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Supplemental Public Comment 3
September 2017

Exploring the Living Seafloor: Southern California Expedition

OCEANA Protecting the World's Oceans

Acknowledgements

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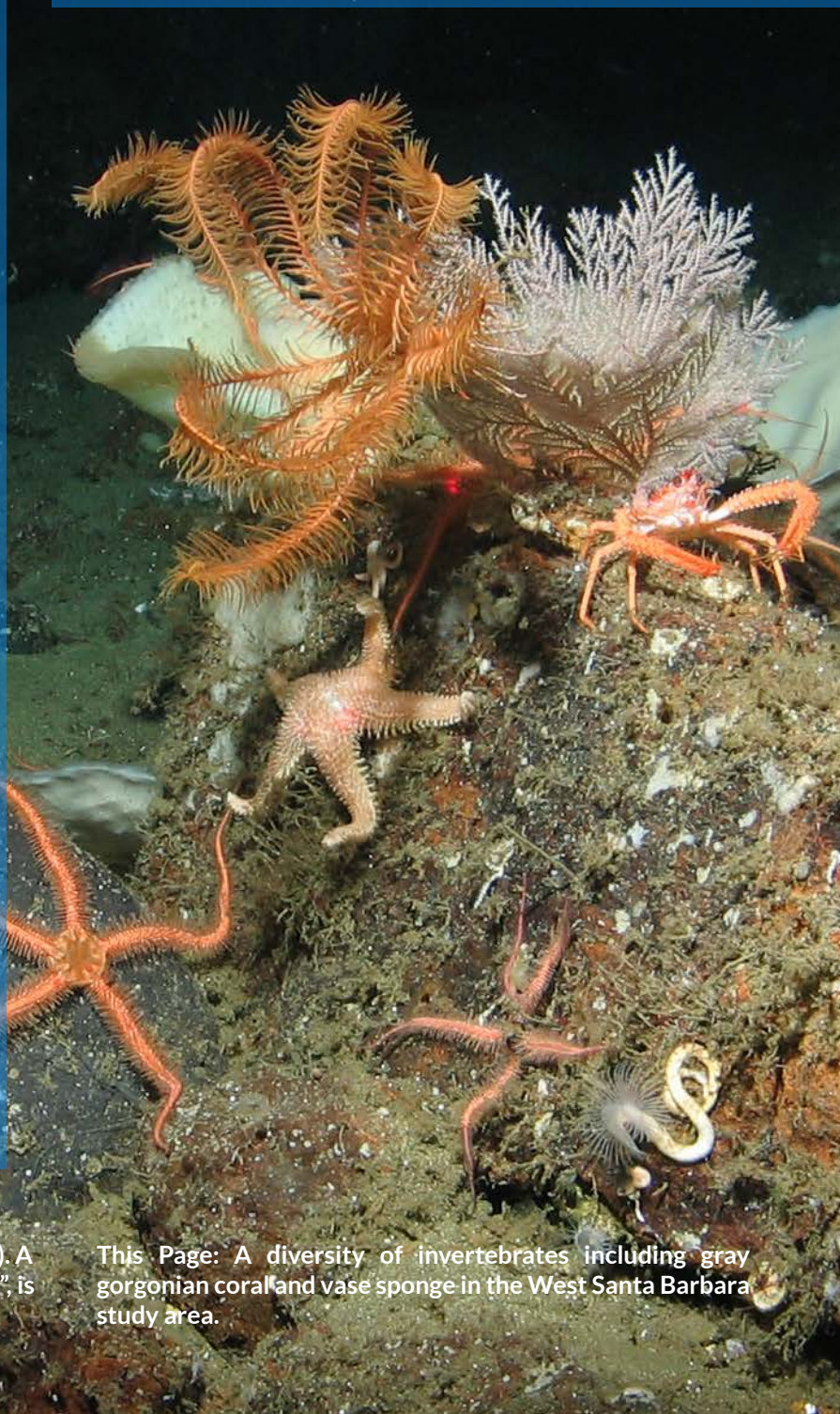


Cover Image: A greenspotted rockfish (*S. chlorostictus*) hides behind yellow gorgonian coral (*Acanthogorgia sp.*). A cat shark (*Scyliorhinidae*) egg case, or "mermaid's purse", is attached to the coral.

This Page: A diversity of invertebrates including gray gorgonian coral and vase sponge in the West Santa Barbara study area.

ABSTRACT

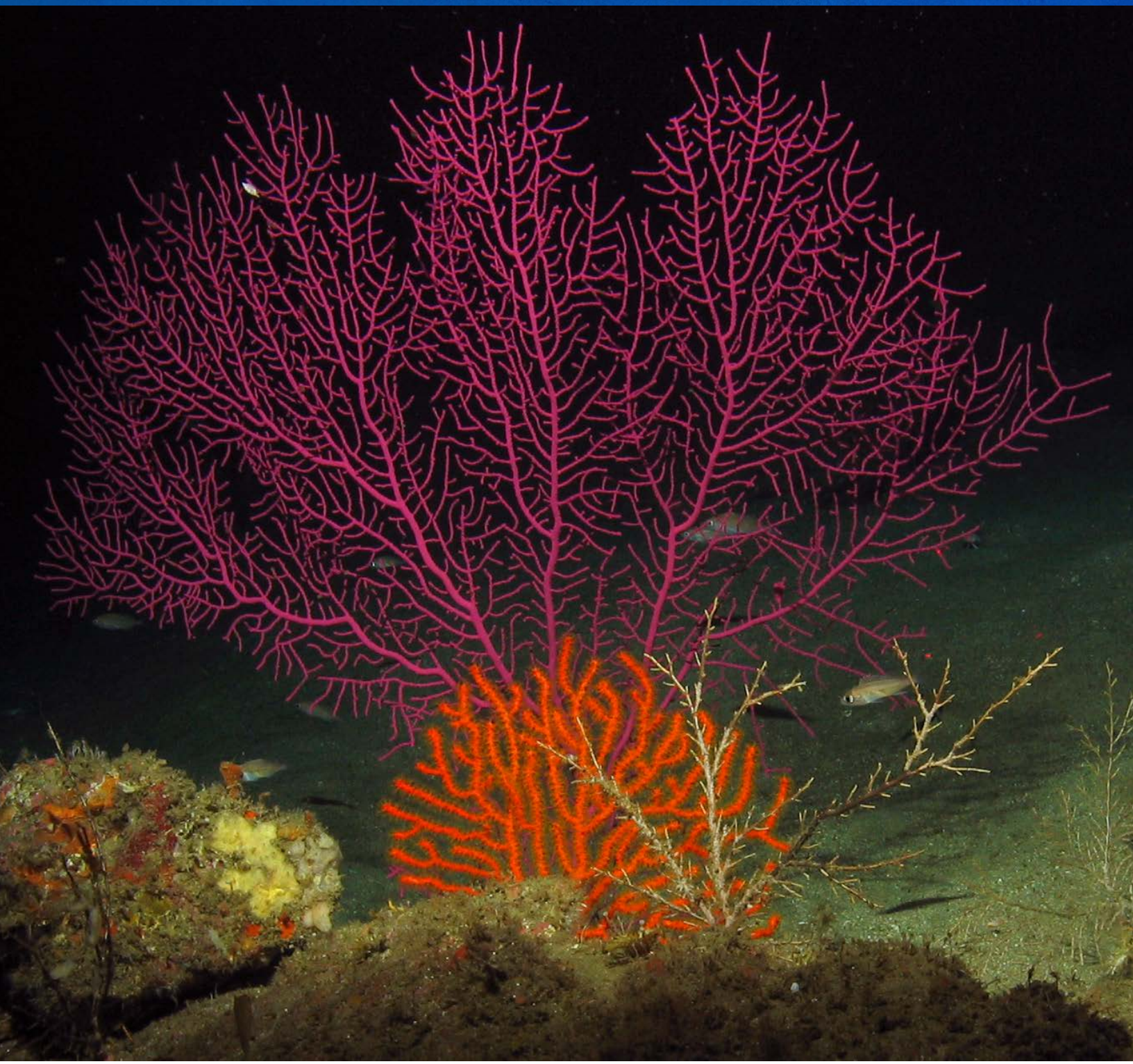
In August of 2016 Oceana, in coordination with Marine Applied Research and Exploration (MARE) and Channel Islands National Marine Sanctuary (CINMS), conducted a five-day research expedition in the Pacific Ocean waters off Southern California to document and characterize seafloor habitats and their associated biological communities, and to help inform and advance the long-term conservation and management of Important Ecological Areas. Using MARE's Remotely Operated Vehicle (ROV) Beagle mounted with high definition video and still cameras, we completed 13 dives including 25 individual, fifteen minute transects from three to 75 miles offshore Southern California at depths ranging from 80 meters (263 feet) to 435 meters (1,427 feet). This study documents the location of fragile living seafloor habitats including deep-sea corals and sponges and characterizes and compares the physical and biological structure across five geographic study areas in the Southern California Bight. In this study, we also document the co-occurence of managed fish species with habitat forming invertebrates at each transect area.

To our knowledge, areas we surveyed off Southeast Santa Rosa Island, Santa Barbara Island and at Butterfly Bank had never been surveyed with underwater cameras. Our findings likely represent the first *in situ* observations of these areas. We documented cold-water corals and sponges at each study area, including a total of 4,786 deep-sea corals, sponges and pennatulids (a type of octocoral including sea pens and sea whips), adding significantly to existing records of such biogenic habitat features in the Southern California Bight region. We also observed 5,059 individual fishes, 4,505 (89 percent) of which we identified as federally managed fish species, principally rockfishes belonging to the genus *Sebastes*. In total, we identified 45 different fish species/groups, 32 of which are federally managed.

All observed managed fish species were present on dives containing corals and sponges, providing additional evidence of co-occurrence between biogenic habitat features and managed fish species. The dive sites surveyed, both in protected and unprotected waters, are biologically diverse, contain sensitive structure-forming invertebrates, and are designated as essential fish habitat (EFH) for managed fish species.

New discoveries of ecologically important and sensitive habitats support taking a precautionary

Lingcod (*O. elongatus*) at the West Santa Barbara study area.



Colorful species of gorgonian corals including this purple *Eugorgia rubens* and orange *Adelogorgia phyllosclera* found off the Channel Islands inside the Oceana EFH proposal area.

approach to the conservation of essential fish habitat with management actions that protect these habitats from bottom trawl fisheries. While bottom trawl fishing effort in the Southern California Bight currently occurs in a few small areas along the mainland coast in waters less than approximately 183 meters (100 fathoms, 600 feet), it should not be allowed to expand into deeper offshore areas that are known to or may contain deep-sea coral and sponge communities.

INTRODUCTION

The Southern California Bight, stretching from Point Conception to the U.S./Mexico border (Figure 1), is a biologically and topographically diverse region of the California Current Ecosystem. Here, productive ocean waters support diverse fish, seabird, sea turtle, and marine mammal populations. The region includes a broad network of submarine canyons, ridges, seamounts, banks and other unique geologic features. This complex underwater topography combined with converging ocean currents of cold, nutrient-rich and warm waters creates ideal circumstances for a thriving and diverse ocean ecosystem.

Also integral to the health of this ecosystem are vibrant communities of seafloor invertebrates. Corals, sponges and pennatulids create biogenic, living habitats in the deep-sea. In the Northeastern Pacific Ocean, these biogenic habitats have been widely documented to provide shelter, and feeding and breeding grounds for commercially and recreationally important fish like rockfish and lingcod (Krieger & Wing 2002, Pirtle 2005, Tissot et al. 2006, Bright 2007, Heifetz et al. 2007, Love et al. 2008, Du Preez & Tunnicliffe 2011, Bizzaro 2014). Like their tropical reef-forming counterparts, these cold-water coral and sponge communities create beautiful "coral gardens"

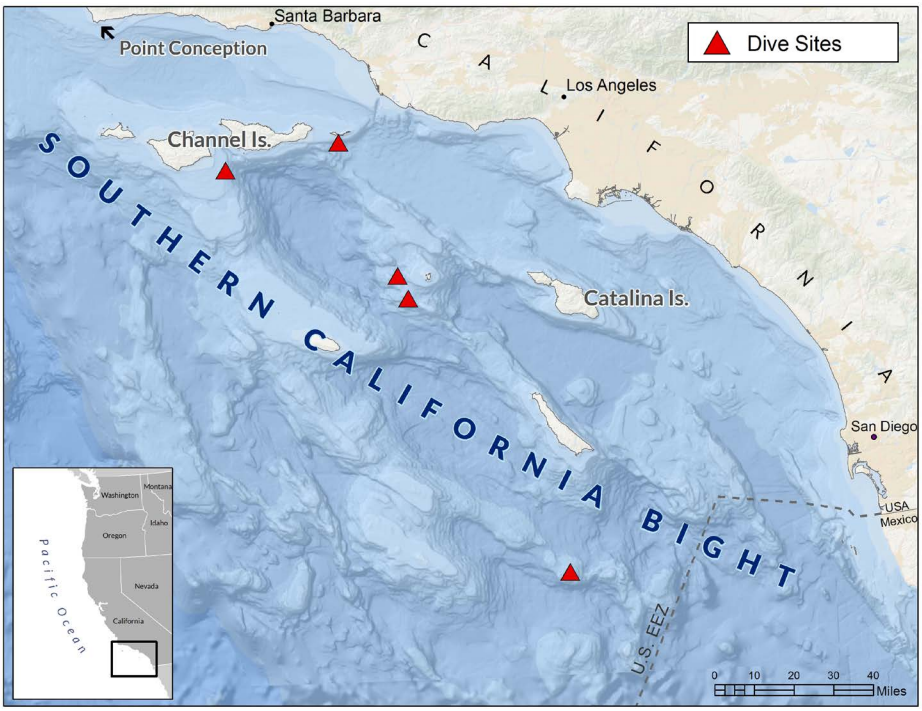


Figure 1. The Southern California Bight showing Oceana study areas.

interspersed along the banks and ridges of the Southern California Bight (Love et al. 2010, Yoklavich et al. 2011). As scientists continue to explore these deep environments, new species and never-before-seen coral gardens are being discovered (Yoklavich & Love 2005, Love et al. 2007, Etnoyer et al. 2017). Not only are these discoveries significant in their own right, the biological importance and sensitivity of these biogenic and relief habitats, like ridges and banks, highlight the need to protect these fragile ecosystems before they are lost.

Identifying Important Ecological Areas and determining biogenic habitat distributions are critical steps in protecting vulnerable marine ecosystems (Ayers et al. 2010). In the Pacific Ocean waters off the U.S. West Coast, scientists use scuba surveys, sonar mapping, bottom trawl surveys, manned submarines, Autonomous Underwater Vehicles (AUVs), and Remotely Operated Vehicles (ROVs) to document habitats containing corals, sponges and pennatulids (Clarke et al. 2015). Despite these studies, many benthic ecosystems along the coast remain unexplored, including vast areas within the Southern California Bight.

Scientists who have explored the deep ocean waters off Southern California have made astounding discoveries. In 2005, for example, scientists reported the discovery of a new species of black coral (*Antipathes dendrochristos*) called "Christmas tree coral" in the Southern California Bight, inspiring further efforts to document this benthic

ecosystem (Yoklavich & Love 2005). Christmas tree corals can vary in color from white to red. Off Southern California, communities of these large, black corals have been observed at densities ranging from zero to 24.4 corals/1,000 square meters (m^2) and total coral density ranged from three to 148 corals/1,000 m^2 (Yoklavich et al. 2013). Researchers have determined that the corals grow slowly at approximately 1.5 centimeters per year. They are also long-lived. One black coral colony collected off Southern California was determined to be 140 years old (Love et al. 2007) while another black coral species collected off Hawaii was determined to be over 4,200 years old (Roark et al. 2009).

"The discovery of the Christmas tree coral clearly demonstrates how much there is yet to learn about marine communities on the seafloor, even along the most populated sections of the west coast" (Yoklavich & Love 2005).

Another important group of corals found off the West Coast is gorgonian coral of the order *Alcyonacea*. Gorgonians can be branching and fan-like or feathery in structure and are sometimes called sea fans. Composed of many tiny polyps, they come in a variety of colors including yellow, red and sometimes purple. Other organisms, such as brittle stars, crabs, barnacles, and polychaetes, attach themselves to gorgonian and black corals to get a better position for collecting food from passing currents.

