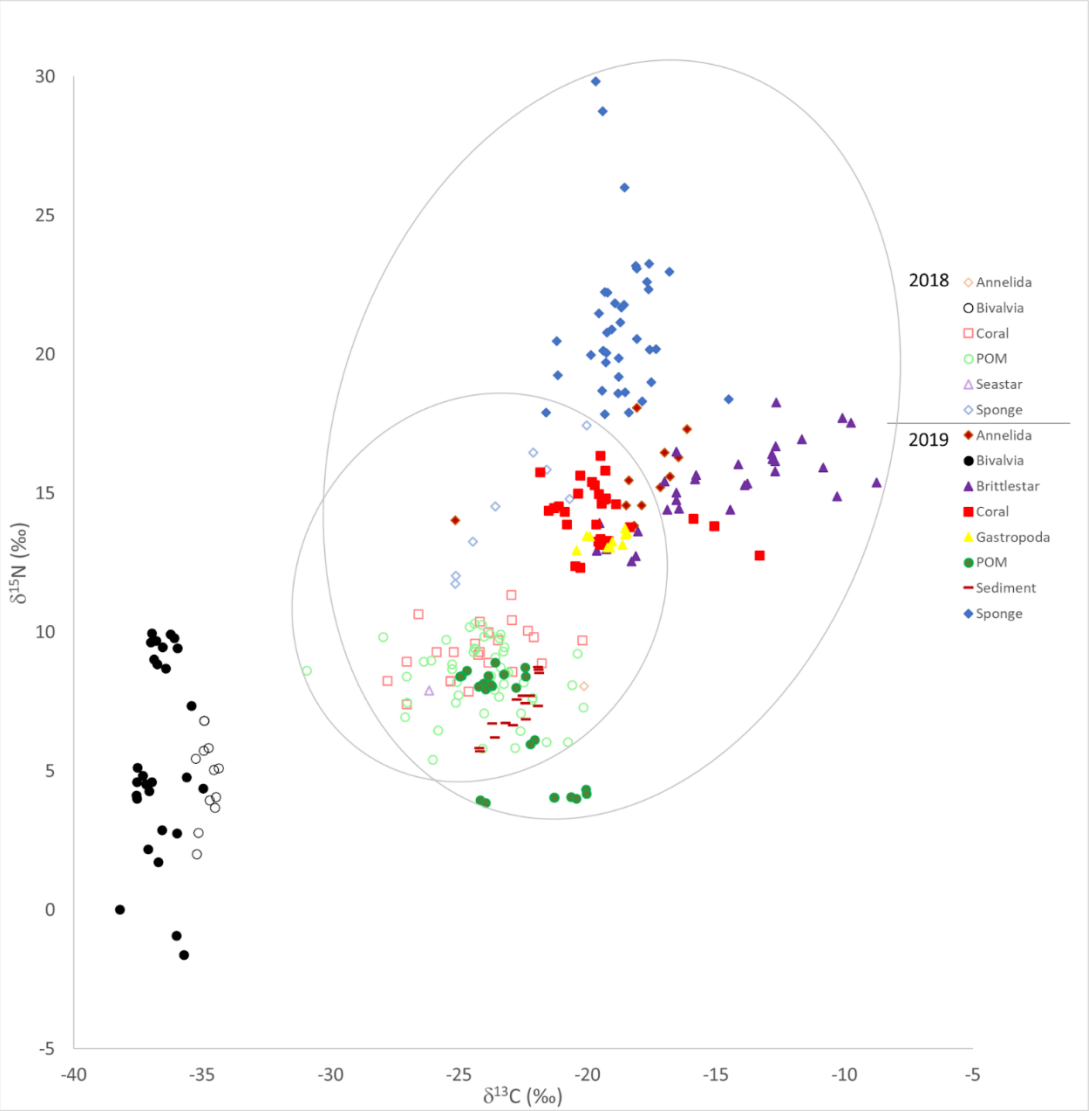



Figure 1. Raw stable carbon and nitrogen isotope data ($\delta^{13}C$ and $\delta^{15}N$, ‰) from 2018 (open symbols) and 2019 (closed symbols) for each major taxonomic group. Isotope data from sediment samples was only available from 2019. Ellipses represent the relative range in isotope data for each survey year.

## Benthic fauna observations

Observations of fauna other than DSCS and fishes varied from site to site (Figure 2, Table 10). Ophiuroids, Asteroidea sea stars, anemones, gastropods, and crabs were observed at all sites, while other fauna (e.g., brachiopods, salps, tunicates, and basketstars) were uncommon. Overall, the most frequently observed phyla were Echinodermata, followed by Arthropoda and Cnidaria. Living pyrosomes were only observed at Santa Lucia Bank, but dead pyrosomes (which were not counted) were frequently observed on the seafloor in southern California (especially Santa Cruz Island South). Exceptionally large numbers of crinoids were observed at Daisy Bank.

