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A CHARACTERIZATION OF THE DEEP-SEA CORAL AND SPONGE COMMUNITY ALONG THE OREGON COAST USING A REMOTELY OPERATED VEHICLE ON THE EXPRESS 2022 EXPEDITION

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Errata (March 2024)

Pages 17, 23, 30: In pie charts, “Denisty” should be “Density”

Page 33, last line: “*Callistephanus* spp,” should be “*Callistephanus* spp.”

Page 34: Acknowledgments should include disclaimer “Any use of trade, firm, or product names is for descriptive purposes only and does not imply endorsement by the U.S. Government.”

A CHARACTERIZATION OF THE DEEP-SEA CORAL AND SPONGE COMMUNITY ALONG THE OREGON COAST USING A REMOTELY OPERATED VEHICLE ON THE EXPRESS 2022 EXPEDITION

A report to NOAA Deep-Sea Coral Research and Technology Program, 2023

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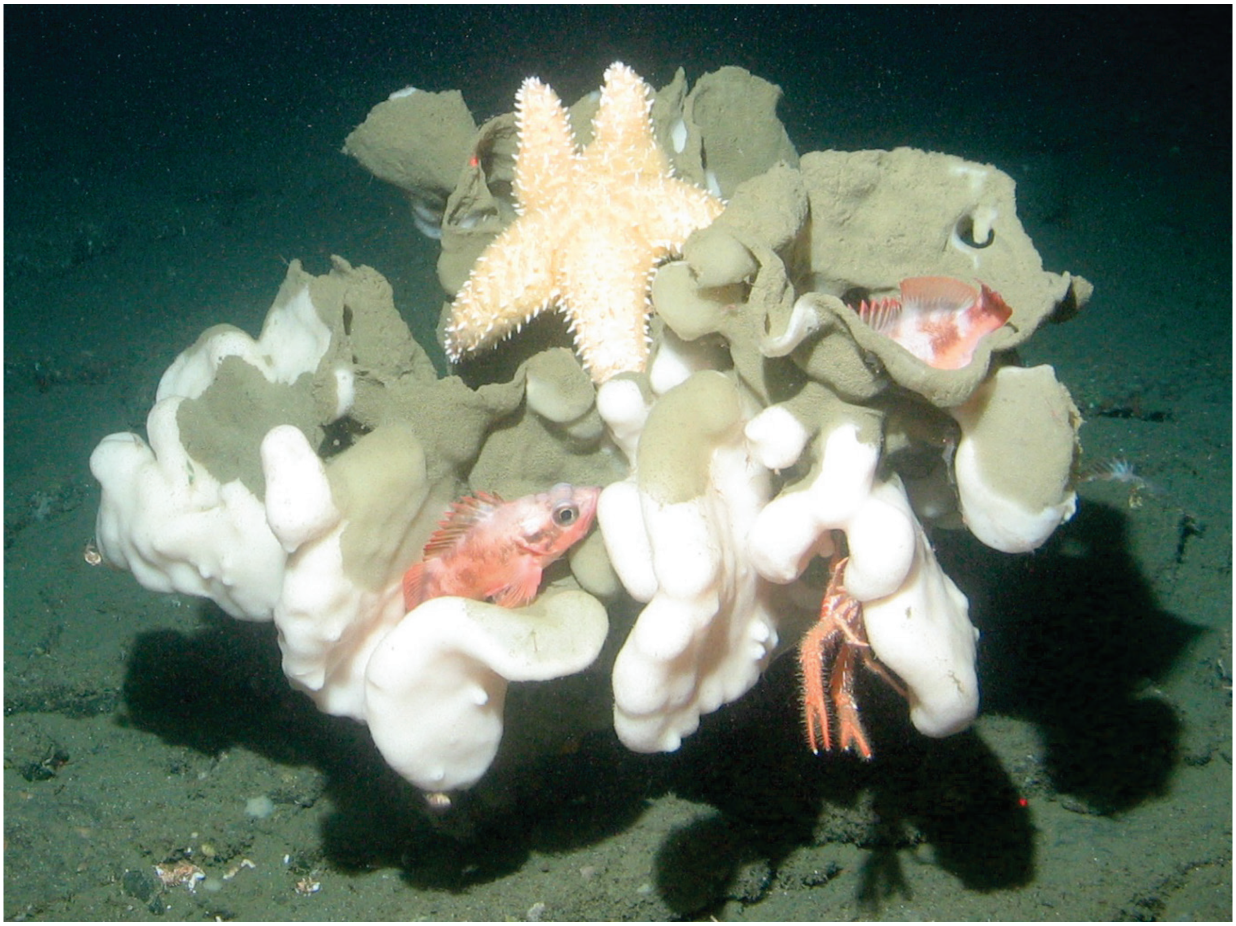


A partially dead *Aphrocallistes vastus* with many sharpchin rockfish and invertebrate associates at 164 m on Coquille bank.

INTRODUCTION AND SCIENTIFIC OBJECTIVES

Deep-sea coral and sponge (DSCS) communities serve as essential fish habitat (EFH) by providing shelter and nursery habitat, increasing diversity, and increasing prey availability (Freese and Wing, 2003; Bright, 2007; Baillon et al., 2012; Henderson et al., 2020). Off the U.S. West Coast, threats to these long-lived, fragile organisms from bottom contact fishing gear, potential offshore renewable energy development, and ocean warming and acidification have been the subject of recent research (Gomez et al., 2018; Salgado et al., 2018; Yoklavich, et al., 2018; Gugliotti et al., 2019). Other DSCS studies have reported new species (Yoklavich and Love, 2005), analyzed species distribution and abundance (Tissot et al., 2006, Watters et al., 2022), developed predictive distribution models (Huff et al., 2013; Rooper et al., 2017; Kreidler, 2020), and discovered medicinal uses for corals and sponges (Essack et al., 2011; Shrestha et al., 2018). Due to the vast area of unexplored seafloor within the territorial waters and the U.S. exclusive economic zone (EEZ; 12-200 nautical miles off the coast) and the technological requirements and expense of deep-sea research, there is still much to learn about the distributions and biology of DSCS. This information is critical to resource managers for effective conservation and management of DSCS habitats. In order to minimize the adverse impacts of fishing on EFH, the Pacific Fishery Management Council (PFMC) and National Marine Fisheries Service (NMFS) designated several seafloor habitat areas as EFH conservation areas (EFHCA), first in 2006 (as part of Amendment 19 to the Pacific coast groundfish fishery management plan) and then again in 2020 (as part of Amendment 28). These areas are closed to bottom trawl fishing at a minimum, and in some cases to all bottom contact fishing gears. In addition to protections afforded by EFH-related regulations, the National Marine Sanctuary Program prohibits certain non-fishing 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 and Research Technology Program (DSCRTP) began a 4-yr funding initiative for the U.S. West Coast in 2017. The goals of the West Coast Deep-Sea Coral Initiative (WCDSCI) were to: 1) gather baseline information on 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. As part of the WCDSCU, an 11-day expedition (3 Sep – 13 Sep 2022) was launched from the NOAA Ship *Bell M. Shimada*, beginning and ending in Newport, OR.

The science team assembled for this cruise were members of the EXpanding Pacific Research and Exploration of Submerged Systems (EXPRESS) campaign, which brings together researchers from federal and nonfederal institutions to collaborate on scientific expeditions targeting the deepwater areas off California, Oregon, and Washington. EXPRESS supports researchers leveraging funding, resources, personnel, and expertise to accomplish more science than would have been possible by a single entity alone. The 2022 expedition included research partners from National Marine Fisheries Service (NMFS) Southwest Fisheries Science Center (SWFSC) and Northwest Fisheries Science Center (NWFSC), Bureau of Ocean Energy Management (BOEM), U.S. Geological Survey (USGS), Pacific Fisheries Management Council Habitat Committee, and Woods Hole Oceanographic Institution.

Research objectives for the cruise were to:

1) Collect DSCS and fish baseline information at three potential offshore wind energy development areas.

2) Collect DSCS and fish data at four EFHCA sites that underwent protection modifications in 2020.

3) Revisit Mendocino Ridge to document the extent of the coral and sponge garden previously discovered in 2018.

4) Collect samples to help in identifying (and understanding) West Coast DSCS and expand use of new technologies (ROV, AUV, and environmental DNA [eDNA]).

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

6) Collect information to validate BOEM supported cross-shelf habitat suitability models for DSCS (see Poti et al., 2020).

7) Test the feasibility of simultaneous AUV and ROV operations using a Wave Glider (Liquid Robotics, Herndon, VA, USA) as a communications hub to the AUV.

STUDY SITES

We surveyed three sites off central and southern Oregon (Fig. 1). Sites were originally selected through recommendations of PFMC (habitat and wind energy concerns), USGS (seep sites), and BOEM (wind energy sites), and were of interest to the researchers on this cruise. One site within the northwest portion of BOEM's Coos Bay wind call area was chosen to get baseline information and because it was near methane seep locations. The Arago Reef site was chosen to determine the extent of the shallow rocky reef in deeper waters and to get baseline information outside and inside the newly closed EFHCA area; however, conditions forced the dive to end before reaching the inside of the EFHCA. The Coquille Bank site was chosen to further survey for DSCS assemblages within an EFH Conservation Area.

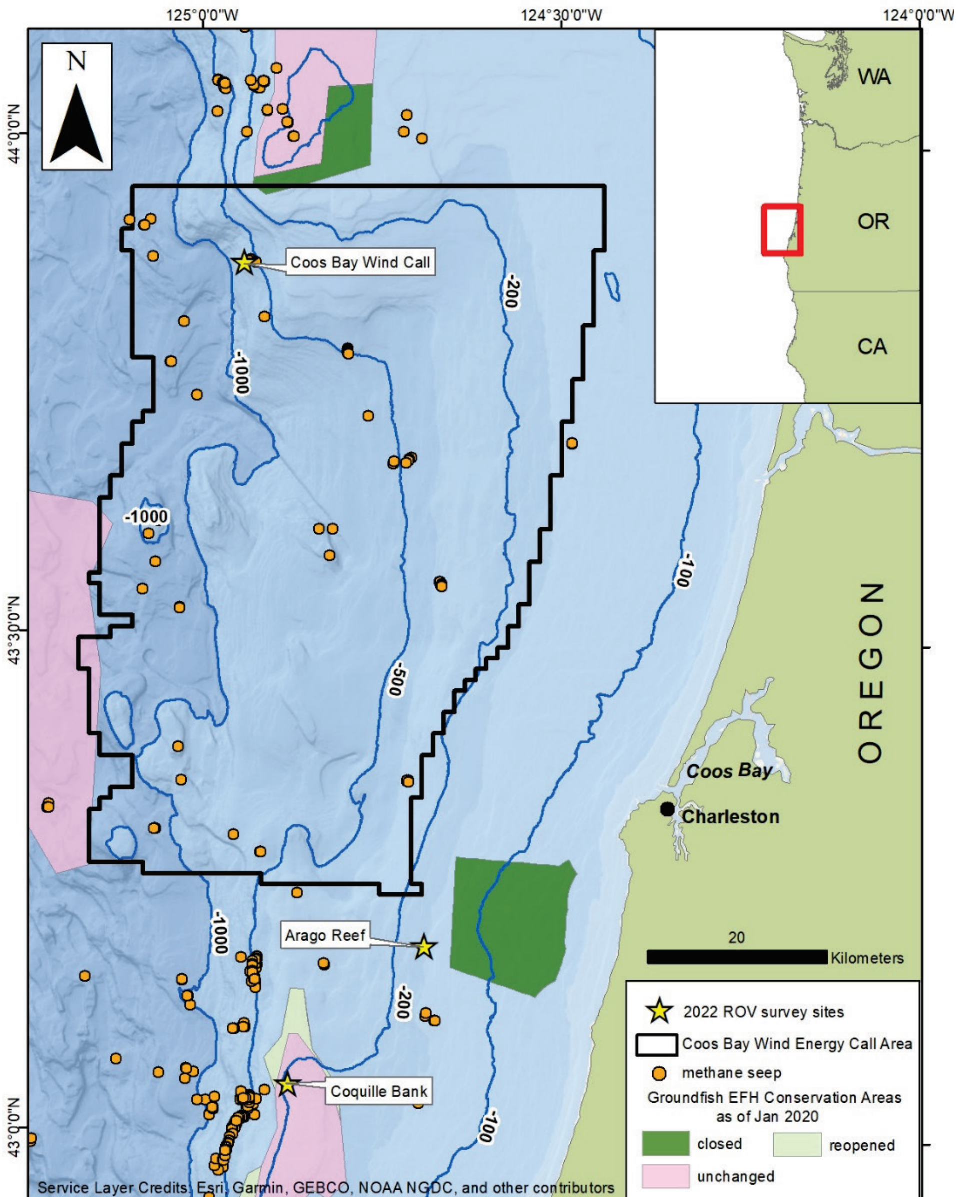


Figure 1. Map of the EXPRESS 2022 study area showing the sites surveyed using the Marine Applied Research and Exploration's remotely operated vehicle, *Beagle* (yellow stars), modifications to groundfish EFH conservation areas, and the Coos Bay Wind Energy Call Area.