Seafloor habitats, such as those in the Southern California Bight, are especially vulnerable to fishing impacts. The biggest direct threat to deep-sea coral communities is bottom trawling. Bottom trawls, with weighted nets and large steel doors, are dragged along the seafloor off the U.S. West Coast to catch species including rockfish, lingcod, California halibut, sea cucumbers, and ocean shrimp (Figure 2). At the same time, however, bottom trawls may catch an abundance of other marine life as bycatch; crush and topple communities of corals, sponges and other habitat forming invertebrates; as well as alter the physical structure of seafloor habitats (Puig et al. 2012, Hannah et

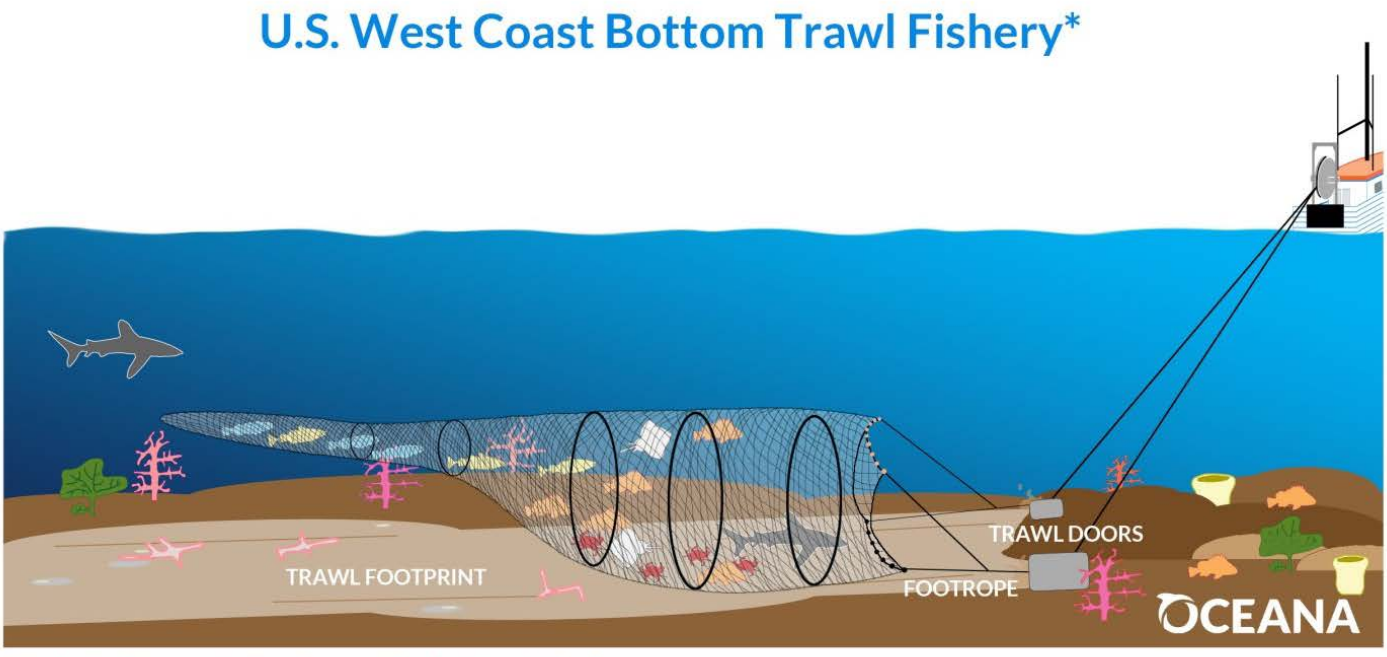
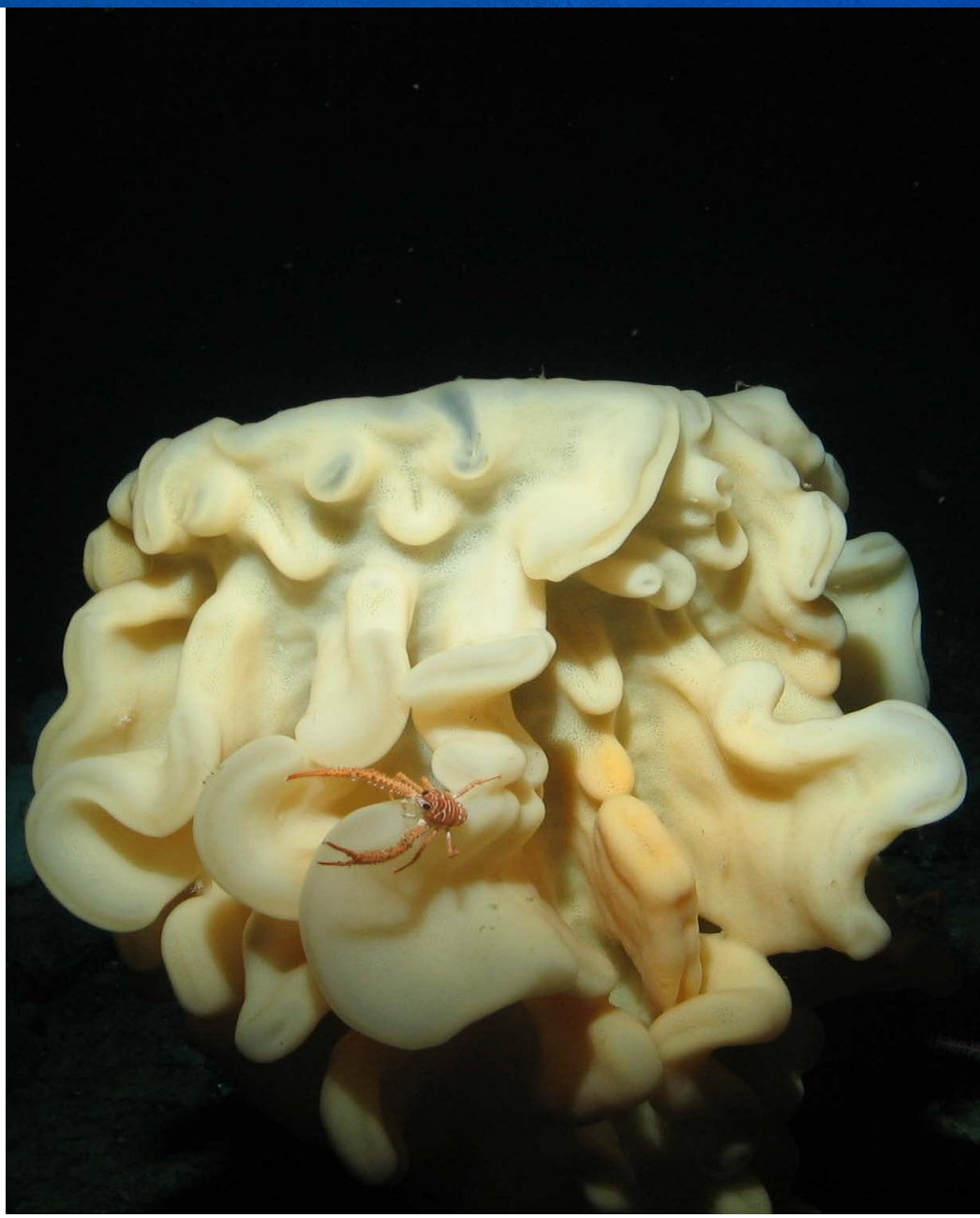


Figure 2. Commercial bottom trawl vessels targeting rockfish, California halibut, dover sole, Pacific cod and lingcod off the U.S. West Coast drag large, heavy doors and footropes along the seafloor. If used in important coral and sponge habitats, they can cause long-lasting damage that may not recover for decades to centuries. While gear configurations vary, the distance between the heavy trawl doors can be from 110 to 650 feet wide and the doors can weigh up to 1,300 pounds.

al. 2009, Hixon & Tissot 2007, Auster & Langton 1999). Globally, bottom trawling has been shown to reduce habitat complexity, productivity, and alter ecological communities (Davies et al. 2007, NRC 2002) and it is recognized to be among the most damaging fishing gears to seafloor habitats on the U.S. West Coast (PFMC 2005, Morgan & Chuenpagdee 2003).

Bottom trawls threaten the health of ecosystems that support fish populations by disturbing important biogenic habitats and seafloor substrates upon which fish rely for shelter, feeding and breeding. To protect such essential fish habitat, fishery management councils are required to "prevent, mitigate, or minimize any adverse effects from fishing, to the extent practicable, if there is evidence that a fishing activity adversely affects EFH in a manner that is more than minimal and not temporary in nature." 50 C.F.R § 600.815(a)(2)(ii); 16 U.S.C. § 1853(a)(7). Actions to achieve this may include, but are not limited to fishing equipment restrictions and time and area closures. *Id.* § 600.815(a)(2)(iii). Thus, to enhance and protect vulnerable seafloor habitats and associated fish communities, in 2005 the PFMC—a 14-voting member federal advisory body—adopted EFH conservation areas which are closed to bottom trawling (Shester & Warrenchuk 2007). While some areas off Southern California were included in those protections, the majority of federal waters off Southern California were not protected (Figure 3).



A lobed sponge with squat lobster observed at Butterfly Bank.

In response to a call for proposals by the PFMC during its five-year review of EFH designation, conservation and management, Oceana, Natural Resources Defense Council and Ocean Conservancy (Oceana et al. 2013) submitted a Comprehensive EFH Conservation proposal. This proposal includes protecting more than 16,000 square miles of the Southern California Bight from bottom trawling. Incorporating minor revisions to avoid impacting current bottom trawl activity, the California Department of Fish and Wildlife submitted a modified version of this proposal (CDFW 2016), which as of the date of this publication is currently under

consideration by the PFMC and National Marine Fisheries Service (NMFS) as part of a distinct EFH conservation alternative (Oceana 2016, Figure 3). Concurrently, the PFMC is also considering removing some parts or all of the trawl Rockfish Conservation Area (RCA). The trawl RCA was implemented to help rebuild overfished rockfish and it may all be reopened to bottom trawling unless simultaneously protected as an EFH conservation area.

To advance the understanding and location of coral and sponge communities and promote their conservation, Oceana, in partnership with MARE and aboard the CINMS research vessel, *R/V Shearwater*, conducted a five-day ocean expedition, from August 7-11 2016, to study this area off southern California.

Here we describe and characterize the seafloor habitats and associated biological communities at five areas surveyed. Four of these areas are within the Oceana EFH conservation proposal being considered by the PFMC and NMFS for protection from bottom trawling. We dove on two other areas in the CINMS that have been previously studied – inside an area called the Footprint and another site

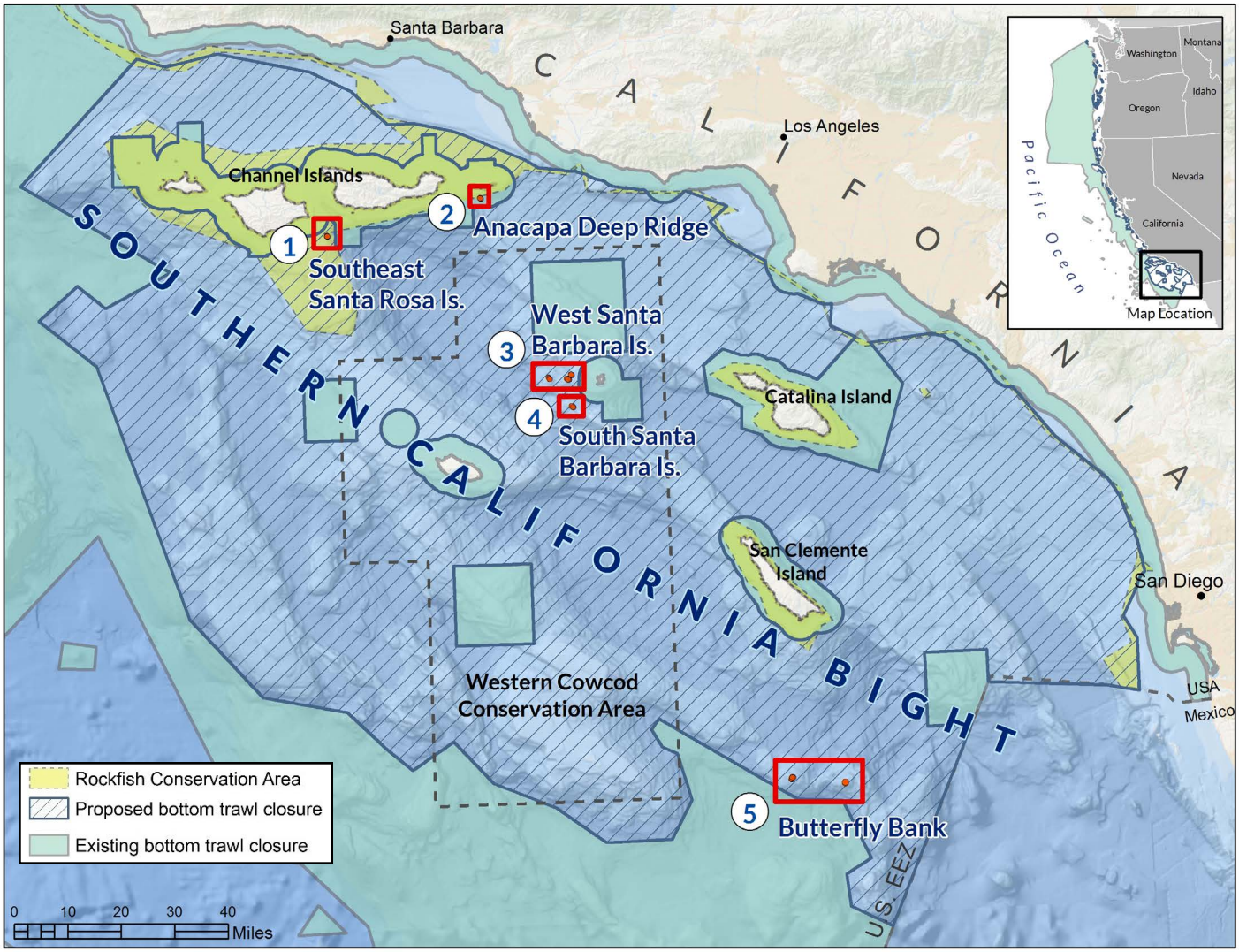


Figure 3. Oceana proposed EFH conservation area for the Southern California Bight as modified by the California Department of Fish and Wildlife (CDFW 2016) (blue hash), showing existing state water groundfish trawl closures and EFH conservation areas, the trawl Rockfish Conservation Area, and the Western Cowcod Conservation Area (grey dashed line). The five study areas where we conducted a combined 25 ROV transects are outlined in red.

south of Santa Rosa Island. Findings on these sites are reported elsewhere (Yoklavich et al. 2013, Etnoyer et al. 2017). In the five areas reported here, we collected more than nine hours of high definition video footage using an ROV along 25 transects.

This expedition is part of larger effort by Oceana to identify, map and characterize Important Ecological Areas in the California Current Ecosystem, which stretches from Vancouver Island, Canada to Baja California, Mexico. Other regions surveyed to date include Monterey Bay, California, areas off the Southern Oregon Coast, the Central Oregon Coast and San Juan Islands in Washington's Puget Sound (Shester et al. 2012, Enticknap et al. 2013). Important Ecological Areas are geographic areas that have distinguishing ecological characteristics such as high productivity or biological diversity, are important for maintaining habitat heterogeneity or the viability of a species, or contribute disproportionately to an ecosystem's health, including its function, structure, or resilience (Ayers et al. 2010, CEQ 2010).

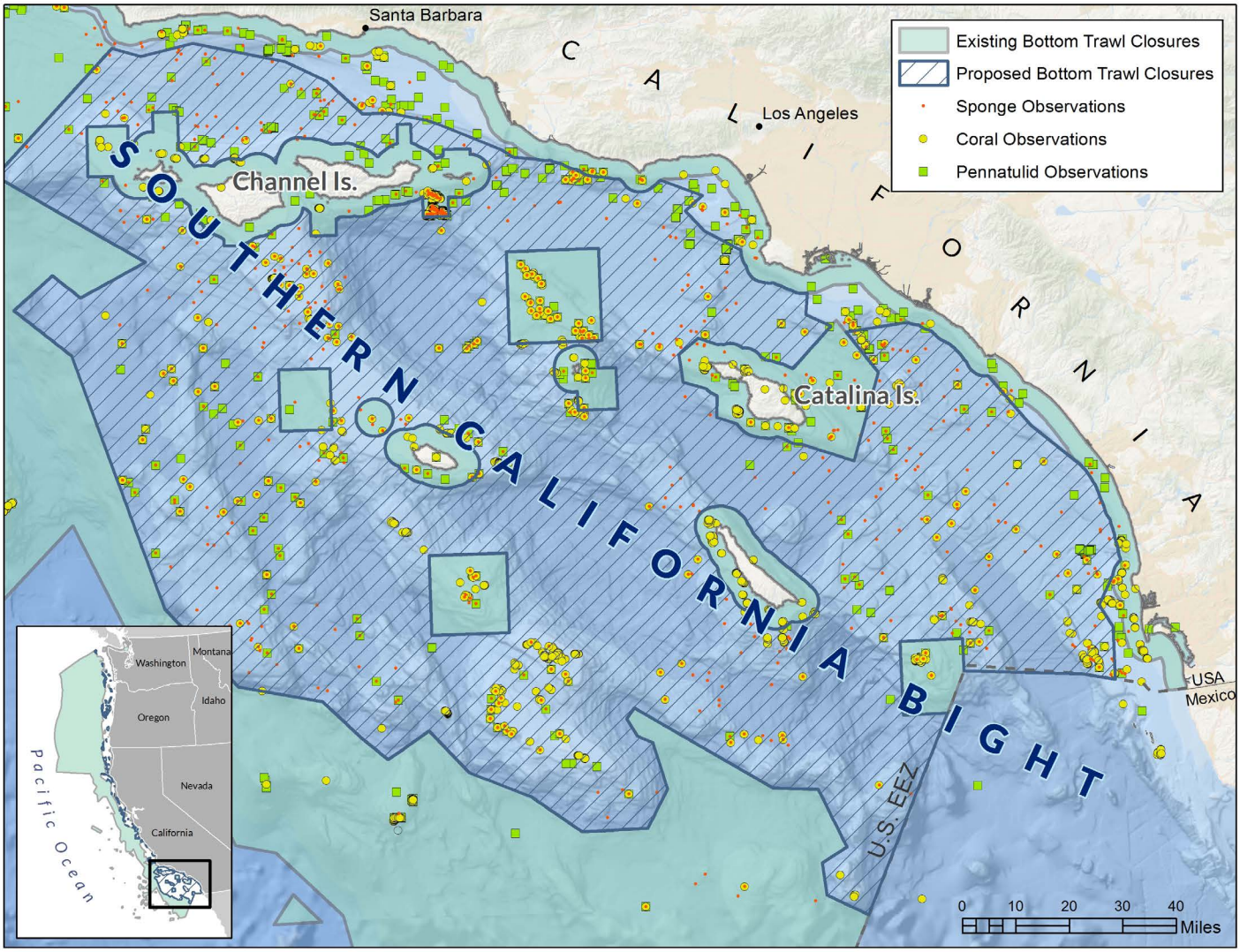
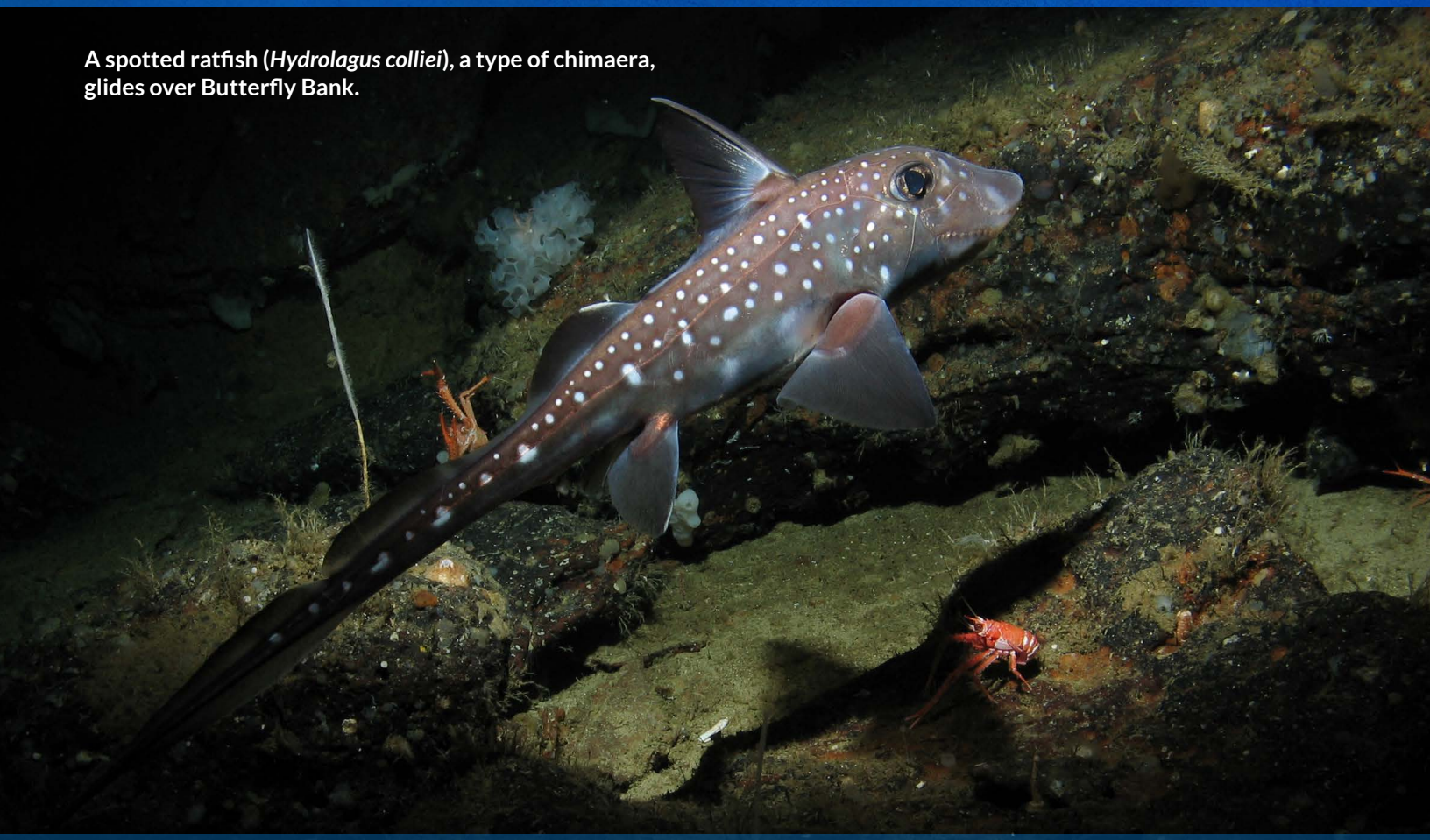