Table 10. Total counts of fauna other than DSCS and fishes observed on transects at sites surveyed using a remotely operated vehicle during the EXPRESS expedition along the U. S. West Coast from 8 Oct – 7 Nov 2019. Total transect area (i.e., survey effort) is indicated for each site.

| Phylum | Taxa | Willapa Canyon | Daisy Bank | Sponge Bycatch | Humboldt Wind Energy | Cordell Bank NMS | Cabrillo Canyon | West Carmel Canyon | Point Sur Slot Canyon | Santa Lucia Bank | Santa Cruz Island South | Anacapa Island South | Santa Catalina |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Total transect area ($m^2$) | | 2296 | 4050 | 3625 | 641 | 2968 | 472 | 2217 | 1609 | 9278 | 3009 | 2061 | 3027 |
| Annelida | Annelid | - | - | 102 | 12 | 723 | - | 2 | 7 | 1864 | 74 | 39 | 60 |
| Arthropoda | Amphipod | 1 | - | - | - | - | - | - | - | 0 | - | - | - |
| | Crab | 5 | 69 | 25 | 9 | 126 | 5 | 12 | 13 | 512 | 9 | 32 | 4 |
| | Galatheid | - | 32 | 8 | 3 | 22 | - | - | - | 743 | 18 | 1327 | 8 |
| | Hermit crab | 4 | - | 3 | - | 79 | - | 1 | - | 3 | 2 | 7 | 11 |
| | Shrimp | 248 | - | 318 | 34 | 1604 | 159 | 389 | 1489 | 502 | 1696 | 123 | 105 |
| | Unk Arthropoda | - | - | 1 | - | 1 | - | - | - | 1 | - | 1 | - |
| | Zooplankton | - | - | - | - | - | - | 3 | - | - | - | - | - |
| Brachiopoda | Brachiopod | - | - | - | - | 155 | - | - | - | 2088 | 1 | 1 | 2 |
| Chordata | Pyrosome | - | - | - | - | - | - | - | - | 12 | - | - | - |
| | Salp | 1 | - | - | - | 9 | - | - | - | 2 | 1 | - | - |
| | Tunicate | - | - | - | 1 | 3 | - | - | - | 5 | - | 23 | 7 |
| Cnidaria | Anemone | 47 | 2 | 86 | 34 | 753 | 78 | 336 | 365 | 1492 | 548 | 100 | 43 |
| | Corallimorph | 1 | - | - | - | 33 | - | - | - | - | 5 | - | 5 |
| | Jellyfish | 10 | - | 56 | - | 16 | 2 | 44 | 21 | 11 | 66 | 78 | 99 |
| | Siphonophore | 25 | - | 1 | - | - | - | 3 | - | - | - | 56 | - |
| | Unk sessile cnidarian | 5 | - | 106 | - | 55 | 37 | - | 2 | 9 | 4 | 2 | - |
| Ctenophora | Ctenophore | 51 | - | 33 | - | 7 | 3 | 6 | 1 | 1 | 1 | 1 | - |
| Echinodermata | Basketstar | - | - | - | - | - | 13 | - | 2 | 3 | - | - | - |
| | Brisingid | - | - | - | - | 1 | - | - | - | 2 | - | - | - |

| Phylum | Taxa | Willapa Canyon | Daisy Bank | Sponge Bycatch | Humboldt Wind Energy | Cordell Bank NMS | Cabrillo Canyon | West Carmel Canyon | Point Sur Slot Canyon | Santa Lucia Bank | Santa Cruz Island South | Anacapa Island South | Santa Catalina |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Total transect area ($m^2$) | | 2296 | 4050 | 3625 | 641 | 2968 | 472 | 2217 | 1609 | 9278 | 3009 | 2061 | 3027 |
| | Crinoid | - | 53079 | 319 | - | 5 | 15 | - | - | - | - | 71 | - |
| | Holothurian | - | 2 | 107 | 25 | 70 | 36 | 8 | 77 | 1645 | 436 | 56 | 76 |
| | Ophiuroid | 2 | 4628 | 28241 | 519 | 11 | 108 | 1 | 11 | 24025 | 30729 | 349 | 21627 |
| | Seabiscuit | - | - | - | - | - | - | - | - | 77 | - | - | - |
| | Sea star | 81 | 170 | 857 | 166 | 65 | 290 | 51 | 15 | 3787 | 86 | 100 | 24 |
| | Unk echinoderm | - | - | 3 | - | 1 | - | - | - | - | - | 3 | - |
| | Urchin | 1880 | - | 777 | 9 | - | - | - | - | 8783 | - | 12762 | - |
| Mollusca | Chiton | - | - | - | - | - | 1 | - | - | - | - | - | - |
| | Clam | - | - | - | - | 23 | - | - | - | - | - | 16 | - |
| | Gastropod | 22 | 5 | 202 | 16 | 255 | 35 | 55 | 60 | 1808 | 320 | 26 | 308 |
| | Nudibranch | - | - | 3 | - | 2 | 1 | - | 1 | - | - | 2 | - |
| | Octopus | - | - | 2 | - | - | - | - | - | 5 | - | 3 | - |
| | Squid | 10 | - | 1 | 1 | - | 1 | - | - | 1 | - | 1 | - |
| | Unk bivalve | - | - | - | - | 1 | - | - | - | - | - | 2 | - |
| | Unk mollusk | - | - | 17 | - | - | - | - | - | - | - | - | - |