FIELD SURVEY METHODS

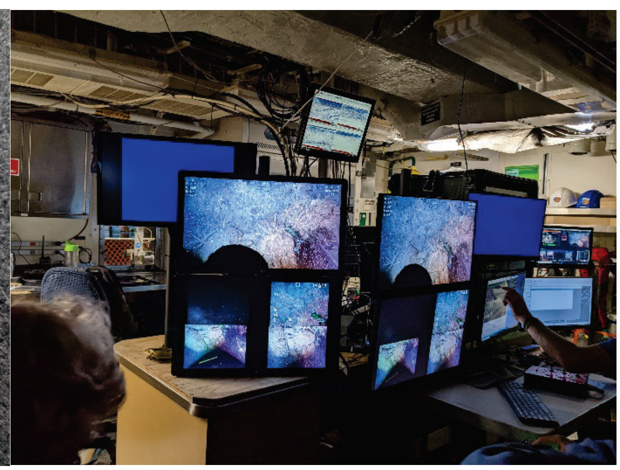
Visual surveys of seafloor communities were conducted using the Marine Applied Research and Exploration (MARE) ROV, *Beagle*. The NWFSC/Pacific Islands Fisheries Science Center's (PIFSC) autonomous underwater vehicle (AUV), *Popoki*, was also utilized; methods and results of the AUV surveys will be provided in an upcoming Site Characterization from the NWFSC. ROV dives were conducted during nighttime and daytime. Although the ROV was rated to 1,000 m water depth, it was constrained to a maximum depth of ~600 m due to limitations of attached sensors. The ROV was equipped with one forward-facing and one downward facing HD video camera, a digital HD still camera, one backward facing camera (to monitor the umbilical cable), 4 forward facing lights (2 x 200 watt and 2 x 250 watt), 2 red scaling lasers mounted 10 cm apart to aid in size estimates and transect width, and a BlueView multibeam sonar (Teledyne Marine). Dive routes were planned in advance in a geographic information system (GIS) using the most recent seafloor bathymetric data available and were located in areas of hard substrata when possible to increase the likelihood of encountering deep-sea corals and sponges. Routes and bathymetric data were loaded into HYPACK software (HYPACK, Middletown, Connecticut, USA) to guide the navigation of the ROV. During dives, the position of the ROV was tracked in real time using an ultra-short baseline (USBL) acoustic system and monitored in HYPACK by the pilot and ship's crew. The ROV was equipped with a 5-function manipulator arm used to collect specimens and a "biobox" storage compartment located near the bottom of the ROV. One Niskin bottle was attached to the ROV frame and used to collect water samples at depth for water chemistry and eDNA analyses.

Varying numbers of quantitative visual transects were conducted during each dive to assess the DSCS and fish communities. Transects targeted ~15 min duration and ~200-250 linear meters of seafloor. During transects, the ROV was flown between 0.5 and 1 m above the seafloor at a rate of 0.25-0.5 knots (0.1-0.2 m/s). Transects were separated by at least 200 m to increase sampling independence. While on transect, the pilots flew the ROV along a pre-planned route, avoiding directional changes to the extent practicable. While underway during transects, still images were recorded periodically to aid identifications. While transiting between transects, the pilots would stop the ROV to photograph DSCS and/or collect specimens. The width of the transect was calculated from the average of measurements taken during post cruise video review. Transect width measurements were recorded approximately every 1 minute and at the start and end of each transect. Transect width was calculated as the ratio of the video monitor width to the laser spots on the video monitor (both measured with a ruler in cm) multiplied by the actual laser width of 10 cm. The raw USBL navigation data were edited for outliers and other erroneous data, interpolated to one second intervals, and smoothed using a 21-point boxcar moving average. Transect area was calculated by multiplying the average transect width by the transect length as determined from the processed navigation data plotted in ArcMap ver. 10.7 (Esri, Redlands CA).

Upon retrieval to the vessel, the ROV was secured, and the collected specimens were retrieved from the biobox and processed. Biological specimens were individually photographed, measured, catalogued, and either frozen or placed in 95% ethanol. Some specimens were further separated into subsamples for various projects and sent to taxonomic experts. Geologic samples were dried and packaged for delivery to USGS personnel.

Before or after most ROV dives, the ship's CTD rosette was deployed to measure oceanographic variables throughout the water column and to collect water samples for eDNA, carbonate chemistry, and nutrients. The rosette was equipped with Niskin bottles, a dissolved oxygen sensor, and a conductivity, temperature and depth sensor (SeaBird SBE-9; Sea-Bird Scientific, Bellevue, Washington, USA) and conductivity sensors. A small, portable video recorder and light setup were attached to the rosette frame during deployment to take associated imagery through the water column whenever possible.

POST-CRUISE DATA ANALYSIS



A video analyst reviewed each video transect, identifying DSCS and fishes to the lowest taxon possible, and enumerating and estimating the maximum width and height of DSCS, and the total length of fishes. When available, the digital still images were used to augment the videos to aid in identifications of difficult to identify taxa and to evaluate invertebrate associations. Data on color, damage (pieces broken off the colony), health (healthy = <10% dead, dying = 10-50% dead, and dead = >50% dead), disposition (upright or knocked over), and fish and invertebrate associations were collected 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 as any invertebrate directly touching a coral or sponge, as described in Yoklavich et al. (2013). Densities of DSCS and fishes were calculated for each study site by dividing the total number counted by the total area of the transects.

Seafloor habitat was classified based on video review of transects. Contiguous patches of substrata were classified following Greene et al. (1999) using a two-letter code to depict the primary (>50%) and secondary (>20% of the remaining) substrata 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 seafloor habitat patch had to last a minimum of 5 sec on the video (covering at least 1 m) to be considered a new and distinct patch. Transect length, habitat patch length, and global position for each DSCS and fish observation were determined from the ROV track lines, which allowed each DSCS and fish observation to be given a specific location along the transect line.

Raw data from the CTD were processed using the manufacturer's software, Seasave V 7.26.7. Depth was determined using a SeaBird CTD digiquartz pressure-sensor with a stated accuracy of 0.015%. Data were accumulated into tab-delimited ASCII text files (in *.cnv format) and include profiles with temperature, conductivity, pressure, oxygen concentration, turbidity, fluorescence, altitude, salinity, and depth.

Dissolved nutrient (ammonium and nitrite [N+N], phosphate, and silicate) concentrations were measured at the University of California at Santa Barbara, Marine Science Institute, using flow injection analysis. Lab analyses were combined with CTD data from water sample collections.

Tissue samples from deep-sea corals and sponges collected during dives will be DNA sequenced for standard molecular barcodes (MutS, COI for corals; 28s for sponges) in order to confirm species identification and contribute to the sequence voucher database for West Coast deep-sea coral and sponge species. Standard Sanger sequencing methods will be carried out at NWFSC on an ABI 3500 sequencer as described in Everett and Park (2018).

eDNA samples collected via the ROV or 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. At the time of this writing, DNA extraction is completed for the physical DSCS specimens and are awaiting sequencing. The DNA extraction for the eDNA samples is ongoing, with expected completion for both in early 2024.

SITE AND EXPEDITION SUMMARY

About 8.6 hours of video imagery and 1,057 still images were collected during nighttime operations (~1600-0400) on 3 ROV dives at 3 locations along the Oregon Coast (Table 1). Depth of surveys ranged from 130-550 m.

Table 1. Dive information for the 2022 EXPRESS cruise. Trans = Transects

Date	Site	# of Trans	Depth Range (m)	Latitude Start	Longitude Start	Latitude End	Longitude End
9/4/2022	Coos Bay	4	550-497	43° 52.554´	124° 56.088´	43° 52.446´	124° 55.134´
9/6/2022	Arago Reef	8	155-130	43° 11.750´	124° 40.281´	43° 10.530´	124° 38.118´
9/6/2022	Coquille Bank	3	183-153	43° 03.042´	124° 50.994´	43° 03.042´	124° 50.364´

A total of 9,885 m^2 of seafloor habitat was classified during the 15 quantitative transects (fig. 2). We combined the two-character habitat codes into 3 groups: hard, mixed, and soft. Hard habitat consisted of any combination of bedrock, boulder, cobble, flat rock. Soft habitat consisted of any combination of mud. Mixed habitat was any combination of hard and soft habitats. The most common habitat type was soft (62.1%) followed by mixed (33.9%) and hard (4.0%).

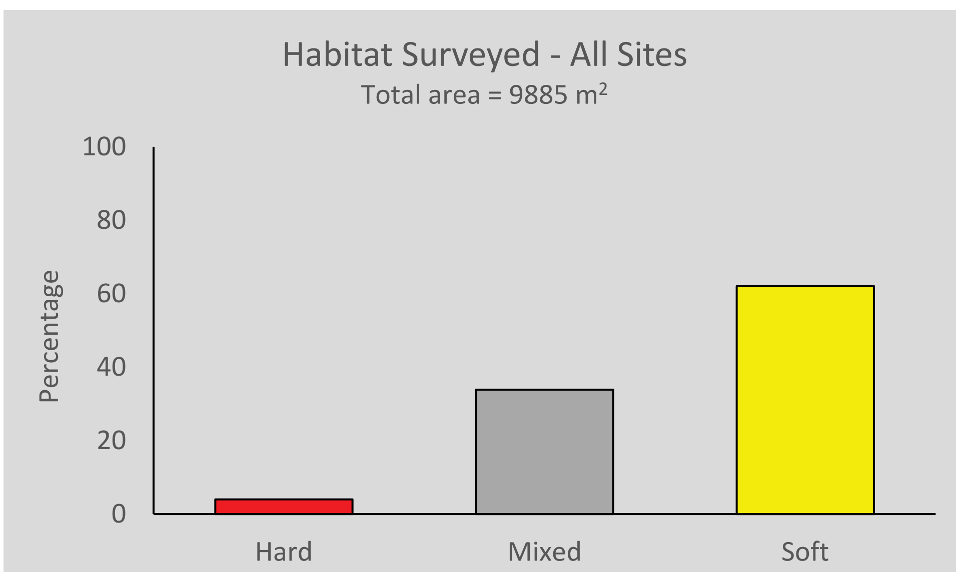
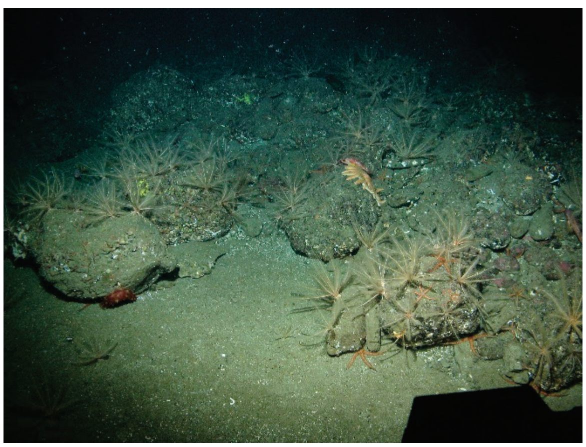


Figure 2. Percentage of hard, mixed and soft seafloor habitats observed during three visual survey dives along the central and southern Oregon coast.