Figure 4. Southern California EFH conservation area proposal area with coral (yellow), sponge (red), and pennatulid (green) records from the NOAA Deep Sea Coral and Sponge Database.



A spotted ratfish (*Hydrolagus colliei*), a type of chimaera, glides over Butterfly Bank.

Study Objectives:

The overall goal of this study is to identify and document Important Ecological Areas off the southern California coast to help inform the long-term conservation and management of marine habitats and biodiversity in this region of the California Current Ecosystem, while demonstrating the importance of a precautionary approach to management. The objectives of this research are to:

1. Survey and characterize the distribution and relative abundance of coral and sponge communities at sites where occurrences have not been documented, including in proposed EFH conservation areas under consideration by the PFMC and NMFS,

2. Quantify associations of federally managed groundfish species with physical and biological habitat features,

3. Characterize physical and biogenic habitats in designated protected areas and areas that are not protected, and

4. Add additional observations of corals and sponges to the NOAA database on the occurrence of these biogenic habitat features.

METHODS

DATA COLLECTION

Study Areas and Dive Sites

We identified five general study areas for the expedition based on a variety of data and information including a thorough review of available bathymetric data, predictive coral and substrate models, vessel range, accessibility due to weather conditions, and input from NOAA's Deep-Sea Coral Ecology Program. Within each study area, we conducted one or more dives in an attempt to obtain multiple transects representative of the diversity of features in the study area. Criteria for these study areas included:

1) areas outside EFH conservation areas that have not yet been explored by ROV or other submersibles but where seafloor mapping data or models predict suitable coral habitat (Guinotte & Davies 2014) or hard substrate. These areas included West Santa Barbara Island (four dives), South Santa Barbara Island (one dive), Butterfly Bank (two dives); and

2) areas that have previously been explored but where additional data and observations would add to the areas' site characterization. These areas included Southeast Santa Rosa Island (one dive), and Anacapa Deep Ridge (one dive, Figure 6).

The Oceana expedition team with Alexandra Cousteau, Marine Applied Research and Exploration (MARE), and captain and crew of the Channel Islands National Marine Sanctuary R/V Shearwater. In the forefront is the ROV Beagle.

ROV Sampling Operations

We used the R/V Shearwater, a 22 meter (m) NOAA research vessel, to complete the 2016 survey. At each dive site, the ROV was piloted along one or more 15-minute transect lines and was flown off the vessel's stern using a "live boat" technique that employed a 317.5 kg (700 lb) clump weight. Using this method, all but 50 m of the ROV umbilical was isolated from current-induced drag by coupling it with the clump weight cable, and suspending the clump weight at least 10 m off the seafloor. The 45 m tether allowed the ROV pilot sufficient maneuverability to maintain a constant speed (0.5 to 0.75 m/sec) and a straight course down the planned survey line, while on transect.

We kept the ship within 35 horizontal meters of the ROV position at all times. To achieve this, we used an acoustic tracking system to calculate the position of the ROV relative to the ship. We calculated the ROV position every two seconds and recorded this along with coordinated universal timecode (UTC) using navigational software. Additionally, the ROV pilot and ship captain utilized real-time video displays of the location of the ship and the ROV, in relation to the planned transect line. We achieved

a consistent transect width, from the forward camera's field of view, using sonar readings to sustain a consistent distance from the camera to the substrate (at the screen horizontal mid-point) between 1.5 and 3 m. In areas with low visibility, we used BlueView multibeam sonar to navigate hazardous terrain.

ROV Equipment

We used the Beagle, an observation class ROV, to complete benthic surveys of select Southern California Bight study locations. The ROV was equipped with a three-axis autopilot including a rate gyro-damped compass and altimeter. Together, these allowed the pilot to maintain a constant heading (± 1 degree) and constant altitude (± 0.3 m) with minimal corrections. In addition, we used forward speed control to help the pilot maintain a consistent forward velocity between 0.25 and 0.5 m/sec while on transect. We used a Tritech® 500 kHz ranging sonar, which measures distance across a range of 0.1–10 m using a 6° conical transducer as the primary method for measuring transect width from the forward-facing high definition (HD) video. We pointed the transducer at the center of the camera's viewing area and used it to calculate the distance to the middle of the screen, which we subsequently converted to width using the known properties of the cameras field of view. We averaged readings from the sonar five times per second and recorded at a one-second interval with all other sensor data. Measurements of transect width using a ranging sonar are accurate to ± 0.1 m (Karpov et al. 2006). The ROV Beagle was also equipped with parallel lasers set with a 10 cm spread and positioned to be visible in the field of view of the primary forward camera. These lasers provided a scalable reference of size when we reviewed the video.

The R/V Shearwater was 'home' for researchers over the 5-day expedition.

We used an ORE Offshore Trackpoint III® ultra-short baseline acoustic positioning system with ORE Offshore Motion Reference Unit (MRU) pitch and roll sensor to reference the ROV position relative to the ship's Wide Area Augmentation System Global Positioning System. We determined the ship's heading using a KVH magnetic compass. The Trackpoint III® positioning system calculated the XY position of the ROV relative to the ship at approximately two-second intervals. We corrected the ship-relative position to real world position

and recorded in meters as X and Y using the World Geodetic System (WGS)1984 Universal Transverse Mercator (UTM) coordinate system using HYPACK® 2013 hydrographic survey and navigation software. Measurements of ROV heading, depth, altitude, water temperature, camera tilt and ranging sonar distance were averaged over a one-second period and recorded along with the position data.

The ROV had four cameras, including one forward facing HD camera, two standard definition cameras and one HD still camera. The primary data collection camera (HD video camera) and HD still camera were oriented obliquely forward. We linked all video and still images using UTC timecode recorded as a video overlay or using the camera's built-in time stamp which was set to UTC time each day.

We linked all data collected by the ROV, along with subsequent observations extracted during post-processing of the video, in a Microsoft Access® database using GPS time. We used GPS time to provide a basis for relating position, field data and video observations (Veisze & Karpov 2002). We used data management software to expand all data records to one second of Greenwich Mean Time (GMT). During video post-processing, we used a Horita® Time Code Wedge (model number TCW50) in conjunction with a customized computer keyboard to record the audio time code in a Microsoft Access® database.

Oceana Senior Scientist Geoff Shester guides ROV cable off the stern of the R/V Shearwater.

Post-Processing and Habitat Characterization

Following data collection, we processed the ROV position data to remove outliers and data anomalies caused by acoustic noise and vessel movement (Karpov et al. 2006). Outliers included deviations from sampling protocols such as pulls (ROV pulled by the ship), stops (ROV stops to let the ship catch up), or loss of target altitude caused by traveling over backsides of high relief structures.

We made an exception at Butterfly Bank- East, where the ROV positional data files were corrupted and we used an average speed method to estimate distance traveled. Using the video, we recorded the timecode for when the ROV was moving at normal operating protocol speeds (m/sec). Next, we calculated the average speed for when the ROV was moving (normal operating speed) for Butterfly Bank-West, which had similar habitat and oceanographic conditions as Butterfly Bank- East. We then used the average speed (m/sec) in combination with the ROVs forward sonar to estimate area covered. Once the data and locations of the remaining

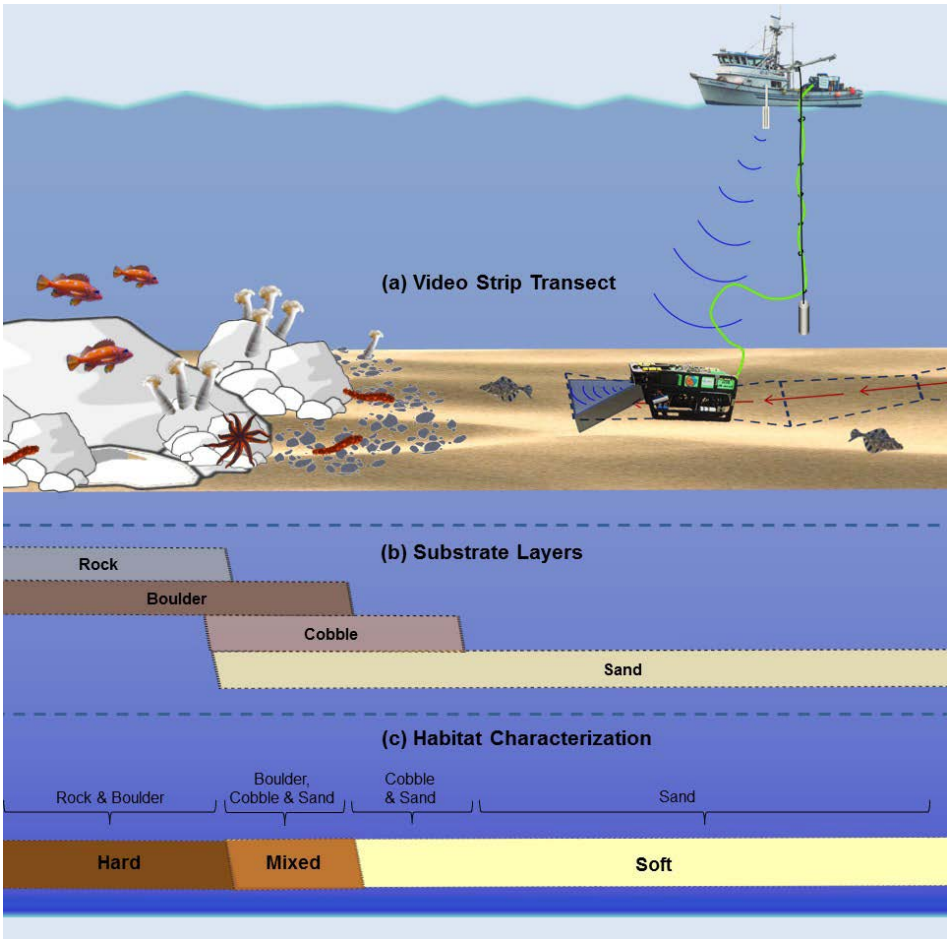


Figure 5. Illustration of (a) basic ROV strip transect methodology used to collect video data along the seafloor, (b) overlapping base substrate layers produced during video processing and (c) habitat types (hard, mixed soft) derived from the overlapping base substrate layers after video processing is completed. Illustration courtesy of MARE.

transects were processed and linked to video, we conducted the following characterizations of the 15-minute transects.

Substrate and Habitat

For each site, we reviewed all collected video for up to six different substrate types: rock, boulder, cobble, gravel, sand and mud (Green et al. 1999). We recorded each substrate as discrete segments by entering the beginning and ending UTC timecode. We completed substrate annotation in a multi-viewing approach, in which each substrate type was recorded independently, enabling us to capture the often overlapping segments of substrates (Figure 5). These overlapping substrate segments allowed us to identify mixed substrate areas along the transect line.

After the video review process, we combined the substrate data to create three independent habitat types: hard, soft, and mixed habitats (Figure 5). We categorized rock and boulder as hard substrate types, while cobble, gravel, sand, and mud were all considered to be unconsolidated substrates and categorized as soft. We defined hard habitat as any combination of the hard substrates, soft habitat as any combination of soft substrates, and mixed habitat as any combination of hard and soft substrates.

Finfish and Invertebrate Enumeration

After completion of habitat and substrate review, we processed video to collect data for use in estimating finfish and macro-invertebrate distribution, relative abundance and density. During the review process, we simultaneously reviewed both the forward and down video files, yielding a continuous and slightly overlapping view of what was present in front of and below the ROV. This approach effectively increased the resolution of the visual survey, by identifying animals that were difficult to recognize in the forward camera, but were clearly visible and identifiable in the down camera.

We enumerated all clearly visible finfish and macro-invertebrates from the video record for the transects only. During multiple subsequent viewings, we classified finfish and macro-invertebrates to the lowest taxonomic level possible. Observations that could not be classified to species level were identified to a taxonomic complex, or recorded as unidentified (UI). During video review, we used both the HD video and HD still imagery to aid in species identification. Each fish or invertebrate

Alexandra Cousteau, Oceana Senior Advisor, with the ROV Beagle.

observation was entered into a Microsoft Access® database along with UTC timecode, taxonomic name/grouping, sex/developmental stage (when applicable), and count. From the species/groupings of invertebrates, we analyzed corals, sponges and pennatulids per study area. We also analyzed the number of fish managed under the Pacific Coast Groundfish Fishery Management Plan (FMP) (PFMC 2016). Throughout this report, consistent with data used at the PFMC, we discuss pennatulids separately from other octocorals, which we refer to as corals. We identified dives in which groups of corals (Alcyonacea, Antipatharia), pennatulids (Pennatulacea), and sponges (branched, boot, gray moon *Spheciospongia confoederata*, hairy boot, laced, large yellow, lobed, nipple, orange puffball *Tethya aurantia*, trumpet, vase) co-occurred with managed fish species/groupings.

"The oceans are the lifeblood of the planet. Living structures on the ocean floor, like corals and sponges, provide nurseries, food and shelter essential for the survival and productivity of important commercial and sportfish species, like rockfish and lingcod. The waters surrounding the islands and offshore banks of Southern California contain prime examples of these spectacular habitats."