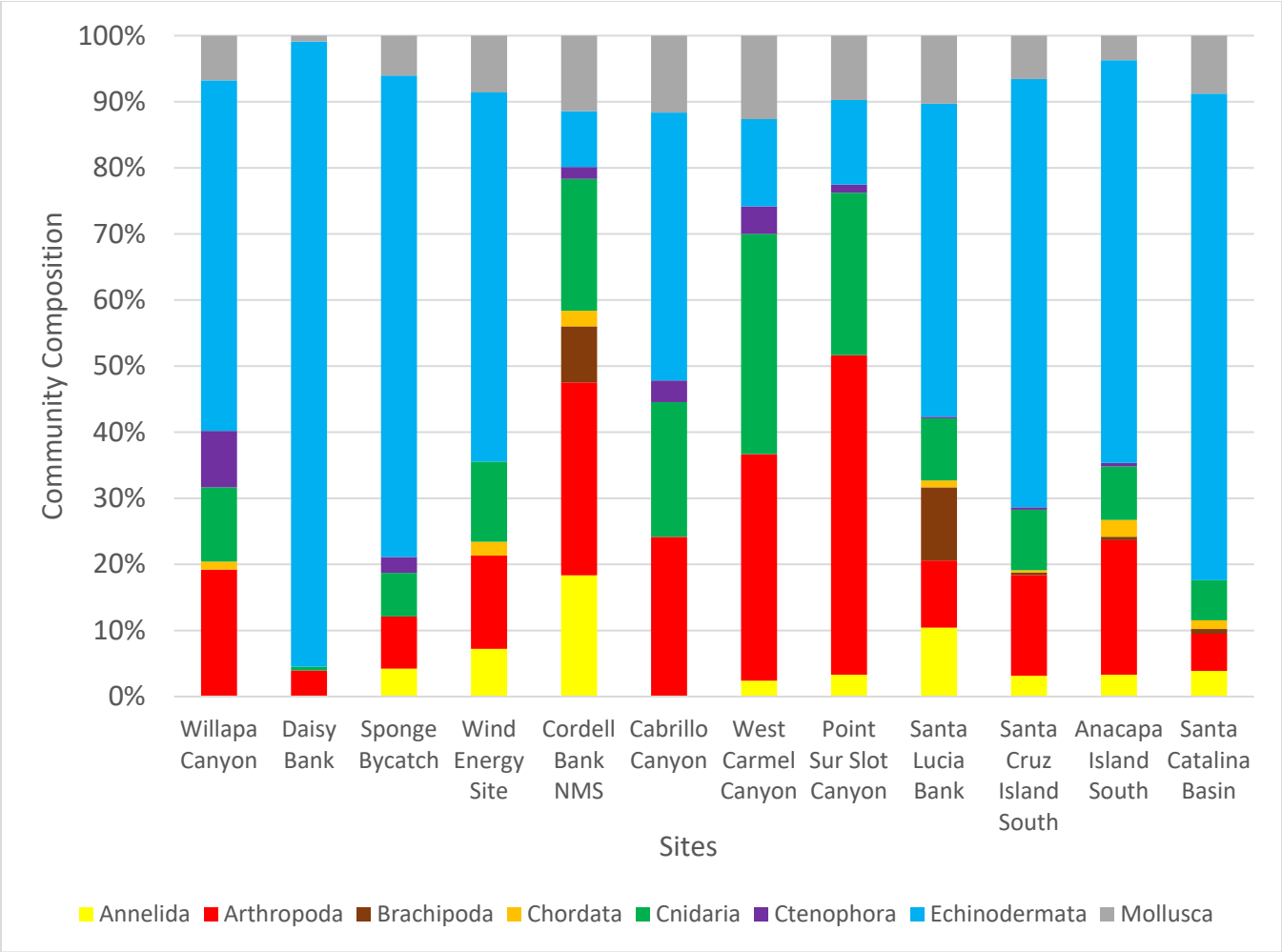



Figure 2. Community composition of phyla documented at each site from video transects using a remotely operated vehicle (ROV) during the EXPRESS expedition along the western U.S. coast from 8 October - 7 November 2019. All fauna, except DSCS and fishes were included. Counts were square root transformed to reduce the influence of frequently observed phyla.

## Latitudinal changes in oceanographic variables

The salinity depth profiles captured a freshwater surface layer in the northern sites, including CTD casts at Willapa Canyon (CTD01), Daisy Bank (CTD02), Sponge Bycatch (CTD03) and the Humboldt Wind Energy site (CTD09) but was absent at Brush Patch (CTD05) (Figure 3, top panel). This general pattern is similar to results from the 2018 *Shimada* cruise (SH-18-12) where CTD casts revealed a more stable, freshwater surface layer and strong surface front in the north, compared to more saline, warmer surface water in the south. For example, in October 2019 the surface waters at Santa Lucia Bank (CTD23), Anacapa Island (CTD28), and Santa Catalina Basin (CTD29) were warmer and more saline than the other sites. This pattern often results from weaker wind forcing in the south and reduced upwelling, and generally captures the difference between the California Current (CC) and the poleward flowing California Undercurrent (CUC), where the CC is characterized by relatively cold, less saline (33–34 PSU), oxygen-rich, nutrient- poor, and higher pH conditions (Pickard, 1964; Reid et al., 1958). The thermocline varied between 50 to 100 m (Figure 3 bottom panel), highlighting the stratification during this time of year, and temperature and salinity depth profiles converged at water depths >600 m with <1°C and <0.5 PSU difference between sites at depth. The only exception was the salinity depth profile at Cordell Bank (CTD19) which showed consistently fresher water throughout the entire water column,

especially in the upper 400 m. Anomalously enriched surface water nutrient concentrations (nitrate+nitrite) at Cordell Bank (Figure 3, middle panel) may reflect localized upwelling as the result of interaction between along-shelf coastal upwelling jets with the topographic high of Cordell Bank (Checkley and Barth, 2009).