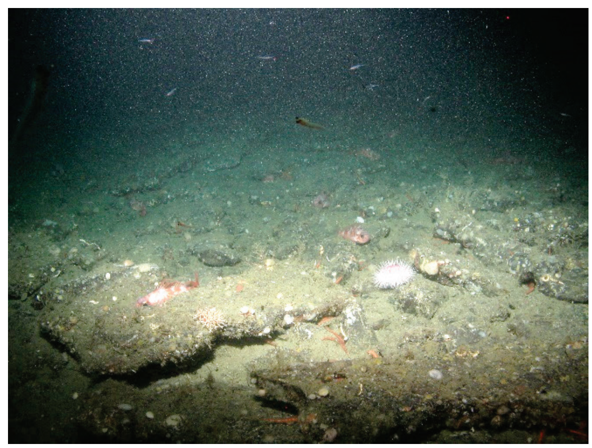
Boulder, mud, and cobble seafloor.

Mud and sand seafloor.

Rock and boulder seafloor with a patch of mud.



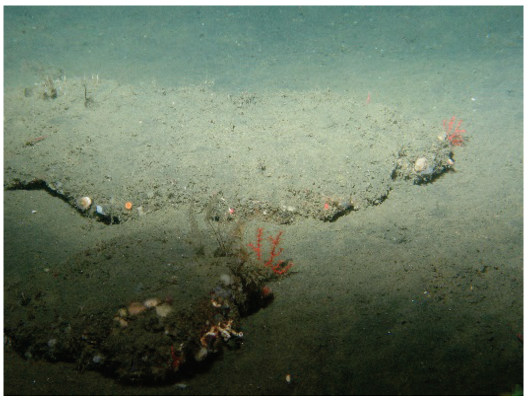
Rock and flat rock seafloor.



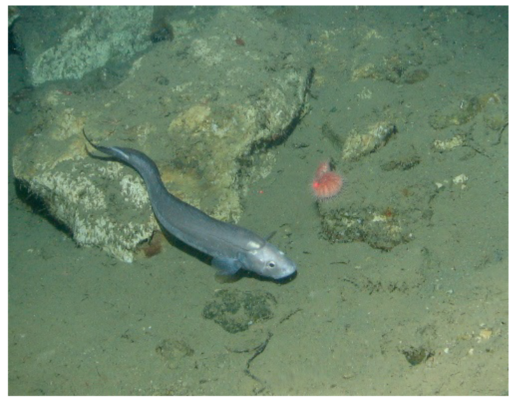
We identified 5 coral taxa, 9 sponge taxa (see Appendix 1 for images of each taxa), and 51 fish taxa from observations of the video footage during the 15 quantitative transects conducted from Daisy to Coquille Banks in Oregon (Table 2-4). We collected 6 biologic specimens, including 1 coral, 2 sponges, and 3 other invertebrates (e.g., brittle stars, bryozoan). Genetic analyses are ongoing for many of these samples.

We counted a total of 46 corals, 65 sponges, and 1,952 fishes during 15 quantitative transects. The most abundant coral taxa were *Callistephanus pacificus* (16 corals) and Plexauridae #3 (red *Callistephanus* type sticks with unknown polyp colors; 12), which were found throughout the study area. We need to mention that the genus *Swiftia* has recently undergone revision and the taxa along the US West Coast have been revised to the genus *Callistephanus* (McFadden et al., 2022). Abundant sponge taxa were *Polymastia* spp. #1 (white nipple sponges, 14 sponges), *Heterochone calyx* (12), and porifera #7 (unidentified branching sponges, possibly *Iophon koltuni*, 12), which were seen throughout the surveys. The *Polymastia* spp. #1 was identified from imagery and may be a new species that was identified from the Olympic Coast National Marine Sanctuary (A. Powell, Pers. Comm.). Fish taxa changed with depth, with shallow (~0-200 m) and mid (~200-400 m) depths dominated by sharpchin rockfish (*S. zacentrus*; 552 individuals) and slender sole (*Lyopsetta exilis*, 183 individuals), while deeper (~400-600 m) regions were dominated by thornyheads (*Sebastolobus* spp., 299 fishes) and sablefish (*Anoplopoma fimbria*, 67 fishes). Overall densities for each site were low for corals from a high of 0.6 corals per 100 m^2 at Coos Bay Wind Energy site to a low of 0.1 corals per 100 m^2 of seafloor at Coquille Bank. Sponge densities also varied from a high of 2.1 sponges per 100 m^2 (Coquille Bank) to a low of 0.1 sponges per 100 m^2 at Arago Reef. Fish densities were highest at Coquille Bank (33.9 fishes per 100 m^2; mostly sharpchin rockfish) to a low of 14.9 fishes per 100 m^2 at Coos Bay Wind Energy site. There were no recorded occurrences of anthropogenic debris.

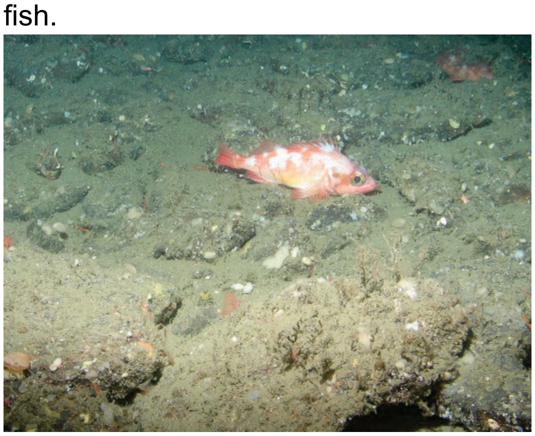
Two *Callistephanus pacificus*, the most abundant coral.



A deep-living two-line eelpout.



A sharpchin rockfish, the most abundant fish.



White nipple sponges, the most abundant sponge.

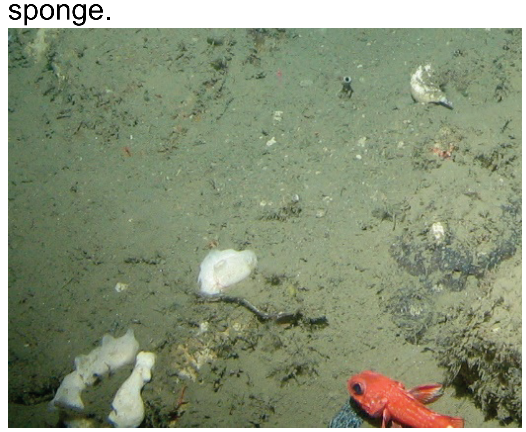


Table 2. Coral taxa observed from video surveys using a remotely operated vehicle (ROV) during the EXPRESS cruise along the Oregon Coast from 3 Sep – 13 Sep, 2022.

Scientific name	**Common name**	**Number**
Callistephanus pacificus	sea fan (red with yellow polyps)	16
Heteropolypus ritteri	mushroom coral	7
Paragorgia spp.	sea fan (white with red polyps)	9
Pennatulacea #1	sea pen (thin)	2
Plexauridae #3	*Callistephanus* type (red w/ unknown polyps)	12

Table 3. Sponge taxa observed from video surveys using a remotely operated vehicle (ROV) during the EXPRESS cruise along the Oregon Coast from 3 Sep – 13 Sep, 2022. See Appendix 1 for images of each taxa.

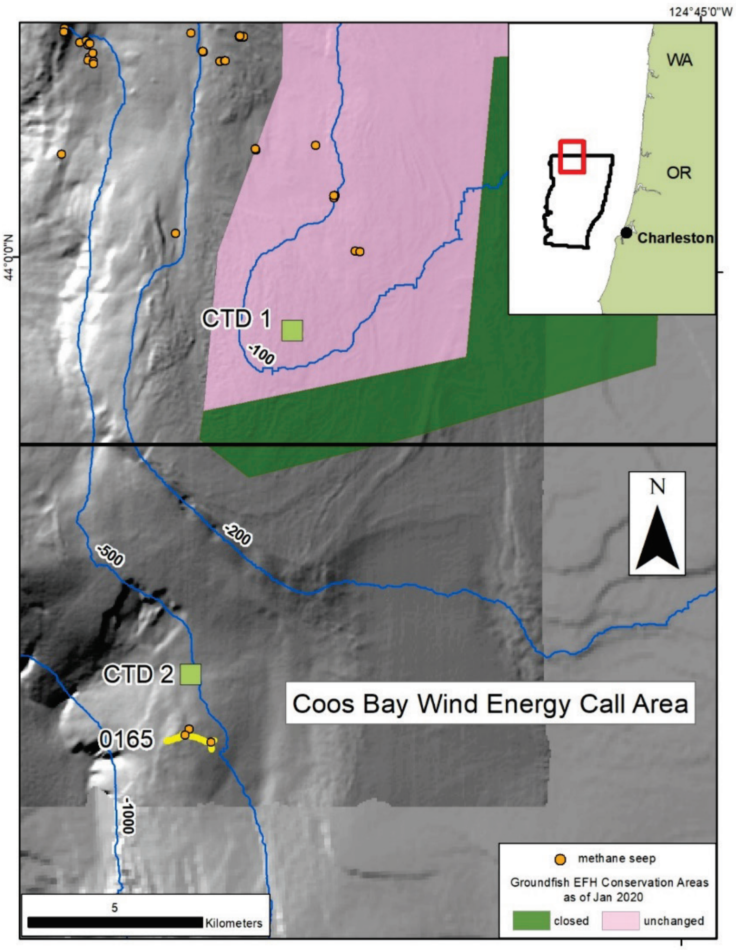
Scientific name	**Common name**	**Number**
Aphrocallistes vastus	quesadilla sponge	2
Heterochone calyx	tan vase/trumpet sponge	12
Poecillastra spp.	fringed shelf sponge	3
Polymastia spp. #1	white nipple foliose sponge	14
Porifera #1	unidentified foliose sponges	2
Porifera #2	unidentified upright flat sponges	4
Porifera #3	unidentified barrel sponges	11
Porifera #5	unidentified vase sponges	5
Porifera #7	unidentified branching sponges	12

Table 4. Fish taxa observed from video surveys using a remotely operated vehicle (ROV) during the EXPRESS cruise along the Oregon Coast from 3 Sep – 13 Sep, 2022. * = taxa in Fisheries Management Plan.