-Alexandra Cousteau, Senior Advisor for Oceana

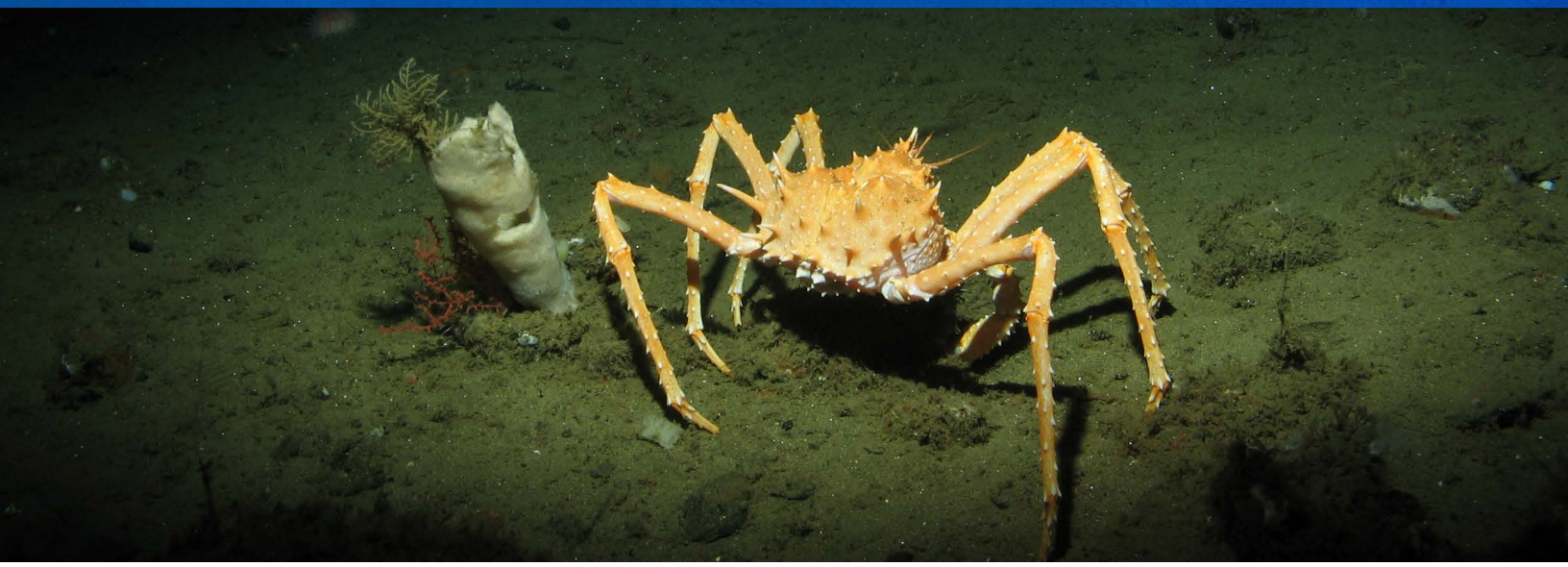
RESULTS

In total, we collected more than nine hours of high definition footage in the five study areas where we completed 25 transects (Figure 3, Table 1, coordinates provided in Appendix A). The transects covered a total distance of 10.8 kilometers (km) and depths ranging from 126 m to 379 m (Table 1). The number of fish observations in the 25 transects totaled 5,059 and comprise 27 distinct species and 17 species groups or complexes; the majority of which are managed under the Pacific Coast Groundfish FMP. Within these transects, we observed a total of 14,006 invertebrates, including 4,786 corals, sponges and pennatulids (1,120; 3,644; and 22 records, respectively). We observed a range of substrate types, however soft and mixed substrates were the most frequent throughout the study.

Table 1. Total sampling effort at five Southern California study areas, showing total transect distance surveyed, total transects and depth range of surveyed areas.

Study Area		Southeast Santa Rosa Is.	Anacapa Deep Ridge	West Santa Barbara Is.	South Santa Barbara Is.	Butterfly Bank	Total:
Number of Transects		3	2	11	3	6	25
Distance (m)		1288	712	5236	1485	3030	11751
Depth (m)	*Min*	126	289	148	220	287	
	Max	171	371	365	272	379	
	Avg	147	324	240	250	316	

A wolf eel (*Anarrhichthys ocellatus*) hides under a large boulder in the Southeast Santa Rosa study area, while the spines of a rockfish can be seen behind a nearby sponge.



California king crab (*Paralithodes californiensis*) off West Santa Barbara Island.

Substrate and Habitat

Overall, the most commonly observed substrates were mud, cobble and rock. Habitat types derived from substrate data show that over the course of this study, 10 percent of observed habitat consisted of hard substrate (rock and boulder), 43 percent was mixed (cobble, boulder, and sand) and 47 percent was soft substrate (cobble, sand, and mud).

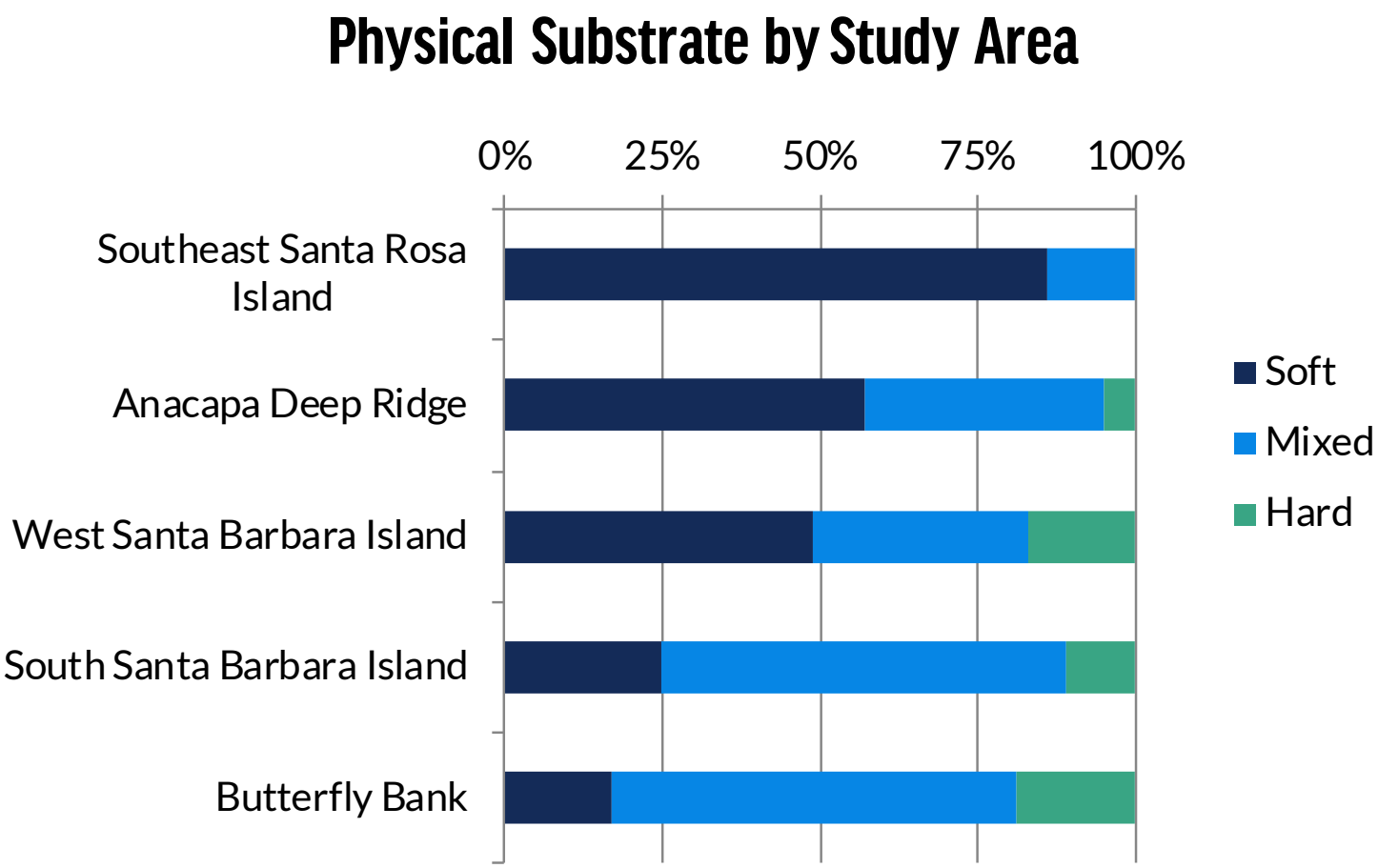


Figure 6. Comparison of relative substrate composition across study areas.

Cowcod rockfish (*S. levis*) were heavily overfished in the 1970s and 1980s. Scientists now project they will recover to healthy levels by 2020. This one was observed in the South Santa Barbara Island study area.

Fish and Invertebrates

Fish

The majority of fish we observed were rockfish (*Sebastes spp.*) which account for 92.7 percent of the total fish count at all study areas combined (Appendix B). Halfbanded rockfish (*Sebastes semicinctus*) were the most abundant rockfish species, accounting for nearly 40 percent of all fish observed. The species groups including juvenile rockfish (young of the year — YOY), swordspine rockfish (*Sebastes ensifer*), *Sebastomus* rockfish (unidentified rockfish of subgenus *Sebastomus*), unidentified adult rockfish, and pygmy rockfish accounted for another 44 percent of all fish observations. We observed cowcod (*Sebastes levis*) at 0.3 percent of the total fish count. Cowcod rockfish were designated as overfished in 2000 but are projected to recover to healthy levels by 2020 (Dick & MacCall 2014). The most abundant non-rockfish grouping was the combfish complex (*Zaniolepis spp.*), which accounts for 2.4 percent of fish observations.

At Southeast Santa Rosa Island, fish densities were higher than at any other study area, with 53 fish/100 m^2 (Appendix B). Halfbanded rockfish represented the majority of the density, accounting for over 45

fish/100 m^2. When halfbanded rockfish are not included in the overall densities of each study area, West Santa Barbara Island had the highest overall density at almost 12 fish/100 m^2. The Butterfly Bank study area had the lowest overall fish density at nearly three fish per 100 m^2.

Invertebrates

Four species/groupings of macro-invertebrates account for approximately 66 percent of the total invertebrate counts (Appendix B). The fragile pink urchin (*Strongylocentrotus fragilis*) is the most abundant species we observed and accounts for approximately 24 percent of the overall count; followed by the squat lobster (*Munida quadrispina*), unidentified lobed sponge (unidentified *Porifera*) and white slipper sea cucumber (*Pusolus sp.*) which account for the remaining 42 percent.

We observed more than 3,600 structure forming sponges from 11 species groupings, accounting for 26 percent of the total invertebrate observations. Corals represent eight percent of invertebrate observations with more than 1,100 records (nine species/groupings). The order Alcyonacea, also called gorgonians, dominates the number of coral species we observed, with three species/groupings representing the majority of observations: gray (*Plumarella sp.*), red *Swiftia sp.* and yellow (*Acanthogorgia sp.*) gorgonians. We also observed fifteen species/groupings of sea stars, but these represented less

Splitnose rockfish (*S. diploproa*) live to at least 86 years. This one rests near urchins, anemones and a feather star at Anacapa Deep Ridge.

Table 2. Co-occurrence of managed groundfish species with each category of corals and sponges on the same transect, indicating where groundfish were observed in habitats containing respective corals and sponges.

	Biogenic Habitat Taxa							
	Corals			Sponges				
FMP fish	Alcyonacea	Antipatharia	Pennatulacea	Branched	Boot	Gray Moon	Hairy Boot	Laced
Aurora/splitnose complex	x	x	x	x	x		x	x
Bank rockfish	x	x		x	x	x	x	x
Blackgill rockfish	x	x	x	x	x		x	x
Bocaccio	x	x		x	x		x	
Bronzespotted rockfish	x			x	x	x	x	
Cowcod	x			x	x	x	x	
Dover sole	x	x	x		x			
Flag rockfish	x			x	x		x	x
Greenspotted rockfish	x	x		x	x	x	x	
Greenstriped rockfish	x	x	x	x	x	x	x	
Halfbanded rockfish	x			x	x			
Lingcod	x	x		x	x		x	
Longnose skate	x		x		x			
Mexican rockfish	x			x	x			
Pacific hake	x			x	x		x	
Pinkrose rockfish	x			x	x	x	x	
Pygmy rockfish	x	x		x	x		x	
Sebastomus rockfish	x	x	x	x	x	x	x	x
Shortbelly rockfish	x	x		x	x	x	x	
Shortspine thornyhead	x	x	x		x		x	x
Small schooling rockfish	x	x		x	x		x	
Splitnose rockfish	x	x	x	x	x		x	x
Spotted ratfish	x	x		x	x		x	x
Squarespot rockfish	x	x		x	x		x	
Squarespot/Widow complex	x	x		x	x		x	
Stripetail rockfish			x					
Swordspine rockfish	x	x		x	x	x	x	
Thornyhead complex	x	x	x	x	x		x	x
Unidentified rockfish	x	x	x	x	x	x	x	x
Whitespeckled rockfish	x	x		x	x		x	
Young of Year	x	x		x	x	x	x	
TOTAL fish species/groups	30	22	11	27	30	11	26	10

A garden of orange gorgonian corals found south of Santa Rosa Island in the Oceana EFH proposal area.

Large Yellow	Lobed	Nipple	Orange Puffball	Trumpet	Vase
	x			x	x
x	x	x		x	x
x	x	x	x	x	x
	x				x
x	x				x
	x				x
x	x	x	x		x
	x			x	x
	x				x
	x				x
	x				
	x				x
x		x	x		x
	x				x
x	x				x
x	x				x
	x				x
x	x	x		x	x
x	x				x
	x			x	x
	x				x
x	x	x	x	x	x
	x	x		x	x
	x				x
	x				x
x	x				x
	x			x	x
x	x	x	x	x	x
	x				x
x	x				x
13	29	8	5	10	29

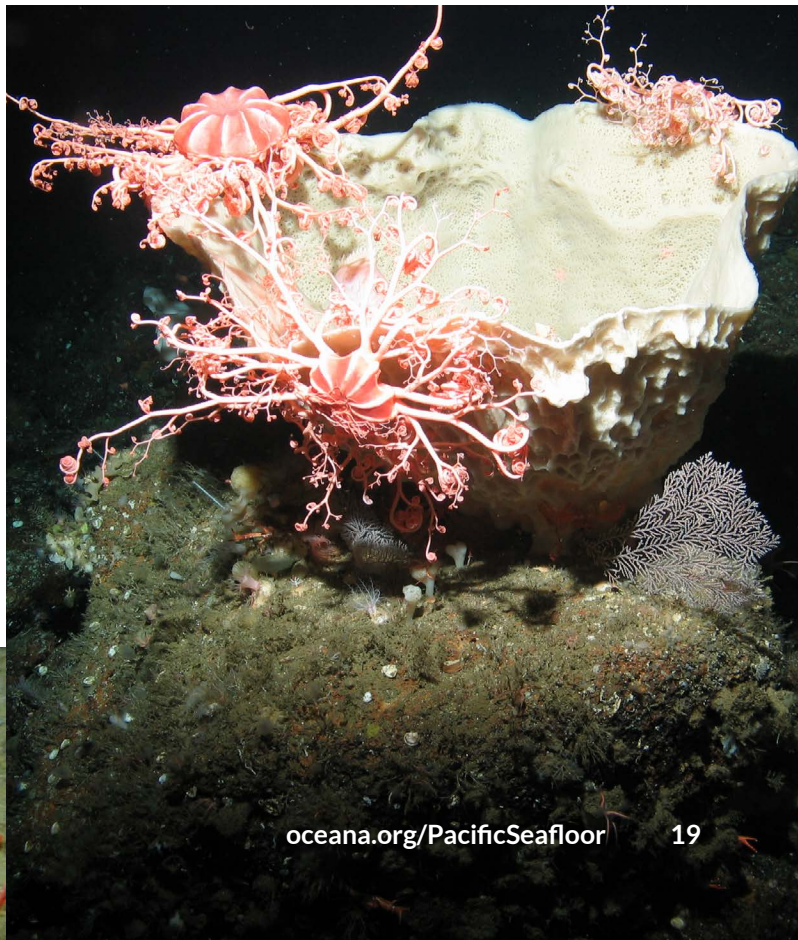
than five percent of the total macro-invertebrate observations.

While Anacapa Deep Ridge had the highest overall density of macro-invertebrates, we found that the Butterfly Bank study area has the highest combined density of corals, sponges and pennatulids, with over 37 of these invertebrates/100 m^2 (Appendix B). West Santa Barbara Island had the most coral, sponge and pennatulid species/groupings of any study area we surveyed with a total of 19 species/groupings (Appendix B).

Co-occurrence

We observed all federally managed groundfish in transects containing corals and sponges or pennatulids (Table 2). The coral group Alcyonacea (gorgonians) and unidentified lobed sponges were present on all dives. The associations identified in Table 2 are consistent with presence/ absence (i.e., Level 1) criteria for designating and protecting a habitat as EFH, as described in the NOAA EFH regulatory guidance, (50 CFR 600.815)

A large vase sponge adorned with basket stars and a gray gorgonian coral at West Santa Barbara Island.



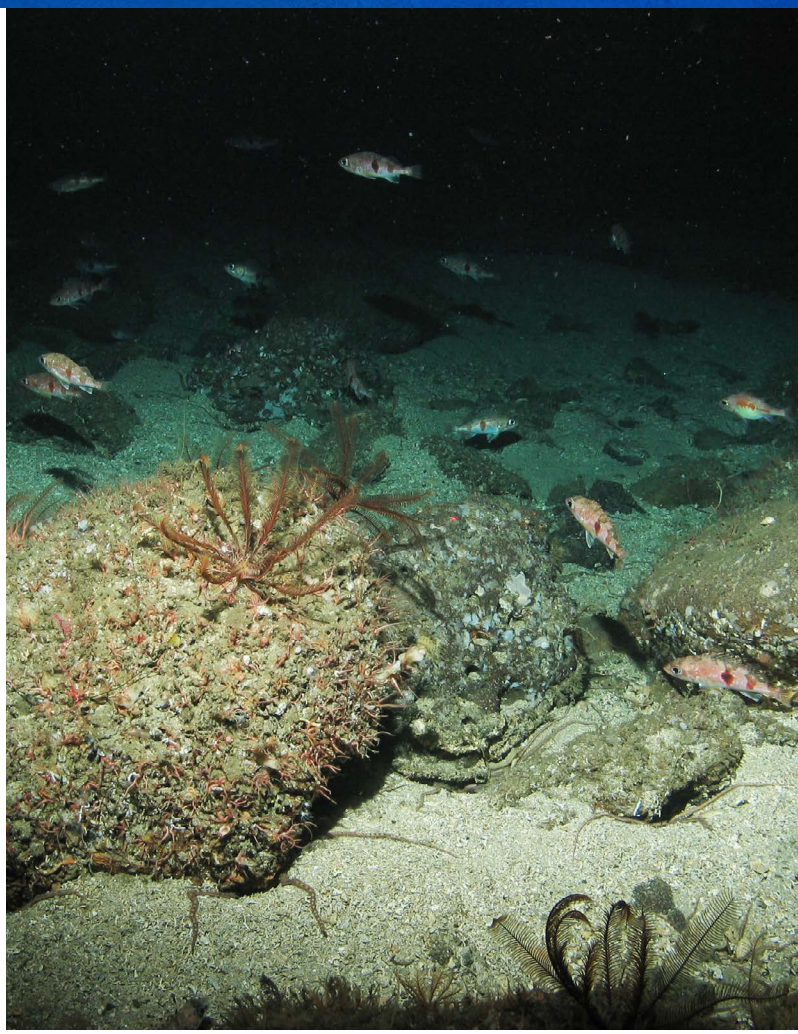
STUDY AREAS

1. Southeast Santa Rosa Island

In this study area, we conducted three transects along the seafloor, exploring a total distance of 1.3 km in an area approximately eight km southeast of Santa Rosa Island. This area is inside the Channel Islands National Marine Sanctuary and inside Oceana's proposed Southern California Bight EFH conservation area. While the area is currently closed to bottom trawling as a trawl RCA (Figure 3) for rebuilding overfished rockfish, the Pacific Fishery Management Council is considering removing this trawl RCA.