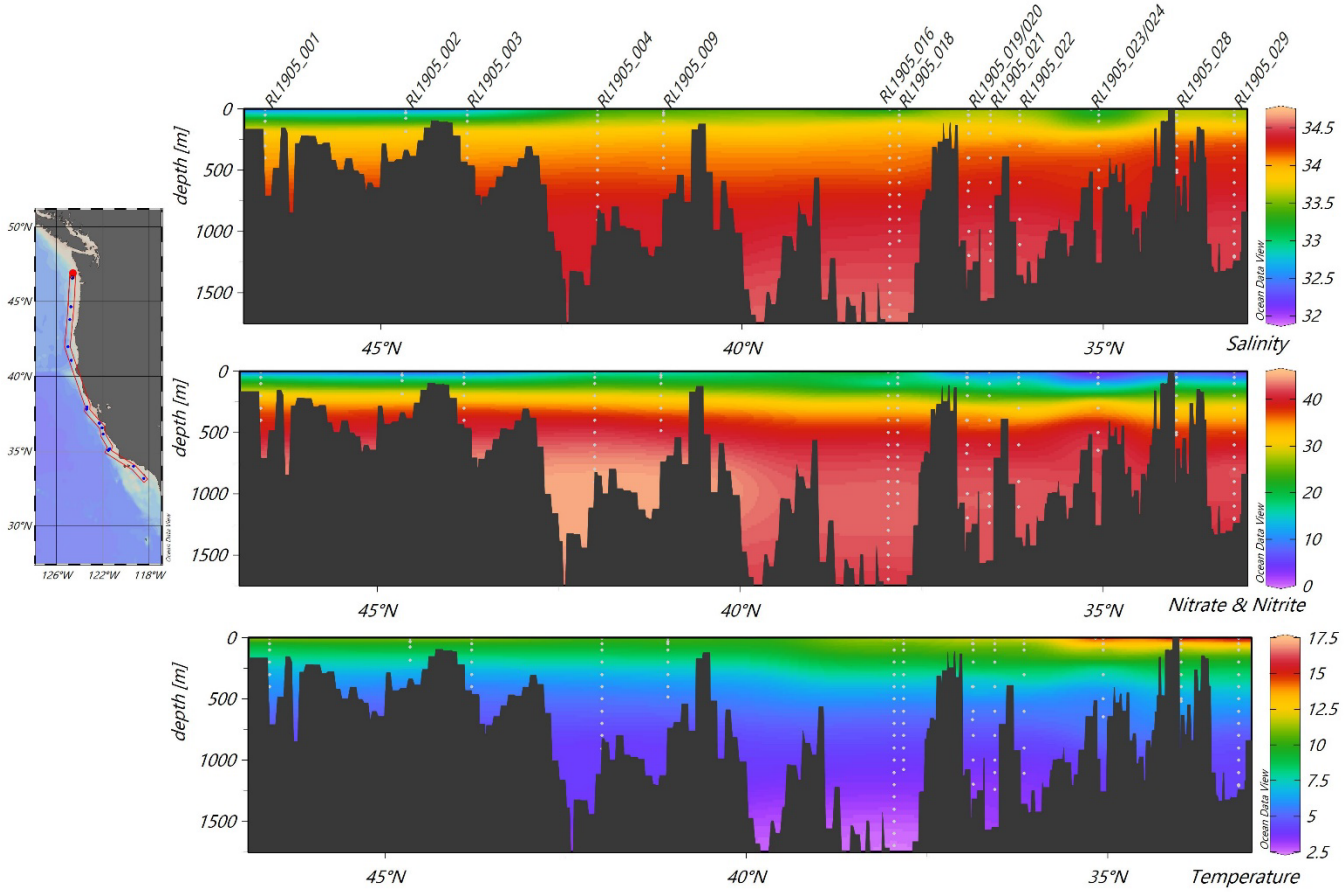



Figure 3. Hydrographic section of depth-salinity (top panel), depth-nutrients (nitrate+nitrite; mmol $L^{-1}$ middle panel), and depth-temperature (°C, bottom panel) generated with ODV v5.1.5 (Schlitzer, 2015) based on 13 CTD casts (white vertical lines) and interpolated using the weighted-average gridding function.

The dissolved oxygen (DO) profiles are consistent with the 2018 *Shimada* cruise with an oxygen minimum zone (OMZ, <2 mg/L) at water depths >300 m (Figure 4, bottom panel) coincident with the transition between the equatorward-flowing CC and the poleward flowing CUC. In contrast, nutrient concentrations (nitrate+nitrite) were depleted in surface water and became enriched with depth (Figure 3, middle panel). In the north, flow from rivers provides buoyant freshwater and nutrients to the upper surface waters. In comparison to the north, the nutricline at CTD sites south of Cordell Bank extended farther into the water column, suggesting less mixing in the upper saline, warmer waters of this region. Therefore, both stronger upwelling and riverine input contribute to higher nutrient concentrations in surface waters in the north, with possible implications to increased biological production (Hickey and Banas, 2008).