Scientific name	Common name	Number	Scientific name	Common name	Number
Agonidae	unidentified poachers	13	*Plectobranchus evides*	bluebarred prickleback	3
Agonopsis vulsa	northern spearnose poacher	1	Pleuronectiformes	unidentified flatfishes	203
Ammodytes hexapterus	sand lance	13	*Raja rhina**	longnose skate	2
*Anoplopoma fimbria**	sablefish	75	Rajidae	unidentified skates	2
Bothrocara brunneum	twoline eelpout	3	Rajiformes egg case	skate egg case	1
Cataetyx rubrirostris	rubynose brotula	4	*Rathbunella* spp.	unidentified ronquil	1
Clupea pallasii	Pacific herring	1	*Ronquilus jordani*	northern ronquil	6
Embassichthys bathybius	deepsea sole	35	Scyliorhinidae	unidentified cat shark	1
*Eopsetta jordani**	petrale sole	56	Scyliorhinidae	unidentified cat shark egg case	1
Eptatretus spp.	unidentified hagfishes	50	*Sebastes chlorostictus**	greenspotted rockfish	4
*Glytocephalus zachirus**	rex sole	78	*Sebastes elongatus**	greenstriped rockfish	76
*Hydrolagus colliei**	spotted ratfish	29	*Sebastes goodei**	chilipepper	2
Icelinus filamentosus	threadfin sculpin	4	*Sebastes helvomaculatus**	rosethorn rockfish	24
Icelinus spp.	*Icelinus* sculpins	9	*Sebastes jordani**	shortbelly rockfish	7
Icelinus tenuis	spotfin sculpin	1	*Sebastes ruberrimus**	yelloweye rockfish	1
Lycodes cortezianus	bigfin eelpout	1	*Sebastes saxicola**	stripetail rockfish	10
Lycodes diapterus	black eelpout	11	*Sebastes* spp.	unidentified rockfishes	2
Lyconema barbatum	bearded eelpout	2	*Sebastes wilsoni**	pygmy rockfish	3
Lyopsetta exilis	slender sole	186	*Sebastes zacentrus**	sharpchin rockfish	552
Macrouridae*	unidentified grenadiers	3	*Sebastolobus alascanus**	shortspine thornyhead	10
*Merluccius productus**	Pacific whiting	11	*Sebastolobus altivelis**	longspine thornyhead	30
*Microstomus pacificus**	Dover sole	126	*Sebastolobus* spp.	thornyheads	259
Myctophidae	unidentified lanternfishes	3	*Sebastomus*	unidentified *Sebastomus*	1
*Ophiodon elongatus**	lingcod	2	*Xeneretmus latifrons*	blacktip poacher	3
Osteichthyes	unidentified fishes	5	Zoarcidae	unidentified eelpouts	6
*Parophrys vetulus**	English sole	20			

STUDY AREA: Coos Bay Wind Energy
DIVE NUMBER: ROV 0165

GENERAL LOCATION AND DIVE TRACKS



STATION OVERVIEW (Coos Bay Wind Energy)

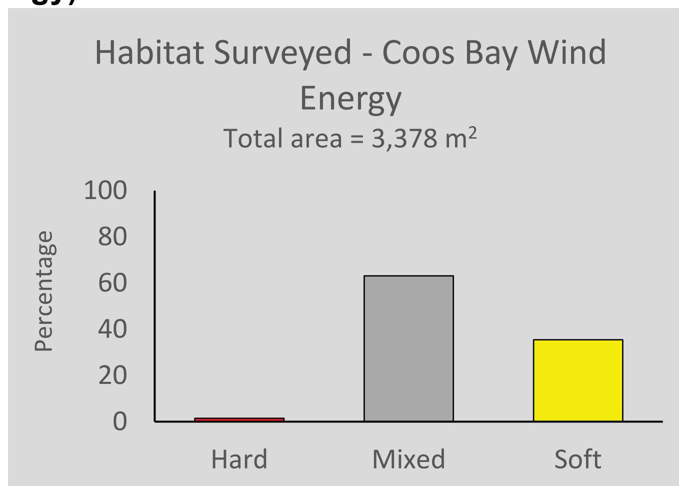
Project	EXPRESS 2022
Chief Scientist	Elizabeth Clarke
Contact Information	NMFS, SWFSC, tom.laidig@noaa.gov
Purpose	Survey deep-sea coral communities along the West Coast
Vessel	NOAA Ship *Bell M. Shimada*; ROV *Beagle* (MARE)
Science Observers	Tom Laidig, Diana Watters, Meredith Everett
Digital Video	3.4 hrs
Digital Still Photos	374 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	3 eDNA; 3 water chemistry
Other	Logbook, SQL server database
Report Analyst	Tom Laidig
Date Compiled	5/17/2023

DIVE DATA (Coos Bay Wind Call North)

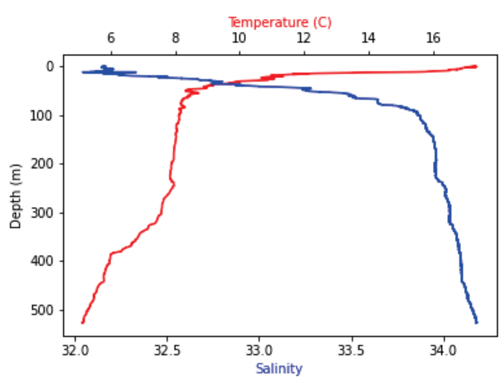
Date	3 Sep 2022	Starting Latitude (N)	43° 52.554’
Minimum Bottom Depth (m)	497	Starting Longitude (W)	124° 56.088’
Maximum Bottom Depth (m)	550	Ending Latitude (N)	43° 52.446’
Start Bottom Time (UTC)	08:07:41	Ending Longitude (W)	124° 55.134’
End Bottom Time (UTC)	11:29:46	Surface Current	n/a
Number 15-min Transects	4	Bottom Current	n/a

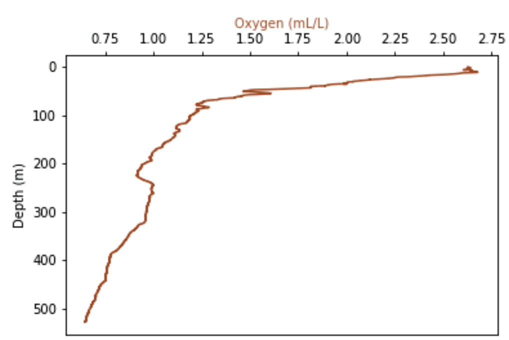
PHYSICAL ENVIRONMENT (Coos Bay Wind Energy)

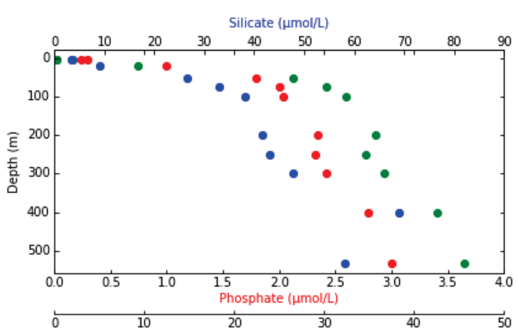
In total, 3,378 m^2 of seafloor were surveyed during 4 quantitative transects conducted during dive 0165 at Coos Bay Wind Energy site in southern Oregon. Habitat types were classified as (1) Hard (1.5% of the total area surveyed), which included large boulders and rock outcrops; (2) Mixed (63.1%), including a combination of mud with boulder, cobbles, flat rock, or rock outcrops; and (3) Soft (35.4%), which consisted entirely of mud.



Temperature (as measured from the shipboard CTD) dropped quickly from the surface to ~50 m and then decreased slowly. Salinity increased while oxygen decreased with depth. Nutrient load (phosphate, silicate, and nitrate [N+N]) gradually increased with depth.

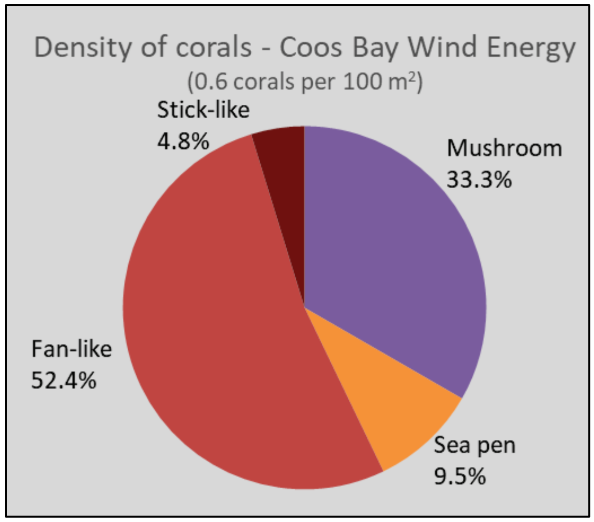






BIOLOGICAL ENVIRONMENT: CORALS (Coos Bay Wind Energy)

A total of 21 individual coral colonies, comprising at least 5 taxa, were enumerated from 4 quantitative transects conducted during Dive 0165 at Coos Bay Wind Energy site off southern Oregon. Coral density was low at 0.6 corals per 100 m^2 of seafloor. Fan-like corals dominated the coral assemblage with 52.4% of all corals, and *Paragorgia* spp. was the most abundant fan-like coral. Most corals were <20 cm wide or tall, except for two tall sea pens (25 and 30 cm tall, respectively).



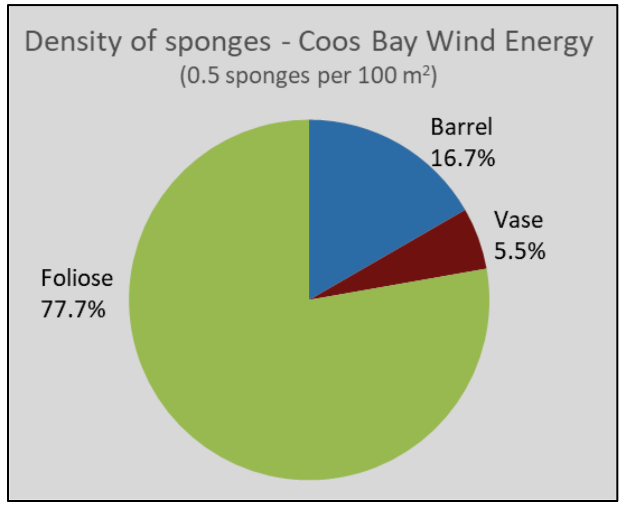
Colors in the pie diagram match colors in the list of coral taxa (below).

Scientific name	Common name	Number
Heteropolypus ritteri	mushroom coral	7
Callistephanus pacificus	sea fan (red with yellow polyps)	2
Pennatulacea #1	sea pen (thin)	2
Paragorgia spp.	sea fan (white with red polyps)	9
Plexauridae #3	*Callistephanus* type (red w/ unknown polyps)	1

No coral specimens were collected during the dive at Coos Bay Wind Energy site.

BIOLOGICAL ENVIRONMENT: SPONGES (Coos Bay Wind Energy)

A total of 18 individual sponges from at least 3 different taxa were enumerated from 4 quantitative transects conducted during Dive 0165 at Coos Bay Wind Energy site off southern Oregon. Overall density was low at 0.5 sponges per 100 m^2 of seafloor. The sponge assemblage was dominated by unidentified foliose (78%) and barrel (17%) sponges.



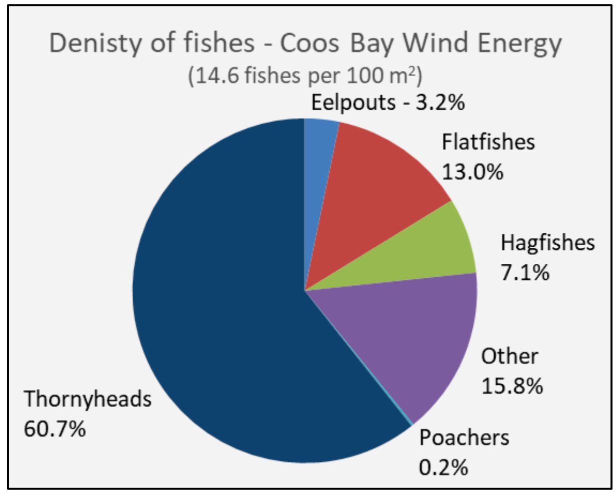
Colors in the pie diagram match colors in the list of sponge taxa (below).

Scientific name	Common name	Number
Porifera #3	unidentified barrel sponges	3
Porifera #5	unidentified vase sponge	1
Polymastia spp. #1	white nipple foliose sponge	14

One sponge specimen was collected during the dive at Coos Bay Wind Energy site and sent to experts for identification. Shipboard identification was a white *Polymastia* spp. (1 specimen). Verified identification from experts are still pending.