Much of the seafloor we surveyed at the Southeast Santa Rosa Island study area consisted of soft substrate. Soft substrate composed 86 percent of the area surveyed and the remaining 14 percent was mixed substrate (Figure 6). This is the shallowest study area and the only site where we observed sand. We also documented 2,337 fish at this site , including a large number of juvenile halfbanded rockfish, indicating this area may serve as a nursery habitat for this species. Of these, 2,226 individuals, representing 16 different species/groupings, are federally managed under the Pacific Coast Groundfish FMP (Appendix B). In total, we observed 237 invertebrates at this location. Of those invertebrates, 62 were corals, sponges or pennatulids (Appendix B, Table 3).

We observed the highest total species density and managed fish species density at this site, but the lowest invertebrate and combined coral, sponge and pennatulid densities (Appendix B). The fish that we documented at highest densities over the transects were halfbanded rockfish followed by combfish, pygmy rockfish, and swordspine rockfish (Appendix B). The number of halfbanded rockfish far exceeded other fish species counted in this area. We observed one bocaccio, as well as lingcod and widow rockfish (Appendix B). The invertebrates we observed at the highest densities include basket stars and unidentified lobed sponge (Appendix B).

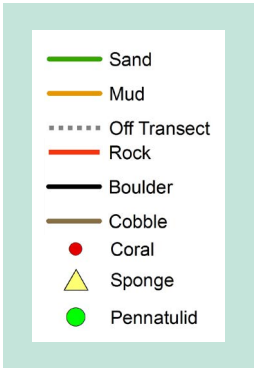


Halfbanded rockfish (*S. semicinctus*) at Southeast Santa Rosa Island.

We discovered high numbers of juvenile rockfish at this site, indicating it may be an important nursery area.

Table 3. Counts of biogenic habitat species (corals, sponges, and pennatulids) at Southeast Santa Rosa Island.

Biogenic Habitat Species	
Coral	**Count**
Red *Swiftia* gorgonian	8
Yellow gorgonian	8
Sponge	**Count**
Unidentified branched sponge	6
Unidentified lobed sponge	33
Pennatulid	**Count**
Sea whip	7
Total	**62**



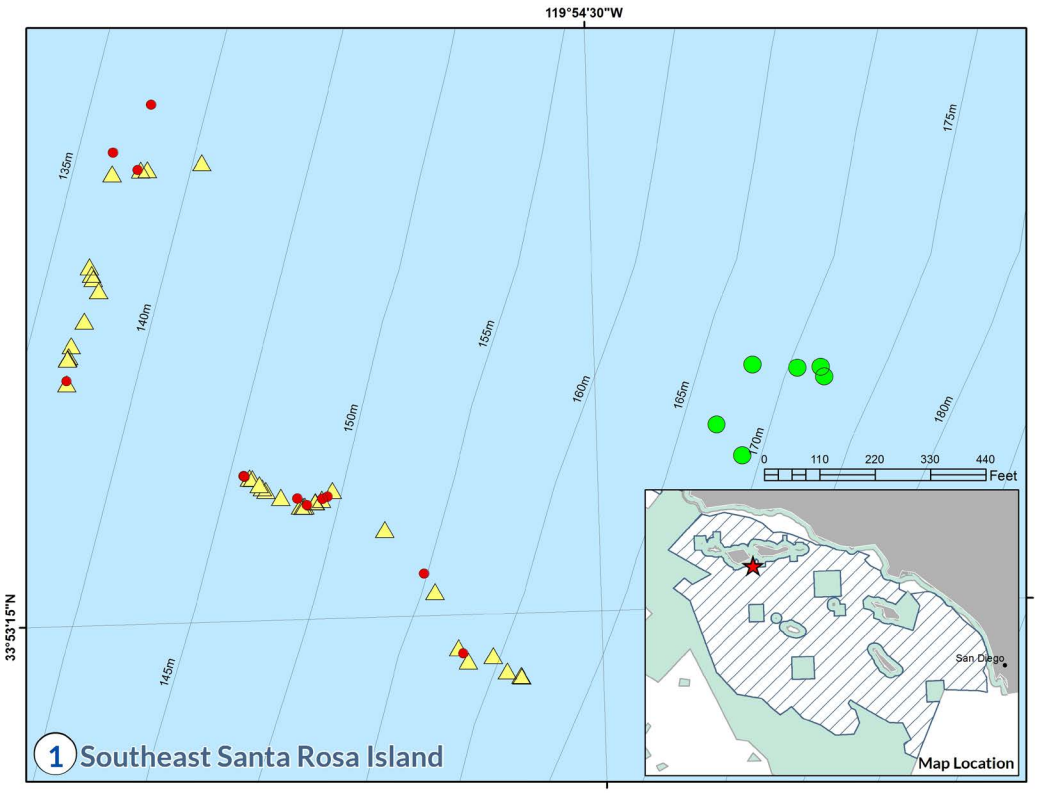


Figure 7. Map of coral, sponge and pennatulid observations along three completed transects at Southeast Santa Rosa Island.

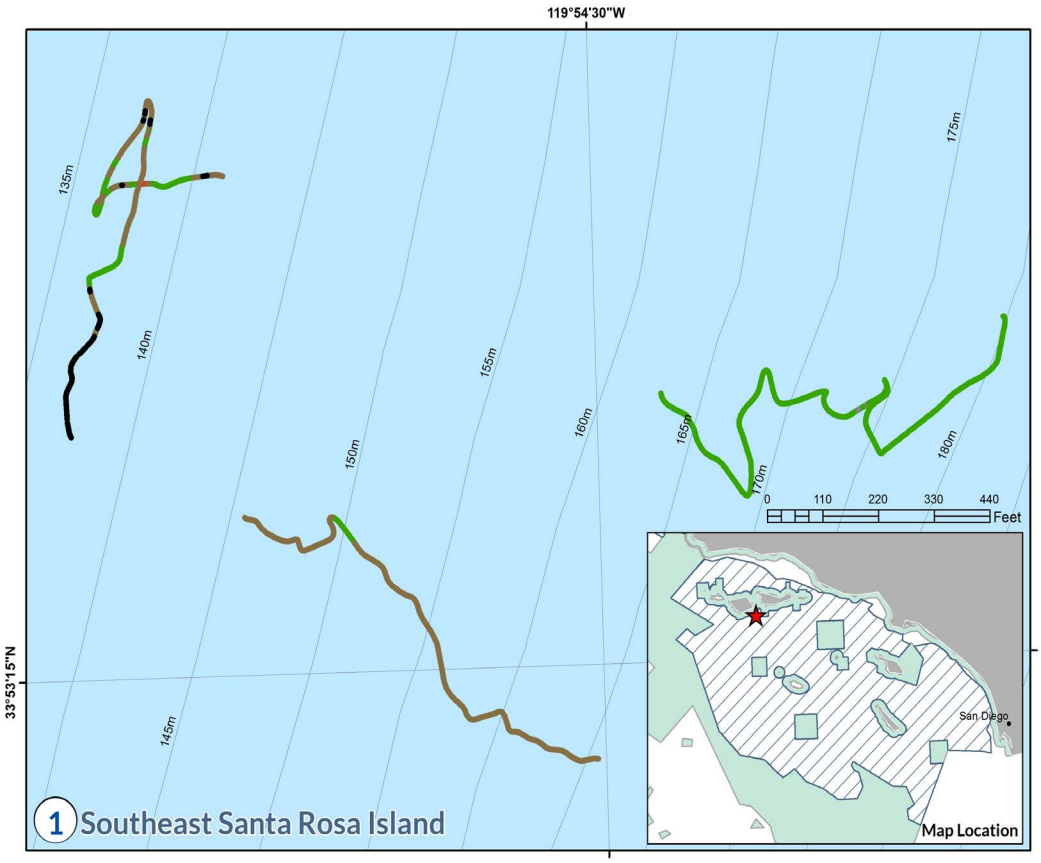


Figure 8. Map of substrate type along the three completed transects at Southeast Santa Rosa Island.

2. Anacapa Deep Ridge

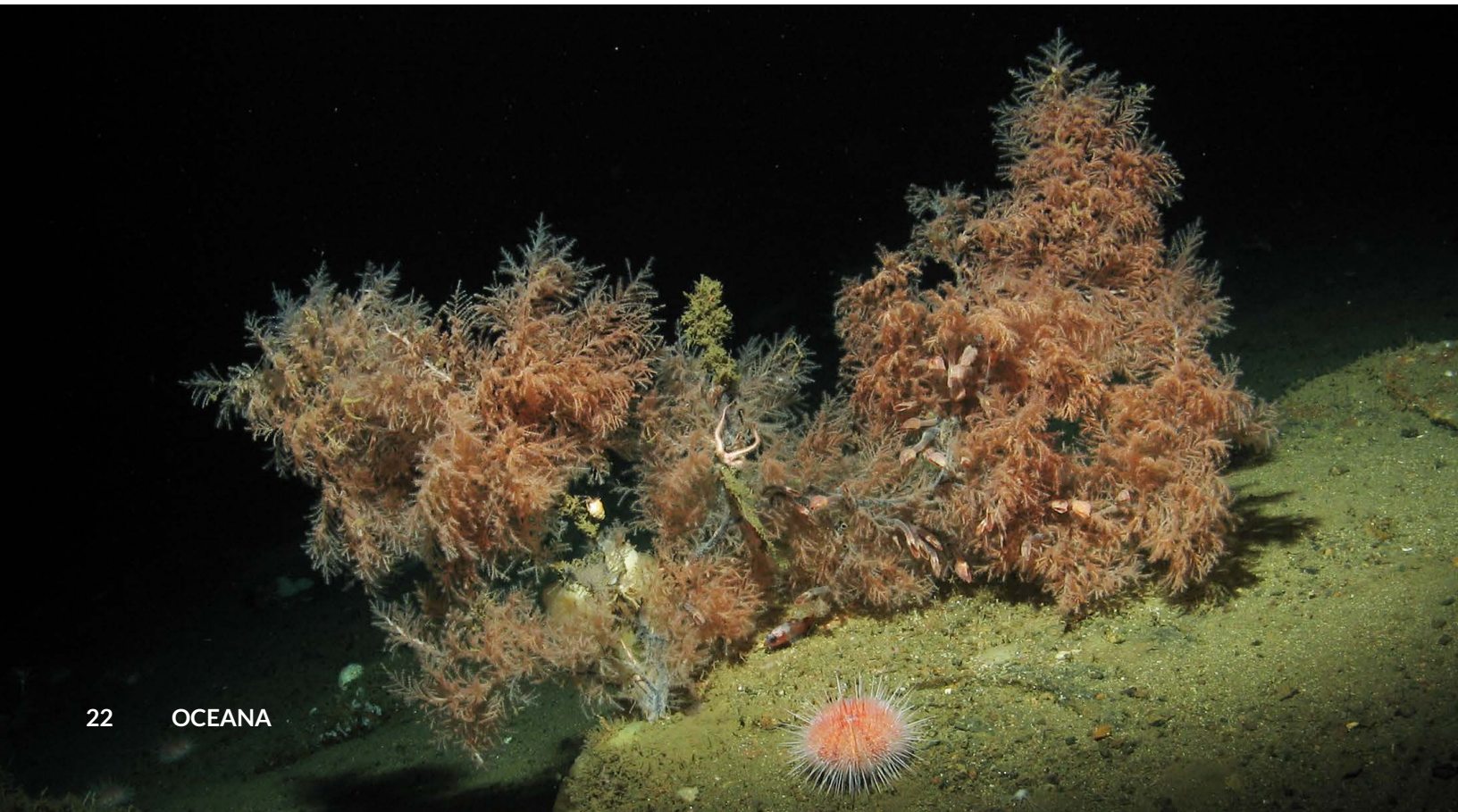
We completed two transects covering more than 0.7 km of the seafloor at Anacapa Deep Ridge, roughly three km south of Anacapa Island, inside the Channel Islands National Marine Sanctuary. We primarily observed soft and mixed substrate on this dive but five percent of the seafloor habitat was hard substrate (Figure 6). At this site, we observed 137 fish, in total, with 95 individual fish identified as managed under the Pacific Coast Groundfish FMP across nine different species/groupings (Appendix B). The total number of invertebrates observed on transect was 2,894, with high numbers of fragile pink urchins. We documented 98 corals, sponges and pennatulids here (Table 4).

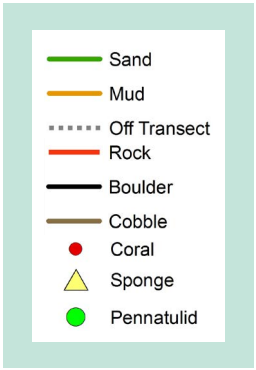
The fish observed at highest densities over the transects were bank rockfish followed by *Sebastomus* (e.g. rosy, starry, swordspine, rosethorn, greenspotted rockfish, and others) and splitnose rockfish (Appendix B). Here, we observed a relatively high density of fragile pink urchins which were feeding on a deceased sea lion. This site has the highest densities of the Antipatharia, black coral and the Alcyonacea, bubblegum coral (*Paragorgia sp.*) of the five study areas surveyed (Appendix B). This is the only study area that is outside of the Oceana EFH conservation area proposal as it is located inside California state waters and already closed to bottom trawling by California state law.

Table 4. Counts of biogenic habitat species (corals, sponges, and pennatulids) at Anacapa Deep Ridge.

Biogenic Habitat Species	
Coral	**Count**
Black coral	10
Bubblegum coral	7
Gray gorgonian	4
Red *swiftia* gorgonian	38
Unidentified orange gorgonian	10
Sponge	**Count**
Unidentified boot sponge	3
Unidentified lobed sponge	19
Unidentified vase sponge	1
Pennatulid	**Count**
Unidentified sea pen	5
White sea pen	1
Total	**98**

A black coral (*Antipathes sp.*) at Anacapa Deep Ridge.





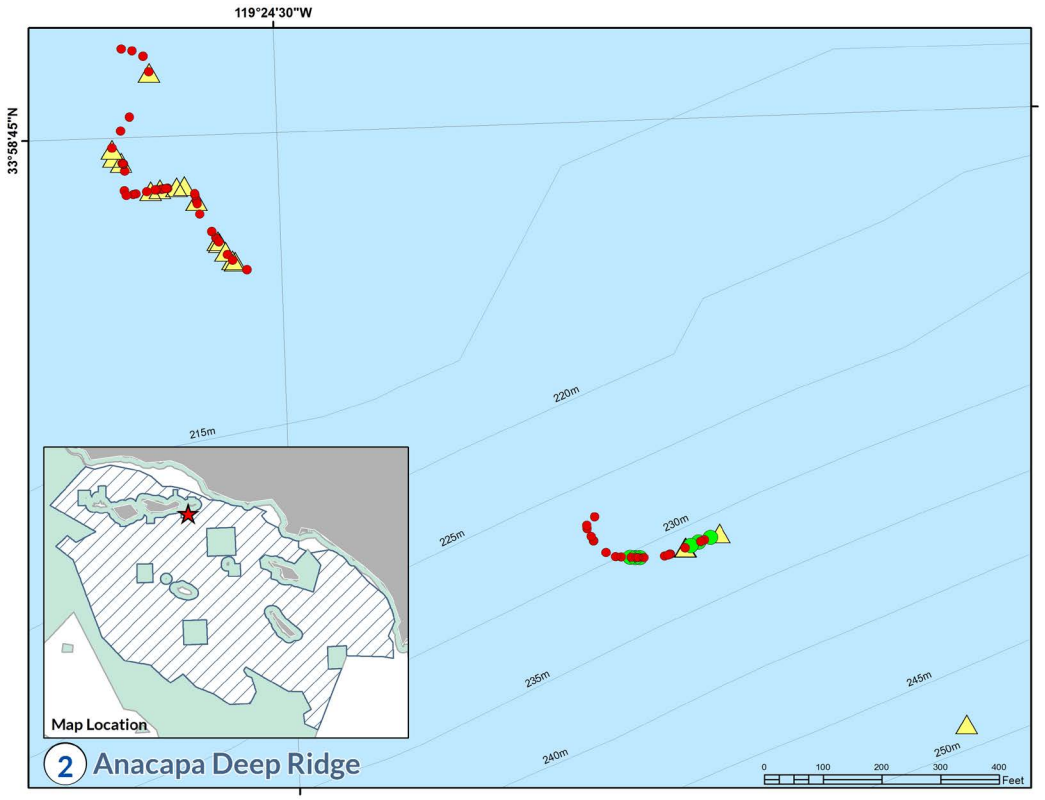


Figure 9. Map of coral, sponge and pennatulid observations along two completed transects at Anacapa Deep Ridge.