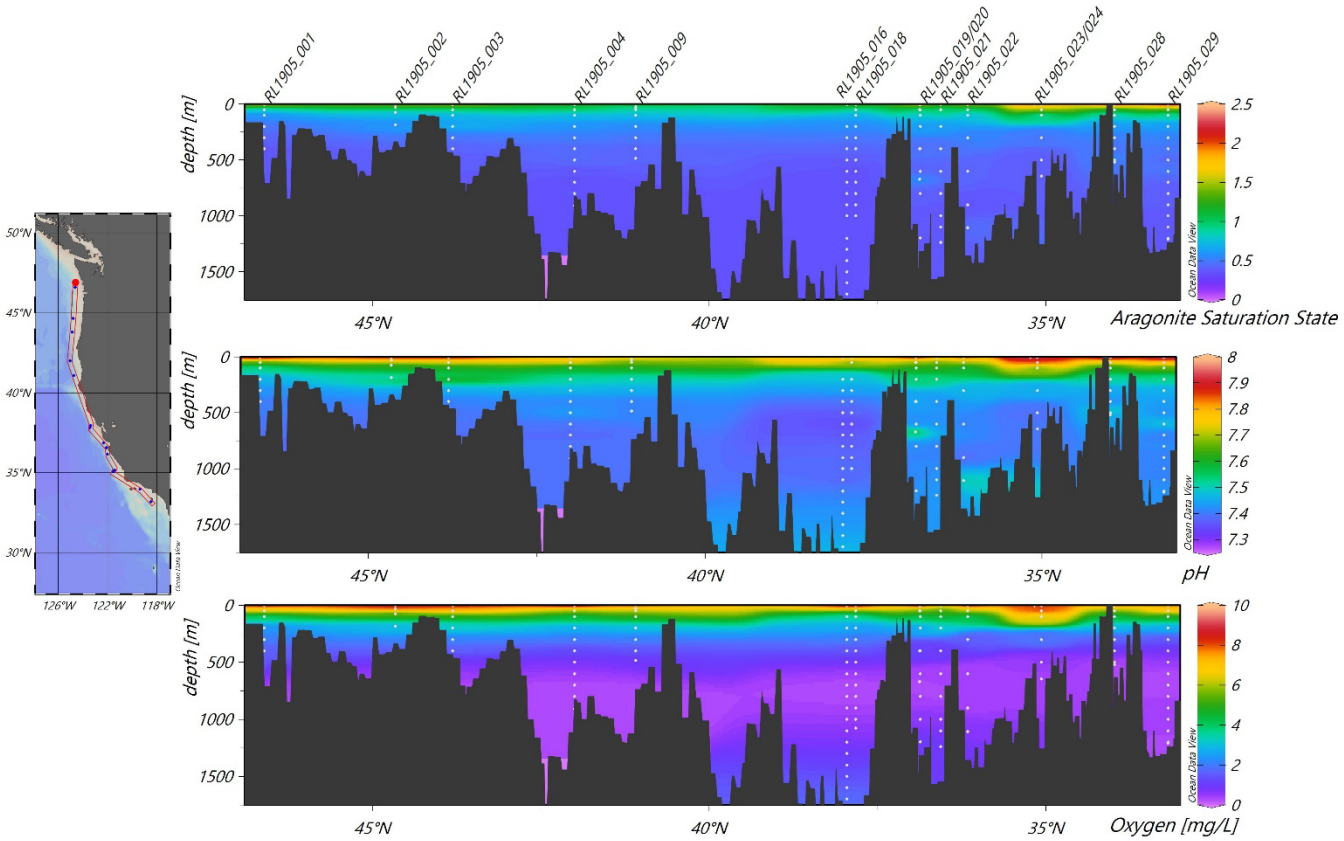



Figure 4. Hydrographic section of depth-aragonite saturation state ($\Omega_{arag}$, top panel); depth-pH (middle panel); and depth-dissolved oxygen (mg $L^{-1}$, bottom panel) generated with ODV v5.1.5 (Schlitzer, 2015) based on 13 CTD casts (white vertical lines) and interpolated using the weighted-average gridding function.

Overall, along the coasts of California and Oregon wind-driven upwelling drives nutrification and biological production (and respiration), resulting in depleted DO levels in deep and bottom waters (Figure 4, bottom panel). This upwelling also enriches deep water with carbon dioxide, resulting in linear relationship ($R^2$=0.80) between DO and aragonite saturation state ($\Omega_{arag}$) (Figure 5c). Temperature was also correlated to DO and $\Omega_{arag}$ with $R^2$ value of 0.77 and 0.86, respectively (Figure 5b, c). A weaker relationship between DO and $\Omega_{arag}$, with respect to salinity, was observed (i.e., $R^2$ < 0.7), possibly reflecting the influence of both upwelled and laterally transported surface waters as seen in the scatter plot of temperature vs salinity (Figure 5d). The aragonite saturation horizon (ASH, i.e., $\Omega_{arag}$ is equal to one), varies between 20 to 80 m (Figure 4, top panel), and is shallowest at the Wind Farm (CTD09). Seawater strongly undersaturated in aragonite ($\Omega_{arag}$ < 0.5) existed at water depths >400 m, highlighting the vulnerability of shelf communities to changes in carbonate chemistry. Variability in shoaling of the ASH may be linked to differences in upwelling strength between the different sites and could be expected to deepen with reduced or late season upwelling during marine heat waves and El Niño events (Davis et al., 2018). This overall pattern is consistent with results from the 2018 *Shimada* cruise, yielding undersaturated seawater at depth. These conditions can thermodynamically inhibit the formation of aragonite, favoring dissolution with pH values <7.5, and potential impacts to deep-sea ecosystems, such as decrease calcification rates (e.g., Gomez et al., 2018). In contrast to bottom water, the pH of surface water varies between 7.8 and 7.9, with higher values corresponding to warmer, saline waters in the south (Figure 4 middle panel).