BIOLOGICAL ENVIRONMENT: FISHES (Coos Bay Wind Energy)

At least 18 taxa of fishes were identified from 4 quantitative transects conducted during Dive 0165 at Coos Bay Wind Energy site off southern Oregon. A total of 493 individual fishes were enumerated, with an overall density of 14.6 fishes per 100 m^2 of seafloor. Thornyheads (*Sebastolobus* spp.) dominated the fish assemblage with >60% of all fishes. The remainder of the fish assemblage included other (15.8%), flatfishes (13.0%), hagfishes (7.0%, *Eptatretus stoutii*), eelpouts (3.2%), and poachers (0.2%). The category 'other' included at least 6 taxa, including sablefishes, grenadiers, longnose skates, catsharks, lanternfishes, and rubynose brotulas.



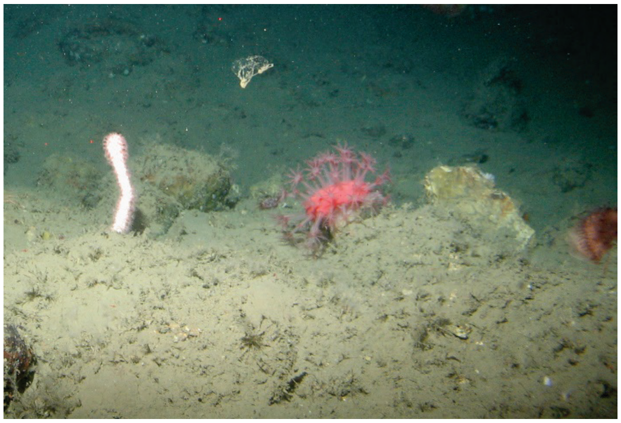
Colors in the pie diagram match colors in the list of fish taxa (below).

No fishes were associated within one body length with 39 corals and sponges.

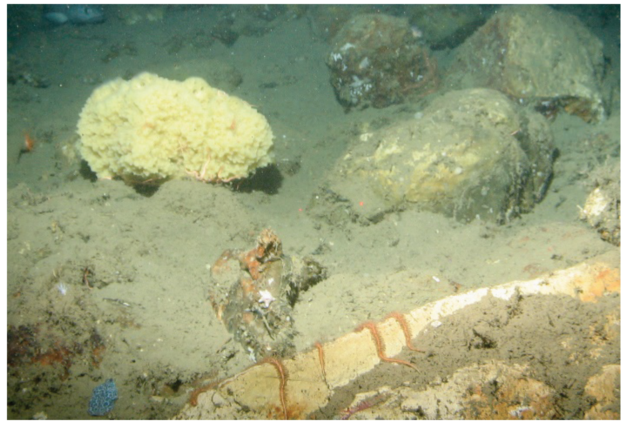
Scientific name	Common name	Number
Agonidae	unidentified poacher	1
Anoplopoma fimbria	sablefish	67
Bothrocara brunneum	twoline eelpout	3
Cataetyx rubrirostris	rubynose brotula	4
Embassichthys bathybius	deepsea sole	35
Eptatretus spp.	unidentified hagfishes	35
Glytocephalus zachirus	rex sole	8
Lycodes cortezianus	bigfin eelpout	1
Lycodes diapterus	black eelpout	11
Macrouridae	unidentified grenadier	3
Microstomus pacificus	Dover sole	21
Myctophidae	unidentified lanternfish	1
Raja rhina	longnose skate	2
Scyliorhinidae	unidentified cat shark	1
Sebastolobus alascanus	shortspine thornyhead	10
Sebastolobus altivelis	longspine thornyhead	30
Sebastolobus spp.	thornyheads	259
Zoarcidae	unidentified eelpout	1

IMAGE GALLERY (Coos Bay Wind Energy)

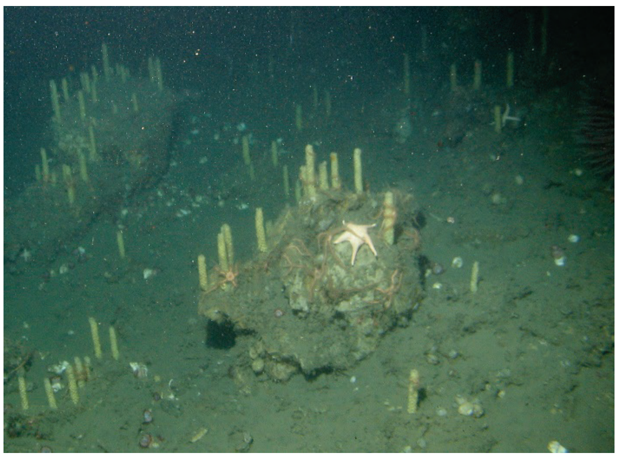
A *Paragorgia* spp. and a mushroom coral on a boulder at 524 m.



A large yellow sponge (likely *Mycale loveni*) at 515 m.



A field of gastropod egg cases at 497 m.



A school of sablefish and a black eelpout on a mud seafloor at 500 m.

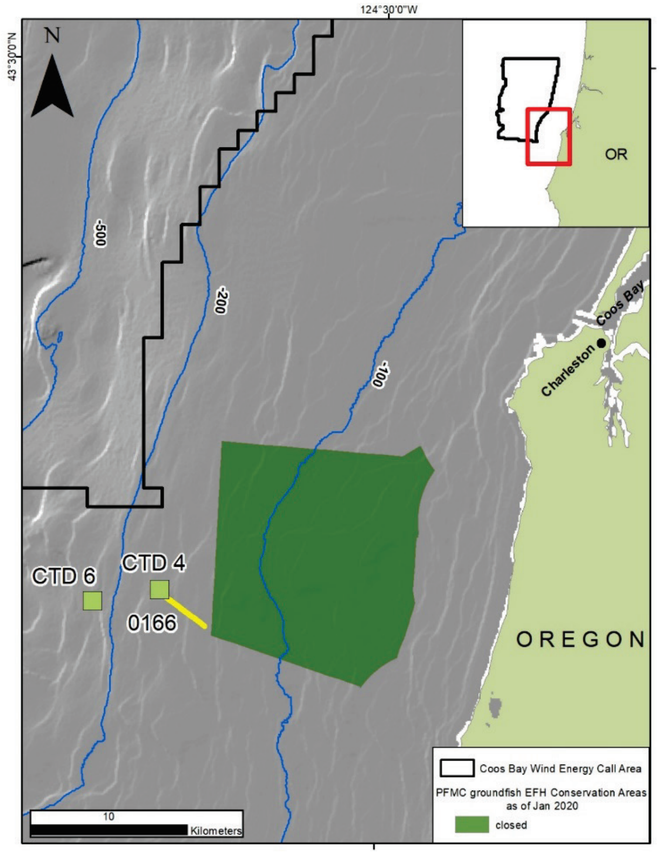
ADDITIONAL COMMENTS (Coos Bay Wind Energy)

No anthropogenic debris items were documented during dives at Coos Bay Wind Energy site.

No corals or sponges were damaged or knocked over, and all appeared alive and healthy.

STUDY AREA: Arago Reef
DIVE NUMBER: ROV 0166

GENERAL LOCATION AND DIVE TRACK



STATION OVERVIEW (Arago Reef)

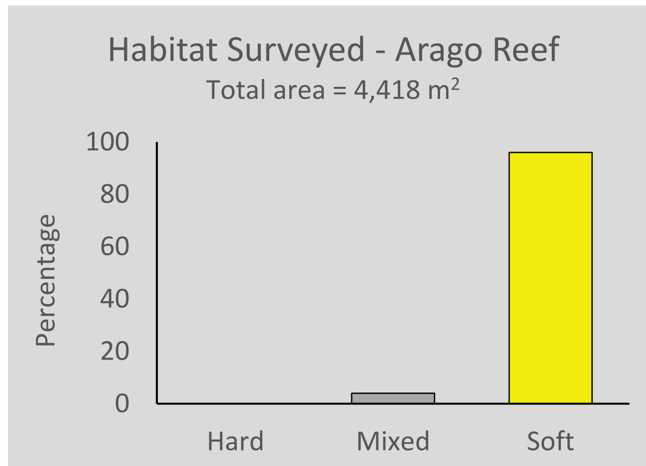
Project	EXPRESS 2022
Chief Scientist	Elizabeth Clarke
Contact Information	NMFS, SWFSC, tom.laidig@noaa.gov
Purpose	Survey deep-sea coral communities along the West Coast
Vessel	NOAA Ship *Bell M. Shimada*; ROV *Beagle* (MARE)
Science Observers	Tom Laidig, Diana Watters, Meredith Everett
Digital Video	3.8 hrs
Digital Still Photos	446 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	2 eDNA; 3 water chemistry
Other	Logbook, SQL server database
Report Analyst	Tom Laidig
Date Compiled	5/17/2023

DIVE DATA (Arago Reef)

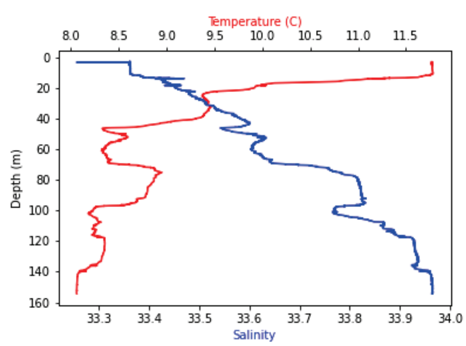
Date	6 Sep 2022	Starting Latitude (N)	43° 11.750’
Minimum Bottom Depth (m)	130	Starting Longitude (W)	124° 40.281’
Maximum Bottom Depth (m)	155	Ending Latitude (N)	43° 10.530’
Start Bottom Time (UTC)	17:07:26	Ending Longitude (W)	124° 38.118’
End Bottom Time (UTC)	20:53:00	Surface Current	n/a
Number 15-min Transects	8	Bottom Current	n/a

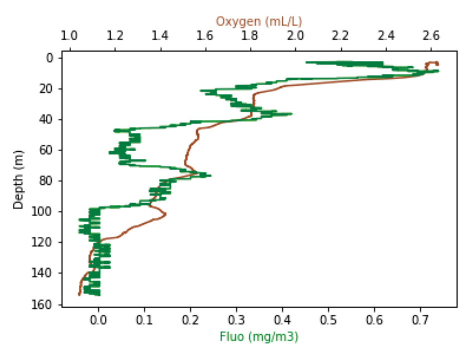
PHYSICAL ENVIRONMENT (Arago Reef)

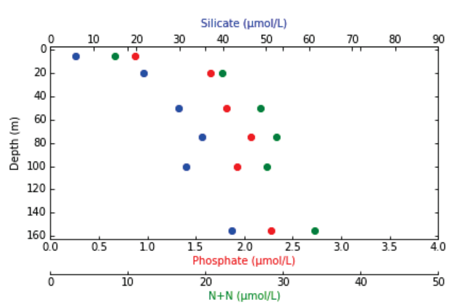
In total, 4,418 m^2 of seafloor were surveyed during 8 quantitative transects conducted during Dive 0166 on Arago Reef off southern Oregon. Habitat types were classified as (1) Mixed (4%), including a combination of mud with boulders and cobbles; and (2) Soft (96%), which consisted entirely of mud. No hard habitat was observed.



A thermocline occurred from the surface to about 40 m and decreased slowly after this with some variations. Salinity increased and oxygen and fluorescence decreased with increasing depth. Nutrient load (phosphate, silicate, and nitrate [N+N]) gradually increased with depth.

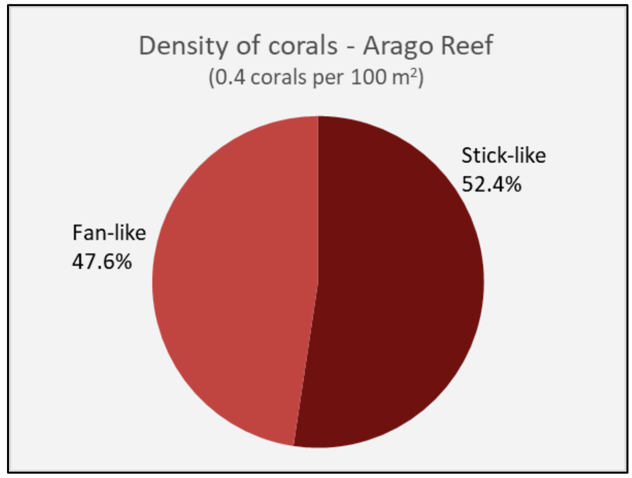






BIOLOGICAL ENVIRONMENT: CORALS (Arago Reef)

A total of 21 individual coral colonies, comprising at least 2 taxa, were enumerated from 8 quantitative transects conducted during Dive 0166 at Arago Reef off southern Oregon. Coral density was low at 0.4 corals per 100 m^2 of seafloor. Stick-like corals were the most abundant corals with 52% of all corals, and fan-like corals were the only other taxa of coral observed (48%).