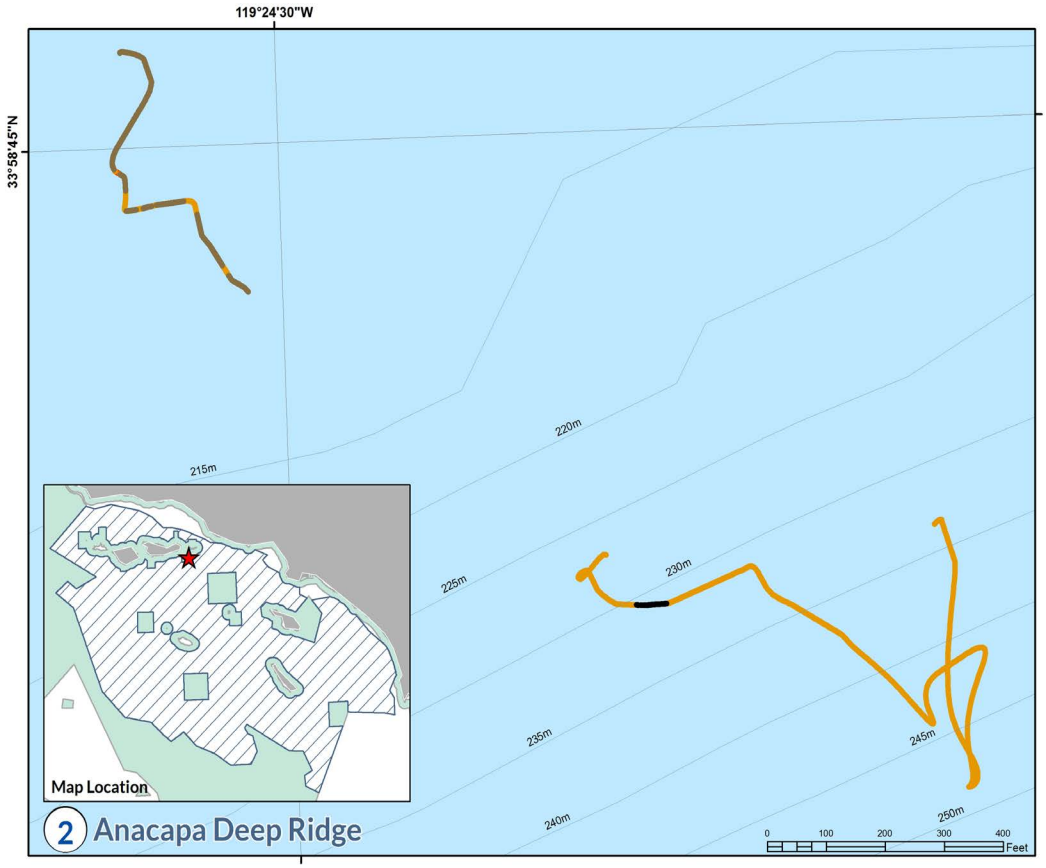


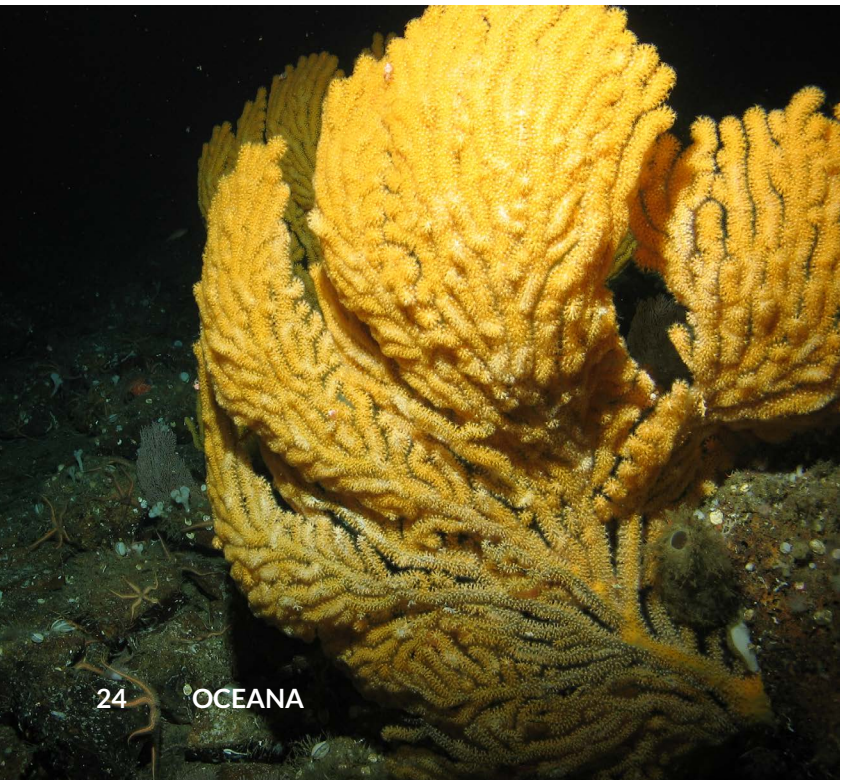
Figure 10. Map of substrate type along the two completed transects at Anacapa Deep Ridge.

3. West Santa Barbara Island

In this study area located nine to 15 km west of Santa Barbara Island, we covered 5.2 km of seafloor along eleven transects. This area is within the Western Cowcod Conservation Area where bottom trawls and most other bottom fishing have been prohibited since 2001 for rebuilding cowcod rockfish. The area, however, is not currently protected from bottom trawling as EFH and the Cowcod Conservation Area may be modified or fully lifted in the future as this rockfish species recovers.

The substrate we observed on this dive is divided between soft substrate and a combination of mixed and hard substrates (Figure 6). We observed a total of 2,098 fish with high numbers of young of the year rockfish and swordspine rockfish. We identified 22 managed fish species/groupings, accounting for 1,963 of the individual fish (Appendix B). We also observed 4,543 invertebrates including relatively high numbers of lobed sponges. We found other corals, sponges and pennatulids here with a total of 2,087 individual organisms counted, representing nineteen species/groupings (Appendix B, Table 5). Of those observations, we documented 845 individual coral colonies.

A large yellow gorgonian coral (*Acanthogorgia sp.*) at West Santa Barbara Island.



The fish we observed at the highest densities over these transects were YOY juvenile rockfish followed by swordspine rockfish (Appendix B). The invertebrate we observed at the highest density is unidentified lobed sponge, followed by squat lobster and gray gorgonians (Appendix B). This study area has the greatest density of gray and yellow gorgonians of all sites surveyed. This site also has the greatest diversity of coral types among surveyed areas.

We discovered previously unidentified coral gardens and rocky reefs here; located inside and outside of the CINMS boundaries.

Table 5. Counts of biogenic habitat species (corals, sponges, and pennatulids) at West Santa Barbara Island.

Biogenic Habitat Species	
Coral	**Count**
Black coral	19
Bubblegum coral	9
Gray gorgonian	552
Mushroom soft coral	4
Red gorgonian	1
Red *Swiftia* gorgonian	111
Unidentified gorgonian	3
Yellow gorgonian	146
Sponge	**Count**
Gray moon sponge	1
Orange puffball sponge	1
Unidentified boot sponge	66
Unidentified branched sponge	206
Unidentified hairy boot sponge	27
Unidentified large yellow sponge	44
Unidentified lobed sponge	724
Unidentified nipple sponge	1
Unidentified vase sponge	167
Pennatulid	**Count**
Unidentified sea pen	2
White sea pen	7
TOTAL	**2087**

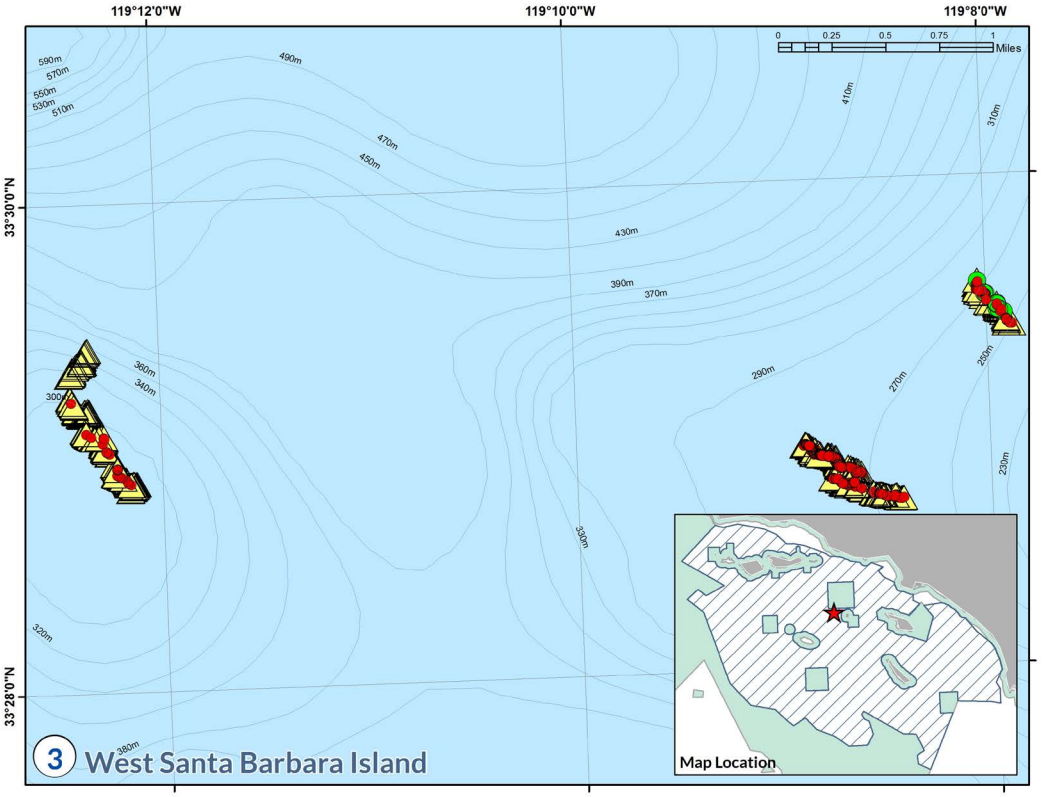
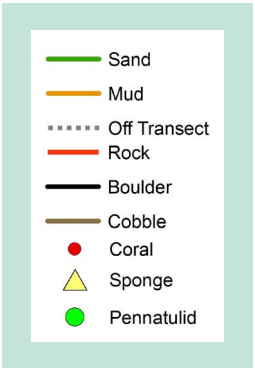


Figure 11. Map of coral, sponge and pennatulid observations along eleven completed transects at West Santa Barbara Island.



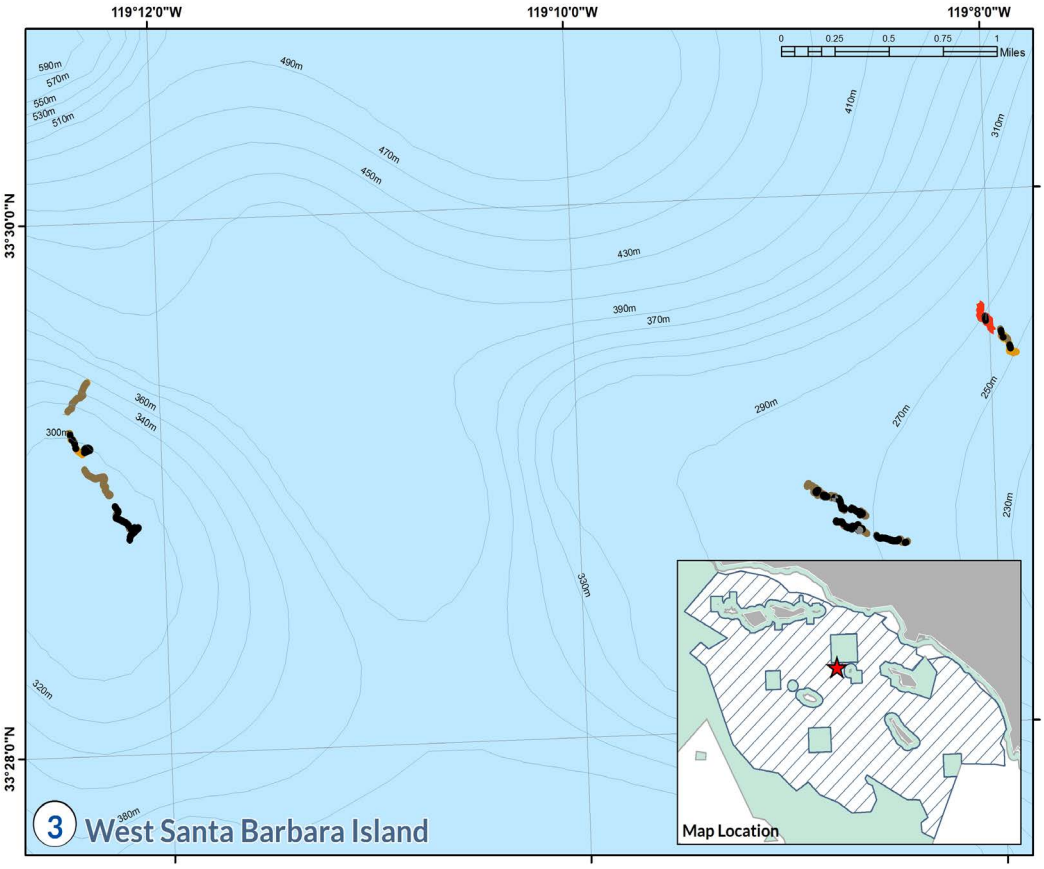


Figure 12. Map of substrate type along the eleven completed transects at West Santa Barbara Island.

4. South Santa Barbara Island

At the South Santa Barbara Island study area, located 11 km off Santa Barbara Island and 76 km from the mainland, we surveyed 1.5 km of the seafloor at a depth up to 272 m. The substrate in this area composed primarily mixed habitat with 11 percent hard and 25 percent soft substrate (Figure 6). At this site, we observed a total of 251 fish, 220 of which are federally managed (Appendix B). While we observed *Sebastomus* rockfish most frequently, this was the only site where we observed cowcod rockfish (Appendix B). The total count of 1,189 invertebrates includes 187 corals and sponges (Appendix B, Table 6). We observed the *Sebastomus* rockfish at the highest density at this site (Appendix B). For the invertebrates, we found squat lobsters and urchins at the highest densities, and across study areas, we observed mushroom soft corals at their highest density at this site (Appendix B).

Table 6. Counts of biogenic habitat species (corals, sponges, and pennatulids) at South Santa Barbara Island.

Biogenic Habitat Species	
Coral	**Count**
Black coral	5
Bubblegum coral	3
Mushroom Soft Coral	20
Red *Swiftia* gorgonian	15
Unidentified orange gorgonian	1
Yellow gorgonian	3
Sponge	**Count**
Gray moon sponge	1
Unidentified boot sponge	7
Unidentified branched sponge	20
Unidentified hairy boot sponge	1
Unidentified lobed sponge	105
Unidentified vase sponge	6
Total	**187**

A mushroom soft coral (*Anthomastus ritteri*) (foreground) at South Santa Barbara Island.

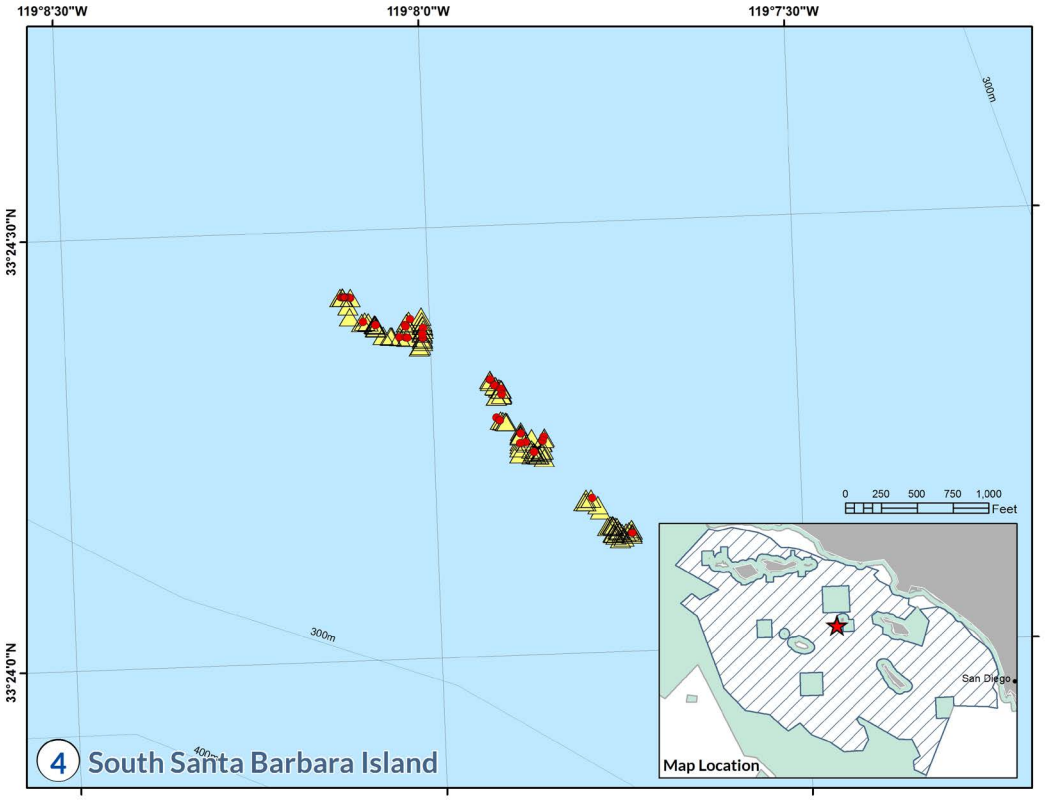


Figure 13. Map of coral, sponge and pennatulid observations along the three completed transects at South Santa Barbara Island.