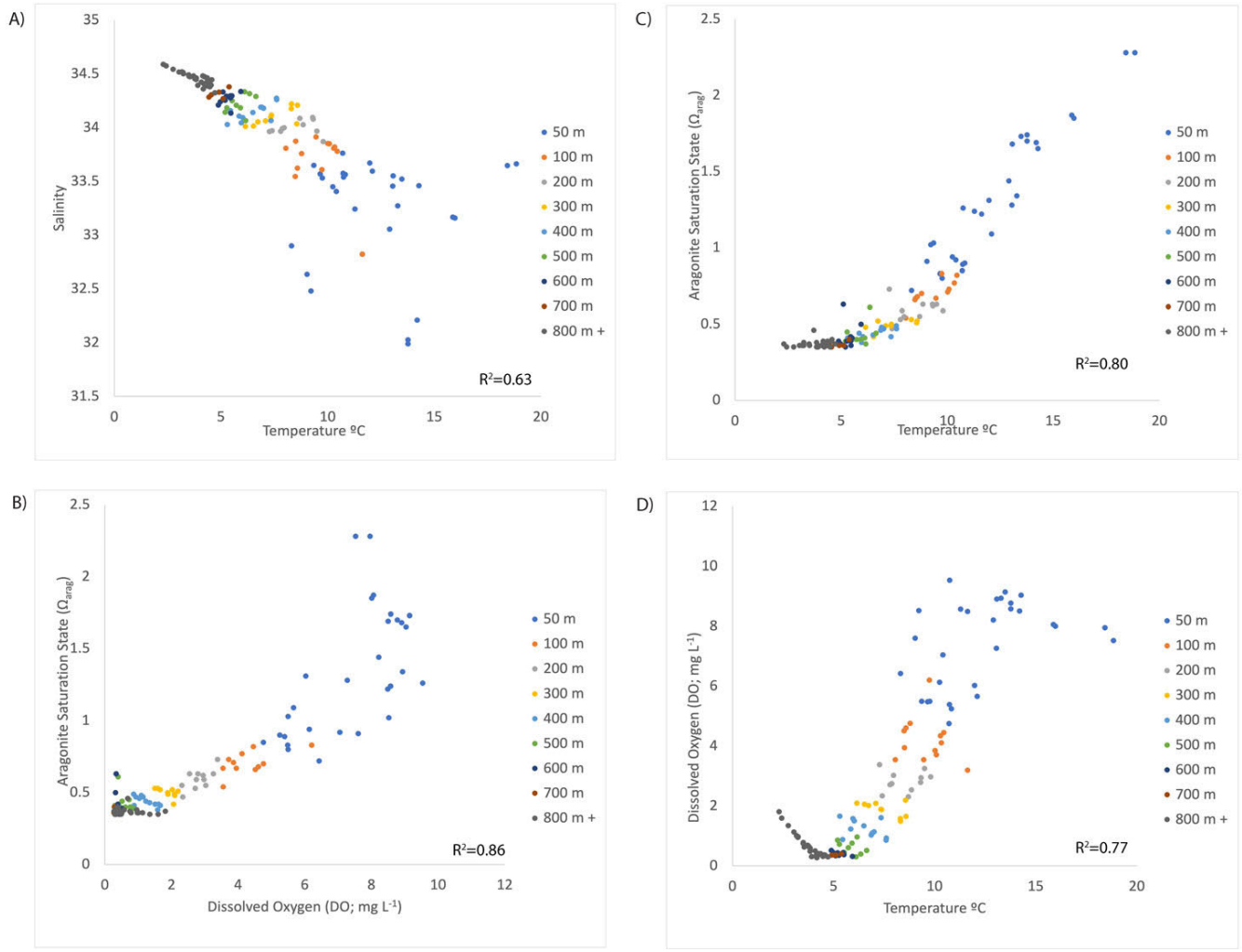



Figure 5. Scatter plot of A) salinity vs temperature (°C); B) dissolved oxygen (mg $L^{-1}$) vs aragonite saturation state ($\Omega_{arag}$); C) temperature (°C) vs aragonite saturation state ($\Omega_{arag}$); and D) temperature (°C) vs dissolved oxygen (mg $L^{-1}$). Correlation coefficients are shown in the bottom right corner for each scatter plot.