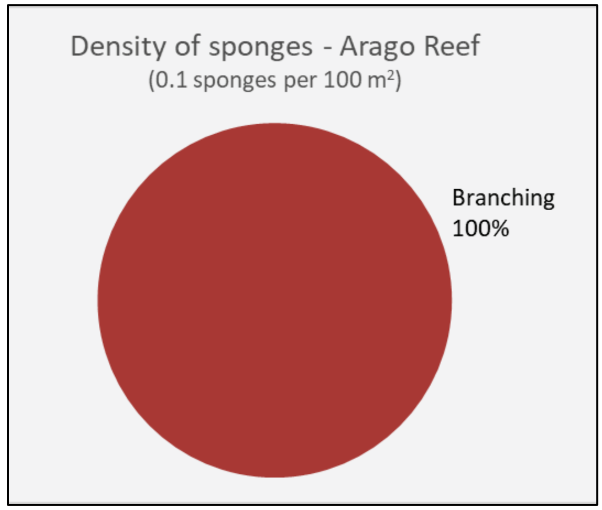
Colors in the pie diagram match colors in the list of coral taxa (below).

Scientific name	Common name	Number
Callistephanus pacificus	sea fan (red with yellow polyps)	10
Plexauridae #3	*Callistephanus* type (red w/ unknown polyps)	11

No coral specimens were collected during the dive at Arago Reef.

BIOLOGICAL ENVIRONMENT: SPONGES (Arago Reef)

Only four individual sponges from one different taxon were enumerated from 8 quantitative transects conducted during Dive 0166 at Arago Reef off southern Oregon. Overall density was very low at 0.1 sponges per 100 m^2 of seafloor. The only sponge taxa observed were unidentified branching sponges.



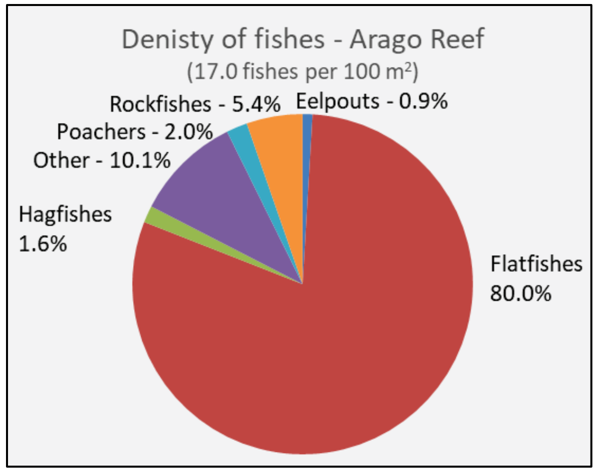
Colors in the pie diagram match colors in the list of sponge taxa (below).

	Scientific name	Common name	Number
	Porifera #7	unidentified branching sponges	4

No sponge specimens were collected during the dive at Arago Reef.

BIOLOGICAL ENVIRONMENT: FISHES (Arago Reef)

At least 31 taxa of fishes were identified from 8 quantitative transects conducted during Dive 0166 on Arago Reef off southern Oregon. A total of 751 individual fishes were enumerated, and an overall density of 17.0 fishes per 100 m^2 of seafloor was calculated. Flatfishes accounted for 80.0% of all fishes observed. Other taxa present were other fishes (10.1%), rockfishes (5.3%), poachers (2.0%), hagfishes (1.6%), and eelpouts (1.0%). This shallow dive had the greatest diversity of fishes for the entire cruise.



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

No fishes were associated within one body length with 25 corals and sponges.

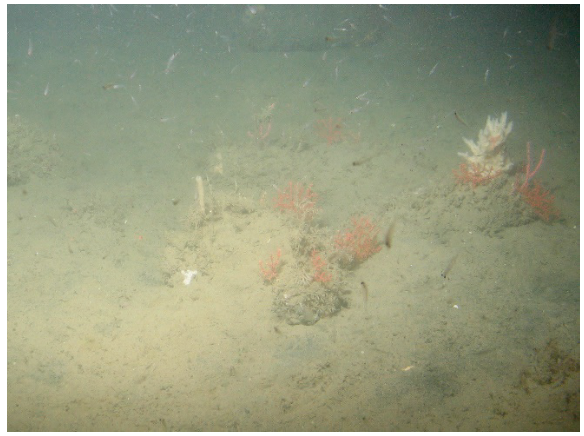
Scientific name	Common name	Number
Agonidae	unidentified poachers	12
Ammodytes hexapterus	sand lance	13
Anoplopoma fimbria	sablefish	8
Clupea pallasii	Pacific herring	1
Eopsetta jordani	petrale sole	56
Eptatretus spp.	unidentified hagfish	12
Glytocephalus zachirus	rex sole	62
Hydrolagus colliei	spotted ratfish	28
Icelinus filamentosus	threadfin sculpin	1
Icelinus spp.	*Icelinus* sculpins	3
Icelinus tenuis	spotfin sculpin	1
Lyconema barbatum	bearded eelpout	2
Lyopsetta exilis	slender sole	183
Merluccius productus	Pacific whiting	2
Microstomus pacificus	Dover sole	77
Myctophidae	unidentified lanternfish	1
Ophiodon elongatus	lingcod	1
Osteichthyes	unidentified fishes	5
Parophrys vetulus	English sole	20
Plectobranchus evides	bluebarred prickleback	3
Pleuronectiformes	unidentified flatfishes	203
Rajidae	unidentified skate	2

Scientific name	Common name	Number
Rathbunella spp.	unidentified ronquil	1
Ronquilus jordani	northern ronquil	6
Sebastes chlorostictus	greenspotted rockfish	4
Sebastes elongatus	greenstriped rockfish	31
Sebastes spp.	unidentified rockfishes	1
Sebastes wilsoni	pygmy rockfish	3
Sebastes zacentrus	sharpchin rockfish	1
Xeneretmus latifrons	blacktip poacher	3
Zoarcidae	unidentified eelpout	5

IMAGE GALLERY (Arago Reef)

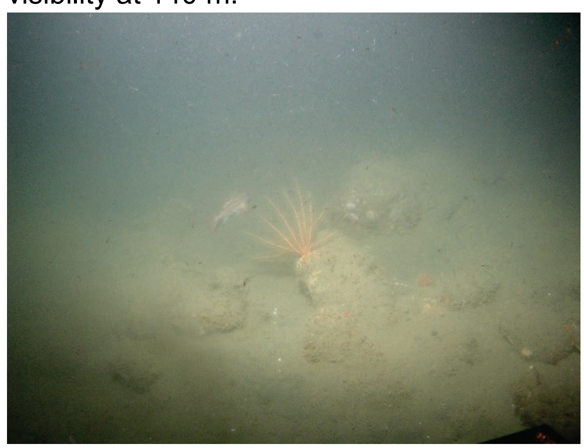
A branching sponge (Possibly *Iophon Koltuni*) and a swarm of euphausiids at 146 m.

Many *Callistephanus pacificus* and a branching sponge on cobbles and boulders at 143 m.



Callistephanus pacificus on a boulder at 142 m.

A crinoid and greenstriped rockfish in low visibility at 140 m.



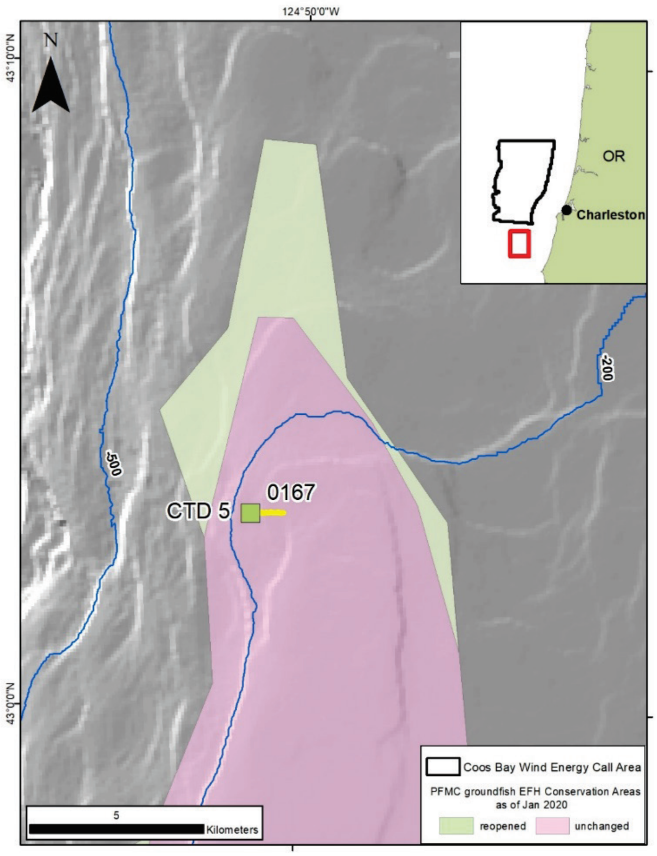
ADDITIONAL COMMENTS (Arago Reef)

No anthropogenic debris items were documented during dives at Arago Reef.

No corals or sponges were damaged or knocked over, and all appeared alive and healthy.

STUDY AREA: Coquille Bank
DIVE NUMBER: ROV 0167

GENERAL LOCATION AND DIVE TRACK



STATION OVERVIEW (Coquille Bank)

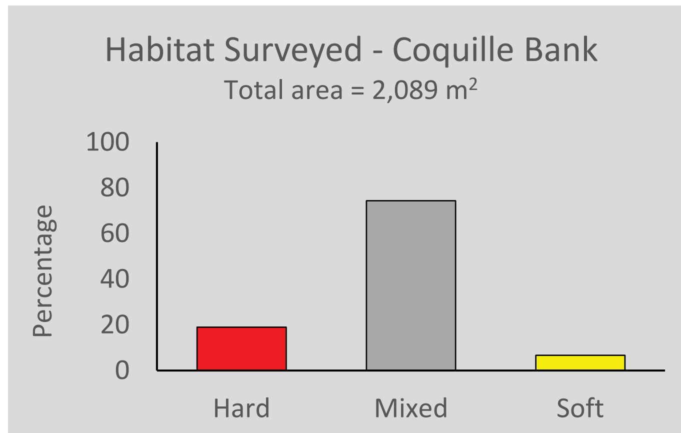
Project	EXPRESS 2022
Chief Scientist	Elizabeth Clarke
Contact Information	NMFS, SWFSC, tom.laidig@noaa.gov
Purpose	Survey deep-sea coral communities along the West Coast
Vessel	NOAA Ship *Bell M. Shimada*; ROV *Beagle* (MARE)
Science Observers	Tom Laidig, Diana Watters, Meredith Everett
Digital Video	1.6 hrs
Digital Still Photos	237 images
Positioning System	Ship: GPS; ROV: USBL
CTD Sensors	Yes
O_2 Sensor (ship CTD only)	Yes
pH Sensor	Yes
Specimens collected	2
Water sample	3 eDNA; 2 water chemistry
Other	Logbook, SQL server database
Report Analyst	Tom Laidig
Date Compiled	5/17/2023

DIVE DATA (Coquille Bank)