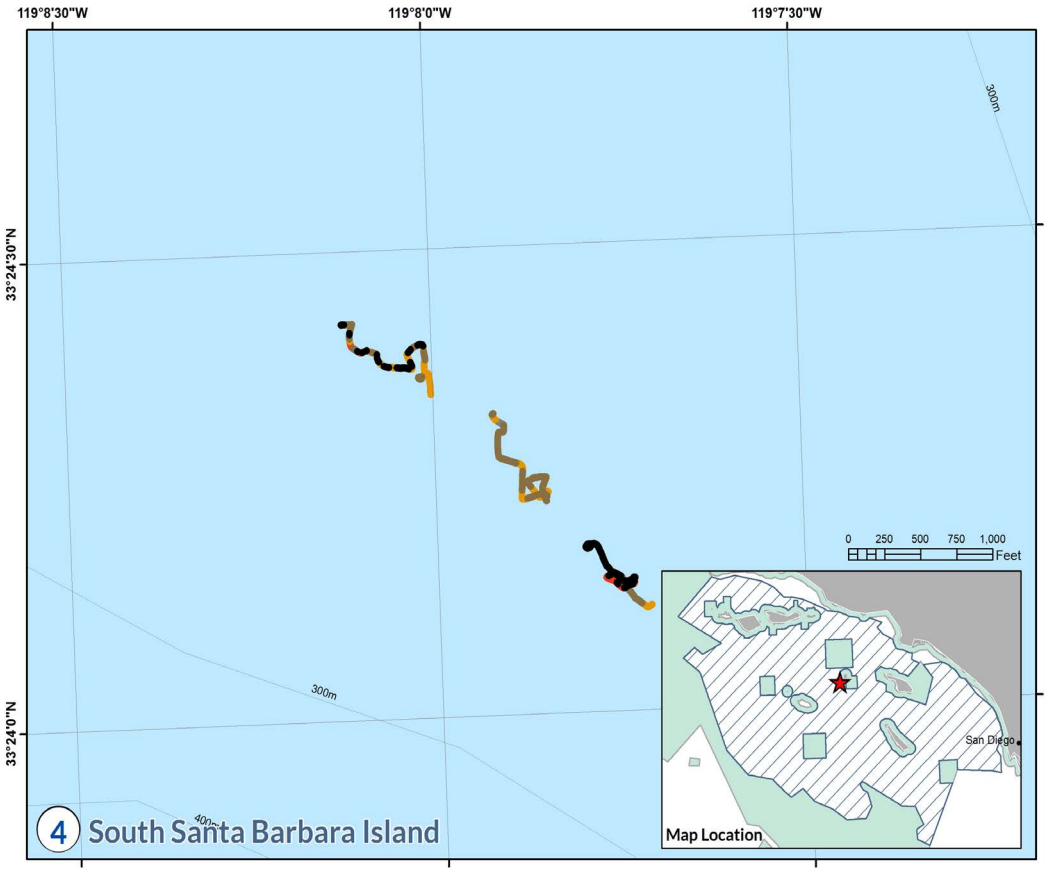


Figure 14. Map of substrate type along the three completed transects at South Santa Barbara Island.

5. Butterfly Bank

At Butterfly Bank – located 120 km offshore San Diego, CA, we completed four transects in the western portion of the bank and two transects in the eastern portion (Figure 15). These transects covered a 2 km distance. The dive at east Butterfly Bank was the only night dive on this expedition. Most of the substrate we observed at the western portion of this site is mixed with a greater percentage of hard habitats, 19 percent, than soft habitats, 17 percent (Figure 6). This is the deepest area we explored during this study, reaching 379 m. Here we documented 236 fish, 222 of which are managed under the Pacific Coast Groundfish FMP (Appendix B). We observed *Sebastomus* rockfish at the highest abundance of the ten, managed species/groupings found here (Appendix B). We documented 5,143 invertebrates including 2,352 corals, sponges and pennatulids (Appendix B, Table 7).

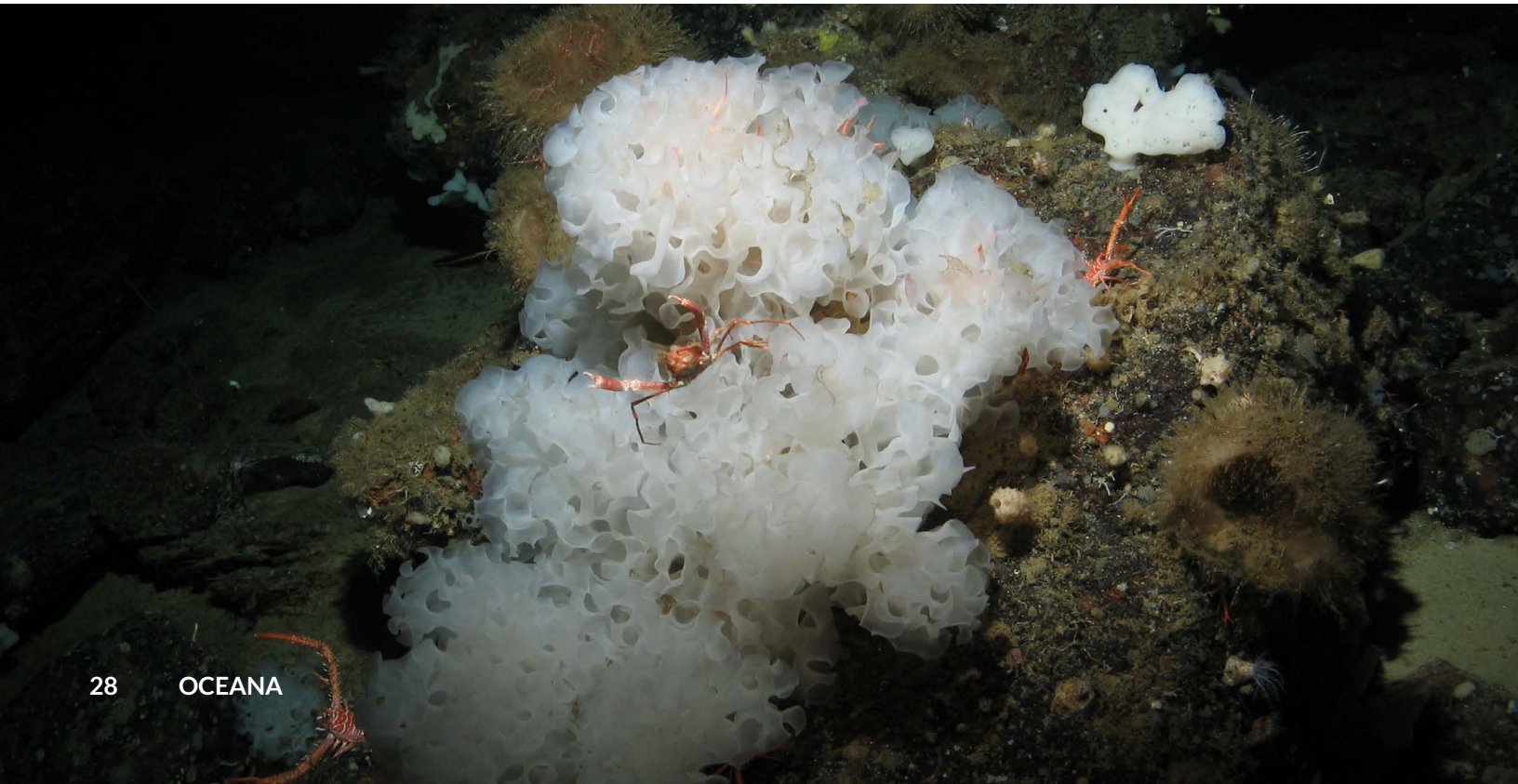
We observed *Sebastomus* rockfish at the highest density for fish species/ groupings at this study area (Appendix B). Here, we observed the highest density of corals and sponges of all study areas including a high density of unidentified lobed, laced, and hairy boot sponge (Appendix B).

We found high numbers and densities of lobed and laced sponges adorning pinnacles and rocky outcrops at Butterfly Bank.

Table 7. Counts of biogenic habitat species (corals, sponges, and pennatulids) at Butterfly Bank.

Biogenic Habitat Species	
Coral	**Count**
Bubblegum coral	6
Mushroom soft coral	13
Red *Swiftia* gorgonian	94
Unidentified orange gorgonian	29
Yellow gorgonian	1
Sponge	**Count**
Unidentified boot sponge	56
Unidentified branched sponge	13
Unidentified hairy boot sponge	403
Unidentified laced sponge	633
Unidentified lobed sponge	1048
Unidentified nipple sponge	3
Unidentified trumpet sponge	14
Unidentified vase sponge	39
Total	**2352**

Laced sponge and squat lobster at Butterfly Bank.



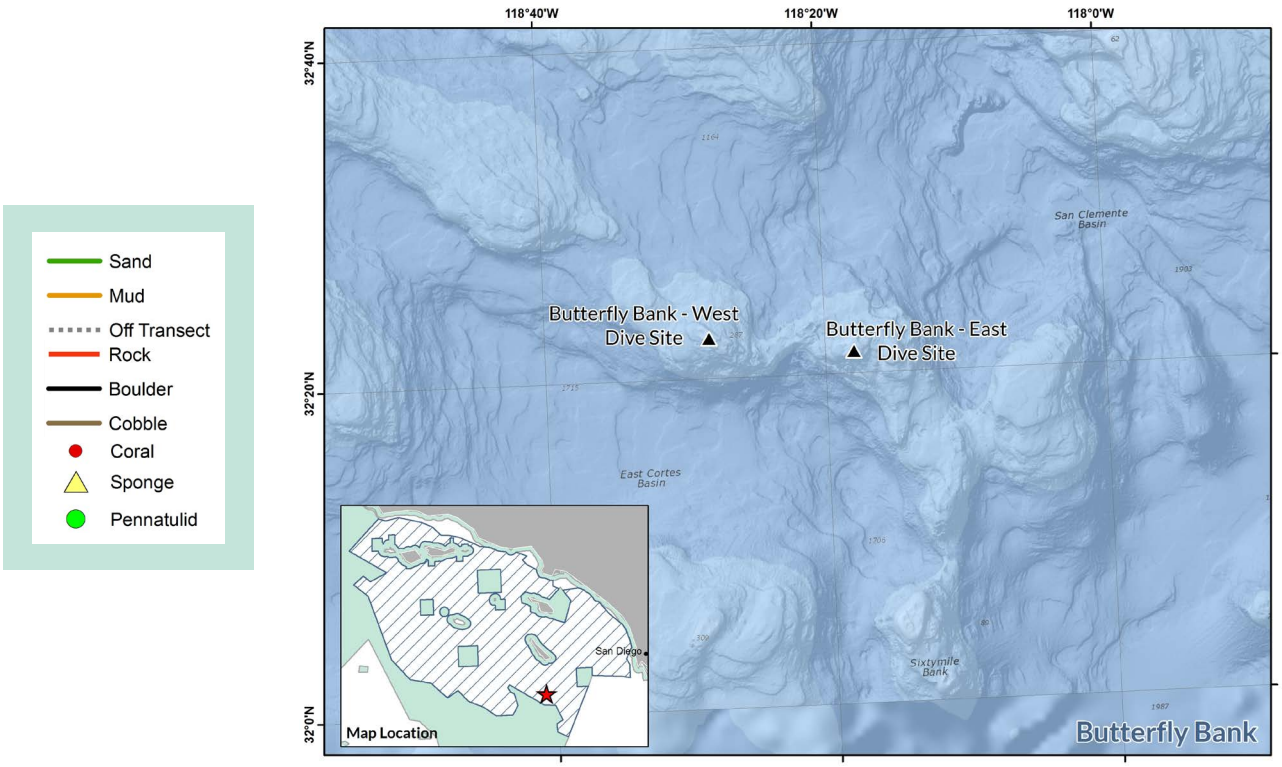


Figure 15. Map of two dive sites in the Butterfly Bank study area.

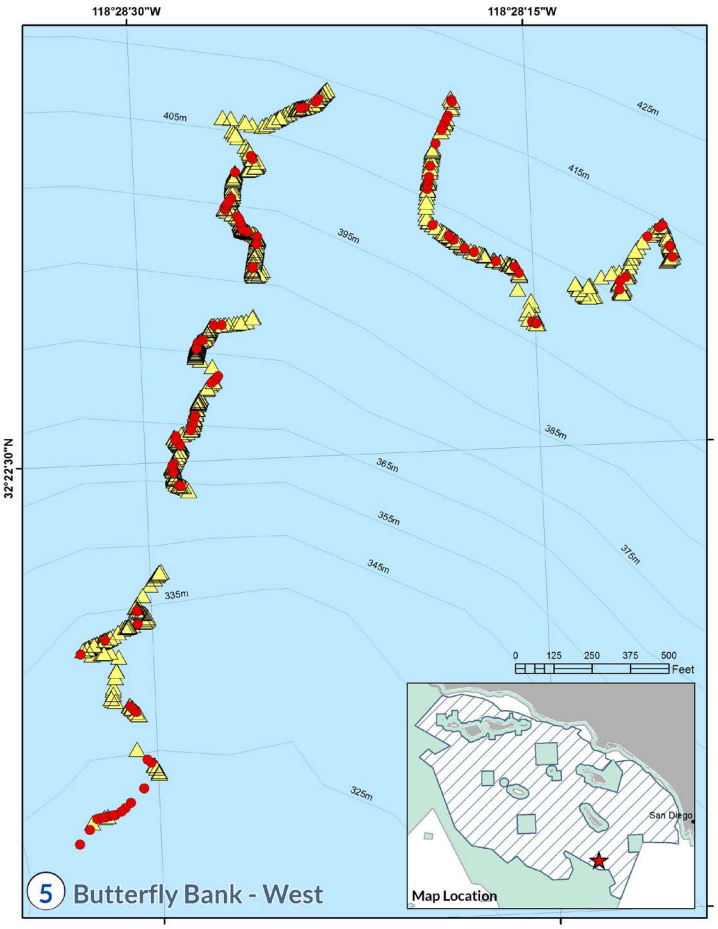


Figure 16. Map of coral and sponge observations along four completed transects at Butterfly Bank- West.

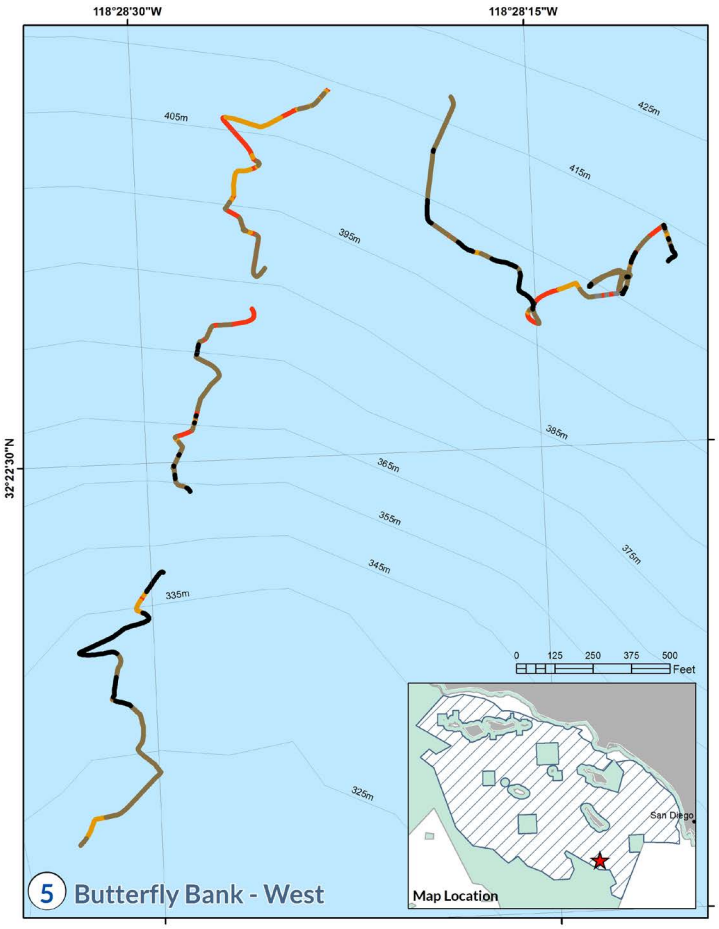
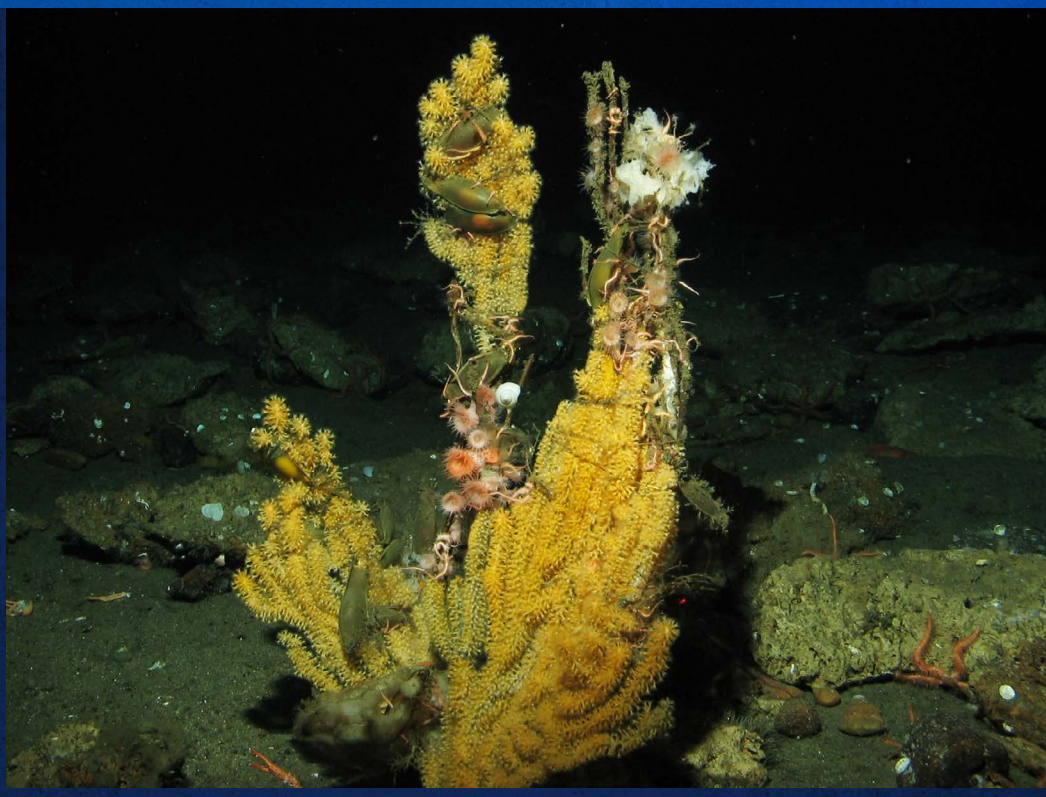


Figure 17. Map of substrate type along four completed transects at Butterfly Bank- West.