## For Further Study

Although this cruise collected huge amounts of data, more exploration is needed. For instance, we were not able to sample the Brush Patch, which is known to have sensitive corals. This area previously showed high incidences of damaged corals (Yoklavich et al., 2018) and is now protected by an EFHCA. Future surveys of this site would help determine recovery times for all the impacted species. Due to ROV issues, we only conducted one transect at the Humboldt Wind Energy site and future explorations here would be beneficial in determining baseline data before any seafloor disturbance occurs. Future research in the Santa Catalina Basin will offer a unique opportunity to survey a dying sponge bed. Along these lines, a 2020 expedition in southern California discovered an apparent sponge reef in CINMS and further study would be prudent to determine the reef extent, condition, and associated fauna (see Powell et al., 2022).

Additional DSCS surveys in waters deeper than <1,000 m would help to quantify species abundances and distributions in the deeper, less explored areas. Survey effort is lacking off northern California and off northern and central Washington. Now that new EFH regulations are in place, future surveys conducted within and around recently modified EFH Conservation Areas will enable scientists to monitor for changes related to increased fishing pressure or to examine the potential rate of recovery of DSCS species in newly closed areas. Further studies examining the relationship between seep-related structures (such as authigenic carbonates) and the distribution of DSCS habitats would also be beneficial.

# ACKNOWLEDGMENTS

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# REFERENCES


Ali, O. M., S. M. O'Rourke, S. J. Amish, M. H. Meek, G. Luikart, C. Jeffres, and M. R. Miller. (2016) RAD Capture (Rapture): Flexible and efficient sequence-based genotyping. Genetics. 202(2):389-400.

Baillon, S., J.-F. Hamel, V. E. Wareham, and A. Mercier. (2012) Deep cold-water corals as nurseries for fish larvae. Front. Ecol. Environ. 10:351-356. doi:10.1890/120022

Baker, M. and N. Prouty. (2022) CTD (Conductivity Temperature Depth) data collected October-November 2019 offshore of California and Oregon: U.S. Geological Survey, https://doi.org/10.5066/P9F7K9F2

Bright, J. (2007) Abundance and distribution of structure-forming invertebrates and their association with fishes at the Channel Islands "Footprint" off the southern coast of California. M.S. Thesis, Washington State University, Vancouver, WA. 66 p.

Checkley, D. M., and J. A. Barth. (2009) Patterns and processes in the California Current System. Progress in Oceanography. 83(1):49 64.

Davis, C. V., K. Hewett, T. M. Hill, J. L. Largier, B. Gaylord, and J. Jahncke. (2018) Reconstructing aragonite saturation state based on an empirical relationship for Northern California. Estuaries and Coasts. 41:2056-69.

Demopoulos, A. W. J., N. G. Prouty, and J. P. McClain-Counts. (2021) Isotope data from Shimada 2018 research expedition. U.S. Geological Survey data release. https://doi.org/10.5066/P9SRF5N2

Demopoulos, A. W. J., D. J. Gualtieri, and K. Kovacs. (2010) Food-web structure of seep sediment macrobenthos from the Gulf of Mexico: Deep-Sea Research II: Topical Studies in Oceanography, v. 57, no. 21-23, p. 1972-1981, doi:10.1016/j.dsr2.2010.05.011

Dickson, A. G., C. L. Sabine, and J. R. Christian. (2007) A guide to best practices for ocean CO2 measurements. PICES Special Publication. 3:1-191.

Essack M., V. B. Bajic, and J. A. Archer. (2011) Recently confirmed apoptosis-inducing lead compounds isolated from marine sponge of potential relevance in cancer treatment. Marine Drugs 9:1580-1606.

Everett, M. V., and L. K. Park. (2018) Exploring deep-water coral communities using environmental DNA. Deep Sea Research Part II: Topical Studies in Oceanography. 150:229-41. doi:10.1016/j.dsr2.2017.09.008.

Ford M. J., J. Hempelmann, M. B. Hanson, K. L. Ayres, R. W. Baird, C. K. Emmons, J. I. Lundin, G. S. Schorr, S. K. Wasser, and L. K. Park. (2016) Estimation of a killer whale (*Orcinus orca*) population's diet using sequencing analysis of DNA from feces. Plos One. 2016;11(1).

Freese, J. L., and B. Wing. (2003) Juvenile red rockfish, *Sebastes* sp., associations with sponges in the Gulf of Alaska. Mar. Fish. Rev. 65:38-42.

Gómez, C. E., L. Wickes, D. Deegan, P. J. Etnoyer, and E. E. Cordes. (2018) Growth and feeding of deep-sea coral *Lophelia pertusa* from the California margin under simulated ocean acidification conditions. PeerJ 6, e5671. doi:10.7717/peerj.5671.

Greene, H. G., M. M. Yoklavich, R. M. Starr, V. M. O'Connell, W. W. Wakefield, D. E. Sullivan, J. E. McRea, and G. M. Cailliet. (1999) A classification scheme for deep seafloor habitats. Oceanologica Acta 22:663–678.

Gugliotti, E. F., M. E. DeLorenzo, and P. J. Etnoyer. (2019) Depth-dependent temperature variability in the southern California Bight with implications for the cold-water gorgonian octocoral *Adelogorgia phyllosclera*. Journal of Experimental Marine Biology and Ecology. 514:118-126.

Henderson, M., D. Huff, and M. Yoklavich. (2020) Deep-sea coral and sponge taxa increase demersal fish diversity and the probability of fish presence. Frontiers in Marine Science 7:1-19. doi:10.3389/fmars.2020.593844.