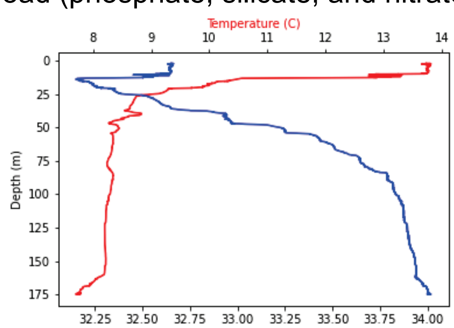
Date	7 Sep 2022	Starting Latitude (N)	43° 03.042’
Minimum Bottom Depth (m)	153	Starting Longitude (W)	124° 50.994’
Maximum Bottom Depth (m)	183	Ending Latitude (N)	43° 03.042’
Start Bottom Time (UTC)	05:00:42	Ending Longitude (W)	124° 50.364’
End Bottom Time (UTC)	06:34:00	Surface Current	n/a
Number 15-min Transects	3	Bottom Current	n/a

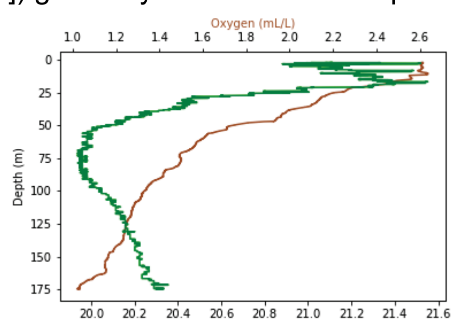
PHYSICAL ENVIRONMENT (Coquille Bank)

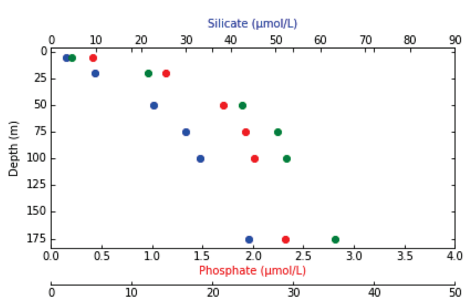
In total, 2,089 m^2 of seafloor were surveyed during 3 quantitative transects conducted during Dive 0167 on Coquille Bank off southern Oregon. Habitat types were classified as (1) Hard (19% of the total area surveyed), which included large boulders; (2) Mixed (74.3%), including a combination of mud with boulders and cobbles; and (3) Soft (6.7%), which consisted entirely of mud.



A thermocline occurred from the surface to about 25 m and decreased slowly after thereafter. Salinity decreased until about 15 m and then increased with depth. Oxygen decreased with increasing depth while fluorescence decreased until 75 m and then slowly increased. Nutrient load (phosphate, silicate, and nitrate [N+N]) gradually increased with depth.

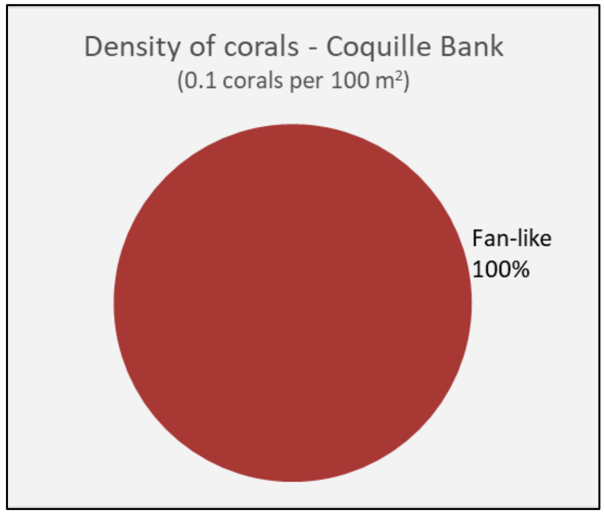






BIOLOGICAL ENVIRONMENT: CORALS (Coquille Bank)

A total of 4 individual coral colonies, comprising at least 1 taxon, were enumerated from 3 quantitative transects conducted during Dive 0167 on Coquille Bank off southern Oregon. Coral density was very low at 0.1 corals per 100 m^2 of seafloor. Fan-like corals were the only taxon observed and all were *Callistephanus pacificus*. All *C. pacificus* were small (10 cm or less in height or width).



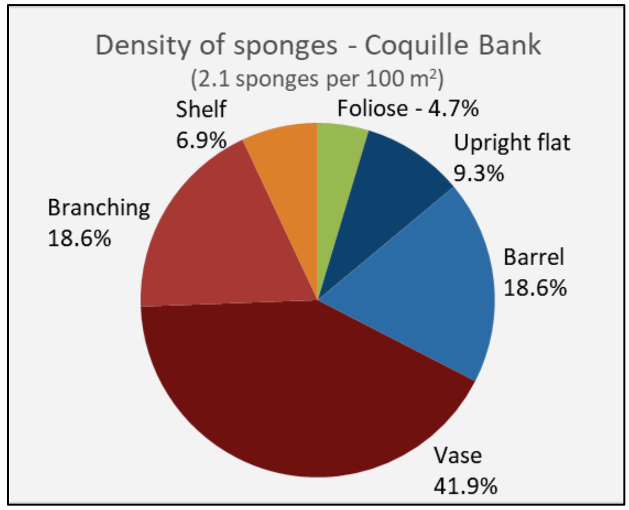
Colors in the pie diagram match colors in the list of coral taxa (below).

Scientific name	Common name	Number
Callistephanus pacificus	sea fan (red with yellow polyps)	4

One coral specimen were collected during the dive at Coquille Bank. Shipboard identification was *Callistephanus* spp. Verified identification from experts are still pending.

BIOLOGICAL ENVIRONMENT: SPONGES (Coquille Bank)

A total of 43 individual sponges from at least 8 different taxa were enumerated from 3 quantitative transects conducted during Dive 0167 on Coquille Bank off southern Oregon. Overall density was the highest of the cruise (but still low compared to previous surveys) at 2.1 sponges per 100 m^2 of seafloor. The sponge assemblage was dominated by vase (42%), barrel (18.6%), and branching (18.6%) sponges. This site had the highest diversity of sponges.



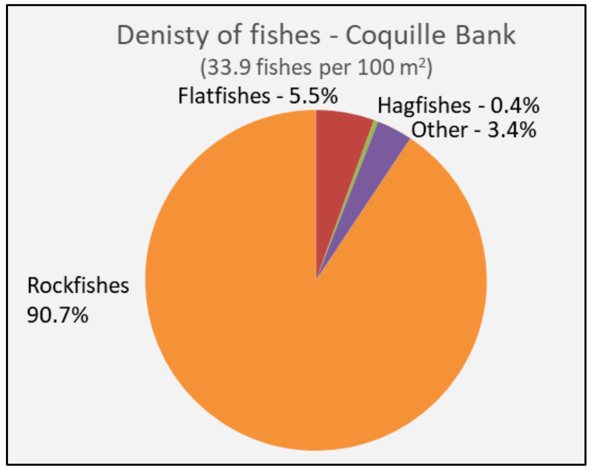
Colors in the pie diagram match colors in the list of sponge taxa (below).

Scientific name	Common name	Number
Porifera #1	unidentified foliose sponges	2
Porifera #2	unidentified upright flat sponges	4
Porifera #3	unidentified barrel sponges	8
Porifera #5	unidentified vase sponges	4
Porifera #7	unidentified branching sponges	8
Heterochone calyx	tan vase/trumpet sponge	12
Poecillastra spp.	fringed shelf sponge	3
Aphrocallistes vastus	quesadilla sponge	2

One sponge specimen were collected during the dive at Coquille Bank. Shipboard identification was *Heterochone calyx/Haliclona* spp. Verified identification from experts was *Heterochone calyx*.

BIOLOGICAL ENVIRONMENT: FISHES (Coquille Bank)

At least 22 taxa of fishes were identified from 3 quantitative transects conducted during Dive 0167 on Coquille Bank off southern Oregon. A total of 708 individual fishes were enumerated, and an overall density of 33.9 fishes per 100 m^2 of seafloor was calculated. Rockfishes (*Sebastes* spp.) accounted for 90.7% of all fishes observed. Sharpchin rockfishes were the most abundant rockfish at Coquille Bank (551 individuals or 86% of rockfishes). Other taxa present were flatfishes (6.6%), other fishes (3.3%), and hagfishes (0.4%). No poachers, eelpouts, or thornyheads were observed.



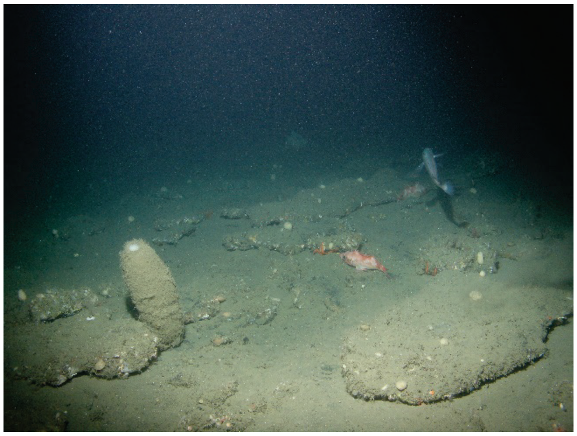
Colors in the pie diagram match colors in the list of fish taxa (below).

Eighteen sponges and no corals had fish associations (38% associations; 17 sharpchin and 1 stripetail rockfish). Fish were associated with seven *Heterochone calyx*, four vase sponges, two barrel sponges, two *Aphrocallistes vastus*, two branching sponges, and one *Poecillastra* spp.

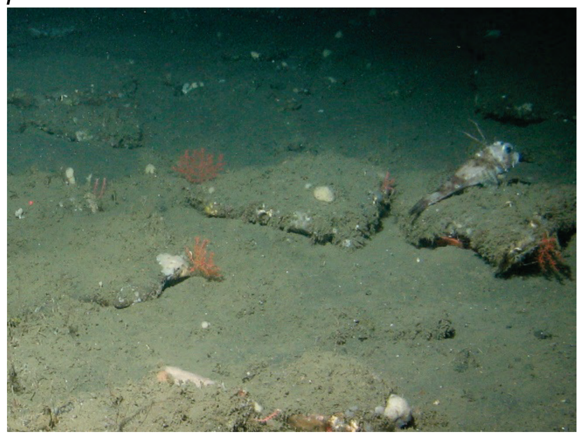
Scientific name	Common name	Number
Agonopsis vulsa	northern spearnose poacher	1
Eptatretus spp.	unidentified hagfishes	3
Glytocephalus zachirus	rex sole	8
Hydrolagus colliei	spotted ratfish	1
Icelinus filamentosus	threadfin sculpin	3
Icelinus tenuis	spotfin sculpin	6
Lyopsetta exilis	slender sole	3
Merluccius productus	Pacific whiting	9
Microstomus pacificus	Dover sole	28
Myctophidae	unidentified lanternfish	1
Ophiodon elongatus	lingcod	1
Rajiformes egg case	skate egg case	1
Scyliorhinidae	unidentified cat shark eggcase	1
Sebastes elongatus	greenstriped rockfish	45
Sebastes goodei	chilipepper	2
Sebastes helvomaculatus	rosethorn rockfish	24
Sebastes jordani	shortbelly rockfish	7
Sebastes ruberrimus	yelloweye rockfish	1
Sebastes saxicola	stripetail rockfish	10
Sebastes spp.	unidentified rockfishes	1
Sebastes zacentrus	sharpchin rockfish	551
Sebastomus	unidentified *Sebastomus*	1

IMAGE GALLERY (Coquille Bank)

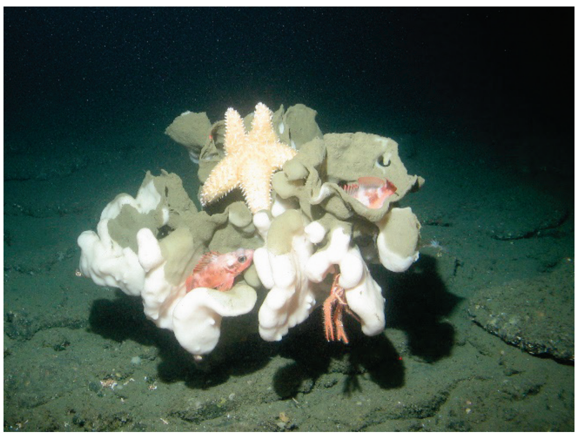
A large barrel sponge at 182 m.



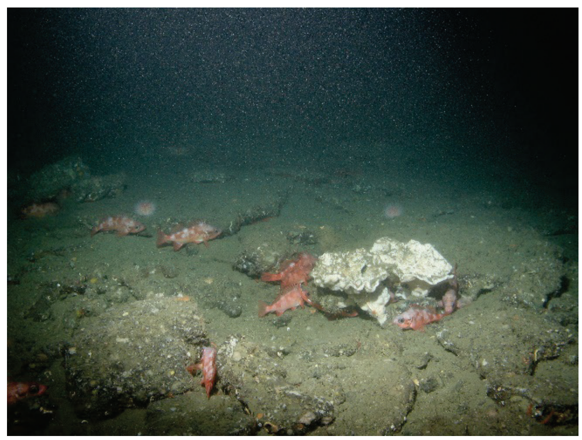
A threadfin sculpin and *Callistephanus pacificus* at 174 m.



A partially dead *Aphrocallistes vastus* with many fish and invertebrate associates at 164 m.



A detritus-covered sponge surrounded by many sharpchin rockfish at 156 m.



ADDITIONAL COMMENTS (Coquille Bank)

No anthropogenic debris items were documented during dives at Coquille Bank.

No sponges were damaged, but seven sponges from 5 taxa had dead or dying areas (condition = 1). One upright flat sponge was knocked over, but was still alive and appeared healthy.

CONCLUSIONS

Although the cruise was hindered by an enormous amount of issues (see below), we successfully completed three days of ROV operations out of the 12 scheduled sea days. During the three dives, valuable baseline data was collected in a proposed wind energy site and an EFH Conservation Area. More sites were to be explored, but sea days were lost due to weather, ship staffing issues, ship mechanical issues, and personnel medical issues. Some of the sites that were planned to be surveyed were 1) two proposed wind energy areas (one off southern Oregon and one off northern California), 2) Mendocino Ridge to better understand the expanse of the coral and sponge gardens located there, 3) Daisy Bank to create 3D mosaics, and 4) in and around newly modified EFH Conservations Areas off Oregon and California.

Deep-sea Corals and Sponges

Densities of DSCS were low for all areas compared to previous surveys (Table 5). Most corals and sponges were 20 cm or less in height (95.5%) and width (91.9%). The larger DSCS were the two *Aphrocallistes vastus*, three *Staurocalyptus* spp., two vase sponges, one barrel sponge, two foliose sponges, and the two thin sea pens. The low densities reflect the high amount of soft sediment on these dives (over 60%). Even with the high amount of mud, only two sea pens were observed on transect. Compared to other surveys along the Oregon coast, the densities were extremely low. In 2018 and 2019, EXPRESS cruises surveyed Daisy and Heceta Banks, Sponge Byctach, and Bandon high spot (AKA Coquille Bank; Laidig et al., 2021, 2022). All areas had higher coral (range = 2.9-17.2 corals/100 m^2) and sponge (range = 1.9-158 sponges/100 m^2) densities. The one exception was Coquille Bank (AKA Bandon High Spot) where the sponge density (2.1 sponges/100 m^2) was similar to densities in the same area surveyed during the 2018 EXPRESS cruise (1.9 sponges/100 m^2, Laidig et al., 2021). However, coral densities differed greatly with the 2022 expedition finding densities of 0.1 corals/100 m^2 compared to 2018 where densities were estimated at 13.2 corals/100 m^2. The 2022 surveys were slightly shallower (183-153 m) than 2018 surveys (371-193 m) which may have had an impact on the habitat or coral taxa. More soft sediment was surveyed in 2018 (23%) compared to 2022 (7%), so habitat alone does not suggest a reason for the difference.

Table 5. Overall coral, sponge, and fish densities and the proportion of fish associations with corals and sponges per site on the 2022 EXPRESS cruise.

	Density (#/100 m^2)			
Site	Coral	Sponge	Fish	Fish associations (%)
Coos Bay Wind Energy	0.6	0.5	14.6	0
Arago Reef	0.4	0.1	17.0	0
Coquille Bank	0.1	2.1	33.9	38.3
Average	0.4	0.9	21.8	12.8

Fishes

Fish densities were about average for the area. In 2018, fish densities varied from 15.9-47.5 fishes/100 m^2 (Laidig et al., 2021) in 2018 and 19.4-38.6 in 2019 (Laidig et al., 2022). Densities at Coquille Bank this year were comparable to densities at Coquille Bank in 2018 (33.9 and 29.1, respectively). The fish assemblage was also similar, but more flatfishes were observed in in 2018 (along with a higher percent of soft habitat).

Range Observations and Extensions

No range extensions were noted during this cruise. However, the absence of *Calcigorgia japonica* on these reefs in southern Oregon strengthens the southern limit for this species as Heceta Bank which was determined during the 2018 EXPRESS cruise (Laidig et al., 2021).

Sand lances (*Ammodytes hexapterus*) were observed at Arago Reef. This is the first time this species has been encountered during an EXPRESS cruise. Rubynose brotulas (*Cataetyx rubrirostris*) were seen at the Coos Bay Wind Energy site. This is at the northern edge of their distribution (Love and Passarelli, 2020).

Coral, Sponge, and Fish Associations

No fish associations were noted at either Coos Bay Wind Energy or Arago Reef, but several were observed at Coquille Bank. There was a high incidence of fish associations with DSCS at Coquille with 18 occurrences out of 47 DSCS individuals (38%). All the associations were with larger sponges >10 cm. Only three of the 13 larger sponges (20 cm or greater in width) had no fish association. Seven of ten large sponges had fish associating with the base of the sponge, while three were located inside the sponge. This high number of associations could possibly be attributed to the high number of fishes in the area, especially sharpchin rockfishes (551 individuals).

Observations of Marine Debris

No marine debris was observed on transect. Only one green bottle was seen during a test dive at Heceta Bank.

Management Implications

Over three square kilometers were surveyed in the Coos Bay Wind Energy area. These data contain baseline information for this wind energy call area. The DSCS and fish assemblages were typical of this area and depth. The low amount of hard substrata observed is a positive sign that the placement of wind energy production units in this area may have minimal adverse impacts on DSCS habitats. However, more surveys need to be conducted at various locations to fully explore the seafloor in this area and quantify the DSCS assemblages.

The surveys on Arago Reef were just outside the EFHCA. The surveys in this area were suggested by the PFMC Habitat Committee to determine the extent of the rocky reef outside the EFHCA. The survey area was mostly mud with an occasional boulder or cobble. Therefore, in this area, the reef did not appear to extend outside the border of the EFHCA. However, corals (mostly *Callistephanus* spp,) were observed on the few boulders encountered.

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

For Further Study

Further explorations at the coral garden at Mendocino Ridge would help determine the extent of coverage of this unique area with the highest densities of corals recorded on the Unites States West Coast to date (Laidig et al., 2021). Surveys could be extended deeper and to the north and south of the ridge to better understand the extent of this area of high coral abundance. Now that the essential fish habitat (EFH) modifications are in place, new surveys conducted within and around these modified EFH conservation areas will enable monitoring for changes related to increased fishing pressure or to examine the potential and rate of recovery of coral and sponge species in newly closed areas. Further studies in the proposed wind energy sites would be useful to get baseline information before these sites are exposed to the construction operations and the final anchoring of the floating wind turbines.

ACKNOWLEDGMENTS

We thank the captain, officers, and crew of the NOAA Ship *Bell M. Shimada* for their hard work during this challenging expedition. The MARE ROV team did an exceptional job conducting ROV operations, aiding in dive planning, and continuing to answer questions about the surveys after the cruise. A big thank you goes out to all of our EXPRESS partners for their help in planning all the different aspects of this cruise and for staffing the ship and answering data requests before, during, and after the cruise. We thank Victor Naklicki for use of a WHOI-owned, Liquid Robotics Wave Glider (although we were not able to adequately pair the Wave Glider with the AUV, it was a successful communication test). This project was funded by grants from BOEM, DSCRTP and NOAA's UxS program. The USGS Environments Program through the Outer Continental Shelf study provided support for this study with additional support from BOEM. Thanks to Miranda Baker and Joanne Ferreira (USGS) for assistance with CTD processing.

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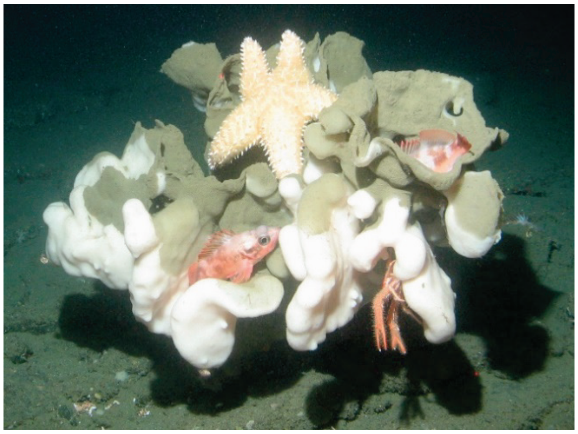
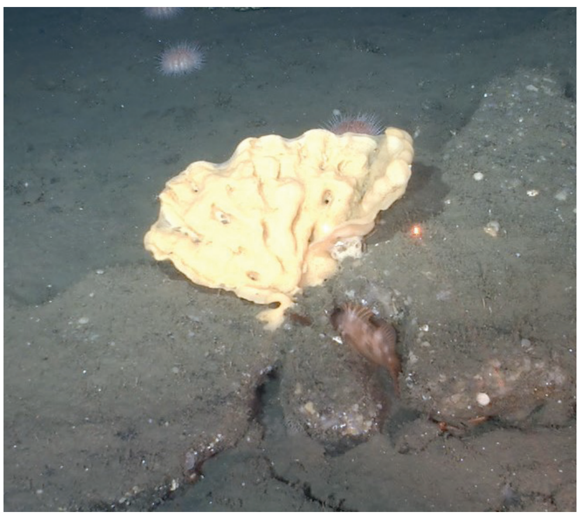
Appendix 1 – Images of the sponge taxa observed on quantitative visual survey transects during the 2022 EXPRESS cruise.



Aphrocallistes vastus – quesadilla sponge



Heterochone calyx - tan vase/trumpet sponge

Poecillastra spp. - fringed shelf sponge

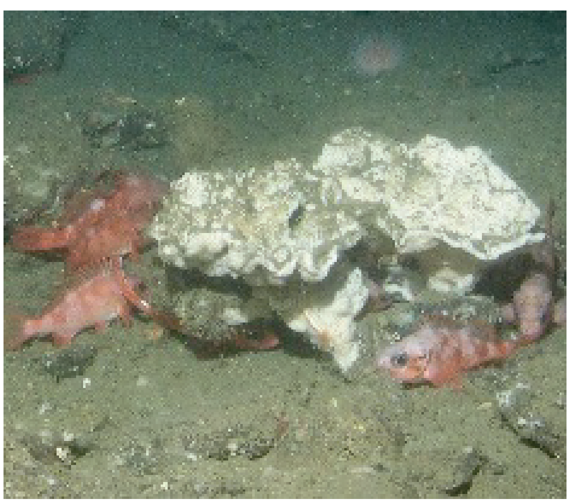
Polymastia spp. #1 - white nipple foliose sponge

Porifera #1 - unidentified foliose sponges

Porifera #2 - unidentified upright flat sponges


Porifera #3 - unidentified barrel sponge


Porifera #7 - unidentified branching sponge


Porifera #5 - unidentified vase sponges