Hickey, B. M., and N. S. Banas. (2008) Why is the northern end of the California Current System so productive? Oceanography 21(4):90–107.

Huetten E., and J. Greinert. (2008) Software controlled guidance, recording and postprocessing of seafloor observations by ROV and other towed devices: the software package OFOP. Geophysical Research Abstracts 10.

Huff, D., M. Yoklavich, M. Love, D. Watters, F. Chai, and S. Lindley. (2013) Environmental factors that influence the distribution, size, and biotic relationships of the Christmas tree coral *Antipathes dendrochristos* in the southern California Bight. Marine Ecology Progress Series 494:159-177. doi:10.3354/meps10591.

Kreidler, N. (2020) Species distribution models for three deep-sea coral and sponge taxa in the Southern California Bight. HSU theses and projects. 431. 104 pp.

Laidig, T., D. Watters, N. Prouty, M. Everett, L. Duncan, L. Clarke, C. Caldow, and A. W.J. Demopoulos. (2021) A characterization of deep-sea coral and sponge communities along the California and Oregon coast using a remotely operated vehicle on the EXPRESS 2018 expedition: A report to NOAA Deep-sea Coral Research and Technology Program. U.S. Department of Commerce, NOAA Technical Memorandum NMFS-SWFSC-657. https://doi.org/10.25923/sd6f-j739

Lewis, E., and D. W. R. Wallace. (1998) Program developed for CO2 system calculations. Oak Ridge, Tennessee: Carbon Dioxide Information Analysis Center, Oak Ridge National Laboratory, U.S. Department of Energy.

Pacific Fishery Management Council. (2019) Pacific Fishery Management Plan; Amendment 28. Available at: https://www.pcouncil.org/actions/amendment-28-pacific-coast-groundfish-essential-fish-habitat-rockfish-conservation-area-modifications-and-magnuson-act-discretionary-closures/ [Accessed April 8, 2021].

Pickard, G.L. (1964) Descriptive physical oceanography. New York: Pergamon. 199 pp.

Pierrot, D., E. Lewis, and D. W. R. Wallace. (2006) MS Excel program developed for CO2 system calculations.

Powell, A., M. E. Clarke, M. A. Haltuch, E. Fruh, J. Anderson, C. E. Whitmire, M. M. Johnson. 2022. First autonomous underwater vehicle observations of a potential petrale sole (*Eopsetta jordani*) spawning aggregation off the US West Coast. Front. Mar. Sci. doi:10.3389/fmars.2022.834839

Prouty, N. G., and M.C. Baker. (2020) CTD profiles and discrete water-column measurements collected off California and Oregon during NOAA cruise RL-19-05 (USGS field activity 2019-672-FA) from October to November 2019: U.S. Geological Survey data release, https://doi.org/10.5066/P9ZS1JX8.

Reid, J. L., G. I. Roden, and J. G. Wyllie. (1958) Studies of the California Current System, CalCOFI Prog. Rep. 7–1-56 to 1–1-58, 27–56. Marine Resources Committee, California Department of Fish and Game, Sacramento, pp. 27–56.

Rooper, C. N., M. Zimmermann, and M. M. Prescott. (2017) Comparison of modeling methods to predict the spatial distribution of deep-sea coral and sponge in the Gulf of Alaska. Deep Sea Research Part I: Oceanographic Research Papers 126:148-161. doi:10.1016/j.dsr.2017.07.002.

Ross, S. W., M. P. Rhode, and A. M. Quattrini. (2015). Demersal fish distribution and habitat use within and near Baltimore and Norfolk Canyons, U.S. middle Atlantic slope. Deep Sea Research Part 1: Oceanographic Research Papers 130: 137-154. doi.org/10.1016/j.dsr.2015.06.004.

Salgado, E. J., S. E. Nehasil, P. J. Etnoyer. (2018) Distribution of deep-water corals, sponges, and demersal fisheries landings in Southern California, USA: implications for conservation priorities. PeerJ 6,e5697. https://doi.org/10.7717/peerj.5697

Schlitzer, R. Ocean Data View, available at: http://odv.awi.de (last access: 13 June 2018), 2015.

Shrestha S, A. Sorolla, J. Fromont, P. Blancafort, and G. R. Flematti. (2018) Crambescidin 800, isolated from the marine sponge *monanchora viridis*, induces cell cycle arrest and apoptosis in triple-negative breast cancer cells. Marine Drugs 16, 53.

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

Yoklavich, M., and M. Love. (2005) Christmas tree corals: a new species discovered off southern California. Current: The Journal of Marine Education 21:27-30.

Yoklavich, M., T. Laidig, A. Taylor, D. Watters, L. Krigsman, and M. Love. (2013) A characterization of the Christmas tree black coral (*Antipathes dendrochristos*) community on three seamounts in the southern California Bight from a survey using a manned submersible. A report to NOAA Deep-Sea Coral Research and Technology Program, July 15, 2013. 82 pp.

Yoklavich, M. M., T. E. Laidig, K Graiff, M. E. Clarke, and C. E. Whitmire. (2018) Incidence of disturbance and damage to deep-sea corals and sponges in areas of high trawl bycatch near the California and Oregon border. Deep Sea Res. Part II 150:156-163. doi:10.1016/j.dsr2.2017.08.005