Other Observations

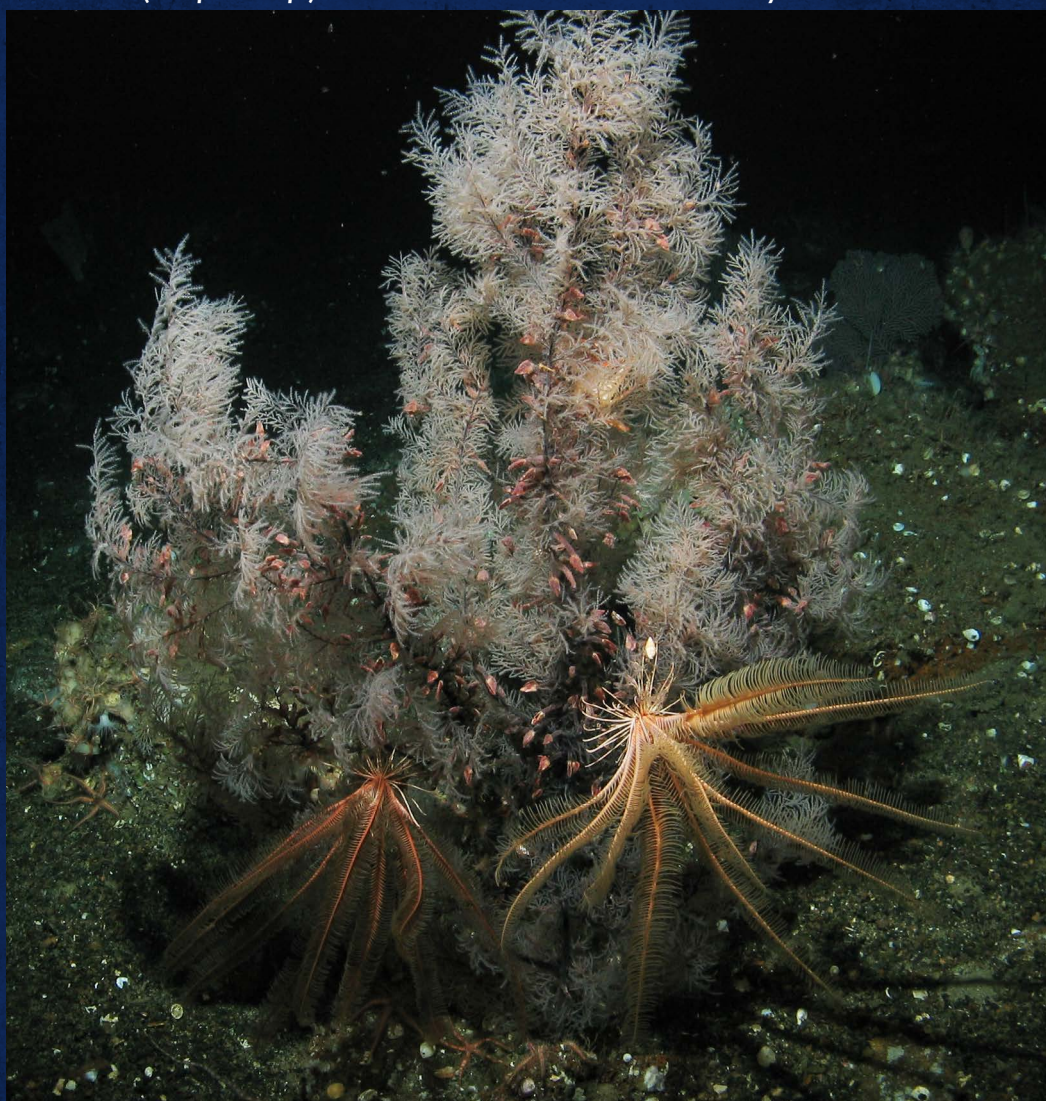
Some other observations and highlights from the expedition include:

- Black corals adorned with hundreds of associated animals, including bright pink barnacles.
- Adult rockfish, including vermillion, flag, bocaccio and cowcod, as well as other commercially valuable fish like lingcod in close association with deep sea corals and sponges.
- Cat shark (*Scyliorhinidae*) eggs laid on yellow corals and laced sponges.
- Octopus wrapped around the base of a vase sponge, appearing to use the sponge for camouflage.
- Ocean sunfish (*Mola mola*), wolf eel, octopus, nudibranchs and other non-commercial marine life associated with the seafloor.
- A large, possible mating aggregation of box crabs on a deep ledge at the South Santa Barbara Island study area.
- Territorial use of sponges by squat lobsters and California king crabs.
- A deceased sea lion at Anacapa Deep Ridge being eaten by pink urchins and spot prawns.



A yellow gorgonian coral adorned with invertebrates and cat shark eggs at the South Santa Barbara Island study area.

Black coral (*Antipathes sp.*) in the West Santa Barbara Island study area.



A flag rockfish (*S. rubrivinctus*) swims among orange gorgonian corals (*Adelogorgia phyllosclera*) off Santa Rosa Island.

DISCUSSION

Corals and sponges create complex and sensitive biological communities in the deep-sea. On the 25 transects we completed in this expedition, we documented 3,644 sponges and 1,120 deep-sea corals, plus 22 pennatulids. Gorgonian corals (Alcyonacea) were the most commonly observed coral type, with three species/groupings representing the majority of coral observations: gray, red *Swiftia* and yellow gorgonians. While species diversity and abundance varied between sites, this study confirms the seafloor of the Southern California Bight contains many complex and sensitive habitat features essential to an array of commercially important deep-sea fishes.

At West Santa Barbara Island, we observed the greatest number of fish and invertebrate species, but we also completed more transects here (eleven) over a greater distance than the remaining four study areas. At Southeast Santa Rosa Island, we documented the highest abundance of fish despite a low abundance of invertebrates, primarily due to a very large count of halfbanded rockfish (Appendix B). At Butterfly Bank, we observed the highest number of invertebrates and the highest density of biogenic habitat species compared with other survey areas (Appendix B). We observed the highest density of invertebrates at Anacapa Deep Ridge, primarily due to very high counts of fragile pink urchin. At the West Santa Barbara Island study area, we observed high numbers of fish and invertebrates, including habitat forming corals and sponges (Appendix B).

We documented a variety of important biogenic habitat (corals, sponges and pennatulids) and important fish species managed under the Pacific Coast Groundfish FMP and noted their associations.

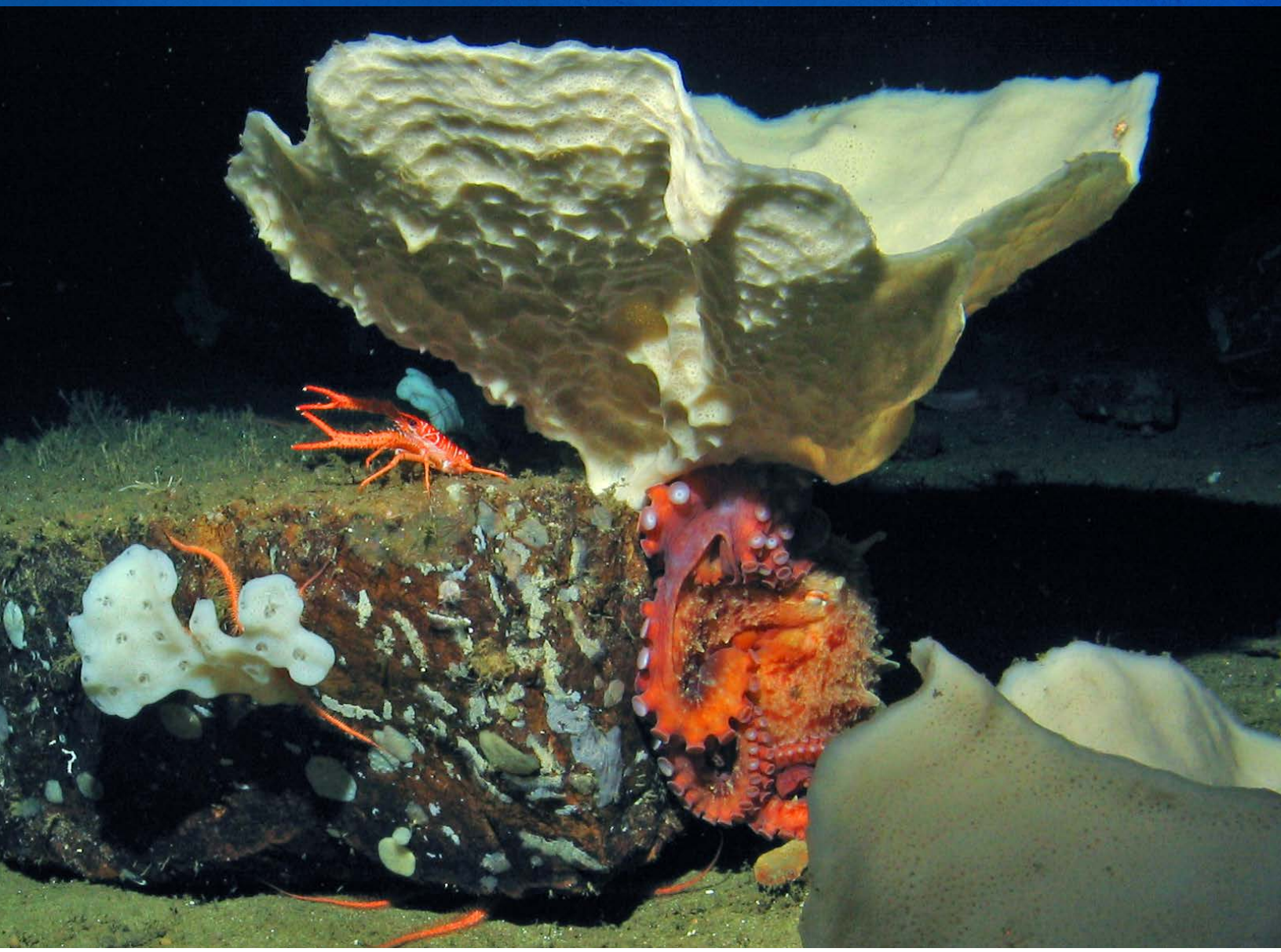
For example, we documented previously overfished species including lingcod, widow, and bocaccio rockfish, plus cowcod rockfish that are currently rebuilding. We also found structure-forming corals, including yellow gorgonian coral, bubblegum coral, and black corals. All observed managed fish species were present at transects that had corals and sponges or pennatulids (Table 2). All observed fish species co-occurred with gorgonian corals (Alcyonacea) and lobed sponges on at least one dive.

Deep-sea corals grow extremely slowly and are highly sensitive to disturbance. Damaged corals and their associated biological communities can take decades to centuries to recover, if at all. We did not observe any evidence of bottom trawl activity at any of the areas we surveyed. Data on the spatial extent of bottom trawling in the Southern California Bight indicates that trawling currently occurs only in areas less than 183 meters (100 fathoms, 600 feet) deep along the mainland coast (CDFW 2016). There is currently no federal groundfish trawling in Southern California due to current economic and regulatory conditions. The sites we surveyed are located further offshore and most are currently protected from bottom trawling because they are either inside the trawl RCA (South Santa Rosa Island), inside California state waters closed to bottom trawling (Anacapa Deep Ridge) or inside the Cowcod Conservation Area (West and South Santa Barbara Island survey areas). Butterfly Bank, however, is open to trawling.

The South Santa Rosa survey area may be imminently vulnerable to trawling if the PFMC decides to lift the trawl RCA without simultaneously adopting the Oceana EFH proposal area for this region. Similarly, areas inside the Cowcod Conservation Area may soon be vulnerable to trawling as this depleted species recovers.

Our findings show that this region warrants a precautionary approach to protections as new discoveries are made and the unique diversity within the Bight is further confirmed. Bottom trawling should not be allowed to expand without first surveying for vulnerable seafloor habitats and a determination made that trawling could occur without adverse impacts. The Southern California Bight portion of the Oceana proposal, as modified by the California Department of Fish and Wildlife (CDFW 2016, Figure 3), would protect more than 16,000 square miles of seafloor habitat. Based on the NOAA Deep Sea Coral and Sponge Database (NOAA 2017), 2,928 coral, 4,568 sponge and 855 sea pen and sea whip records (8,351 combined) have been identified to date inside the Oceana proposed Southern California Bight EFH conservation area. Our study adds an additional 3,289 records inside this area for a total of 882 corals, 2,386 sponges and 21 pennatulids. This is a 39 percent increase in the combined number of coral, sponge and pennatulid records currently in the NOAA Deep Sea Coral and Sponge Database.

A rockfish finds shelter under a sponge adorned with a brightly colored basket star and feather like fern stars at Anacapa Deep Ridge.



An octopus hides out while a squat lobster stands guard beneath a vase sponge in the West Santa Barbara Island study area.

Deep-sea studies are important for the discovery of new biogenic habitat species, like the Christmas tree coral, as well as for documentation of coral, sponge and pennatulid locations. Protecting these vibrant communities is essential, not only for fisheries but as a part of Southern California's diverse ocean heritage and unique wildlife. Beautiful coral gardens, such as those we found off Santa Barbara Island, are being discovered just off the coast of one of the most populated areas in the United States.

As a part of an ongoing effort to identify and protect Important Ecological Areas, this study documented the distribution and abundance of coral and sponge communities, co-occurrence between federally managed groundfish species and physical and biogenic habitat features, and characterized habitats in designated protected areas and areas that are not protected in the Southern California Bight. All biogenic habitat records will be submitted to NOAA's Deep Sea Research and Technology Program for inclusion in the National Deep-Sea Coral and Sponge Database. Future research will further document the location and extent of deep-sea coral and sponge communities, and build on the connections between those habitats and the fish populations that live there.

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An octopus observed at the Butterfly Bank study area.

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Brown box crab (*Lopholithodes foraminatus*) aggregation observed at South Santa Barbara Island study area.

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Bubblegum corals (*Paragorgia sp.*) are a type of gorgonian sea fan found throughout the Southern California Bight. We observed this specimen at Butterfly Bank.

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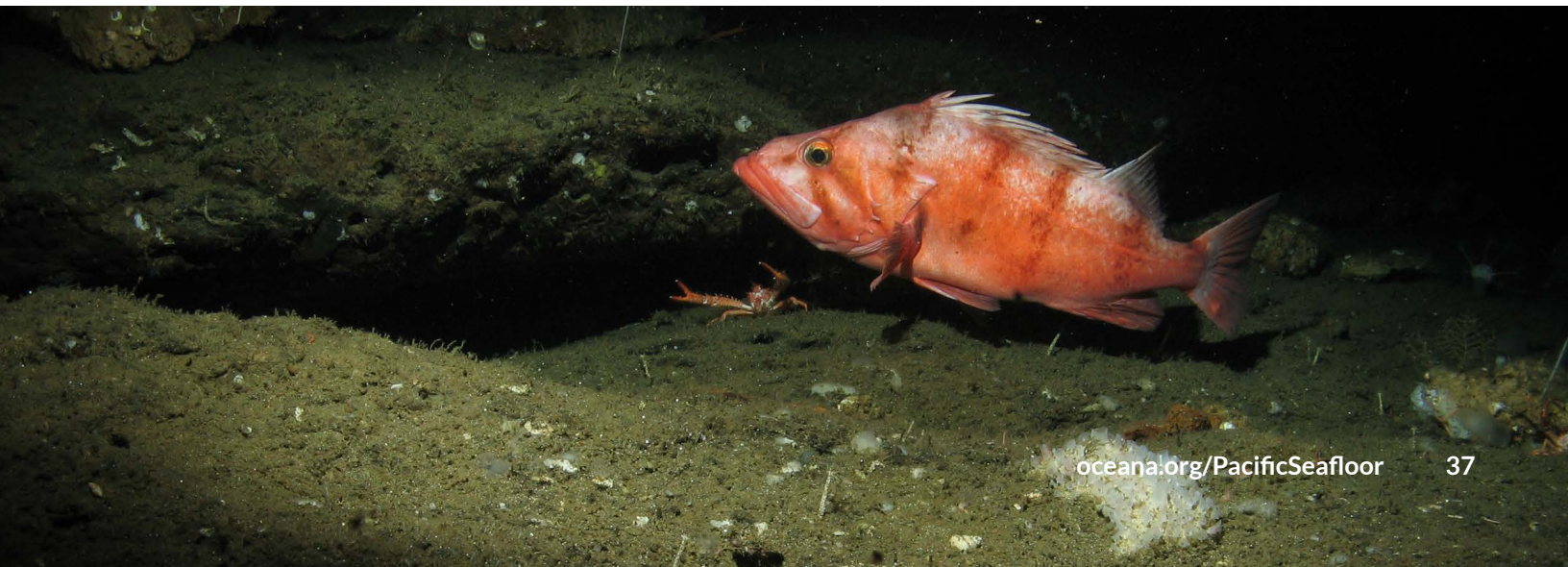
Cowcod rockfish (*Sebastes levis*) near a rocky outcrop at South Santa Rosa Island. Once severely overfished, cowcod rockfish are making a recovery in Southern California thanks to catch limits and habitat protections.



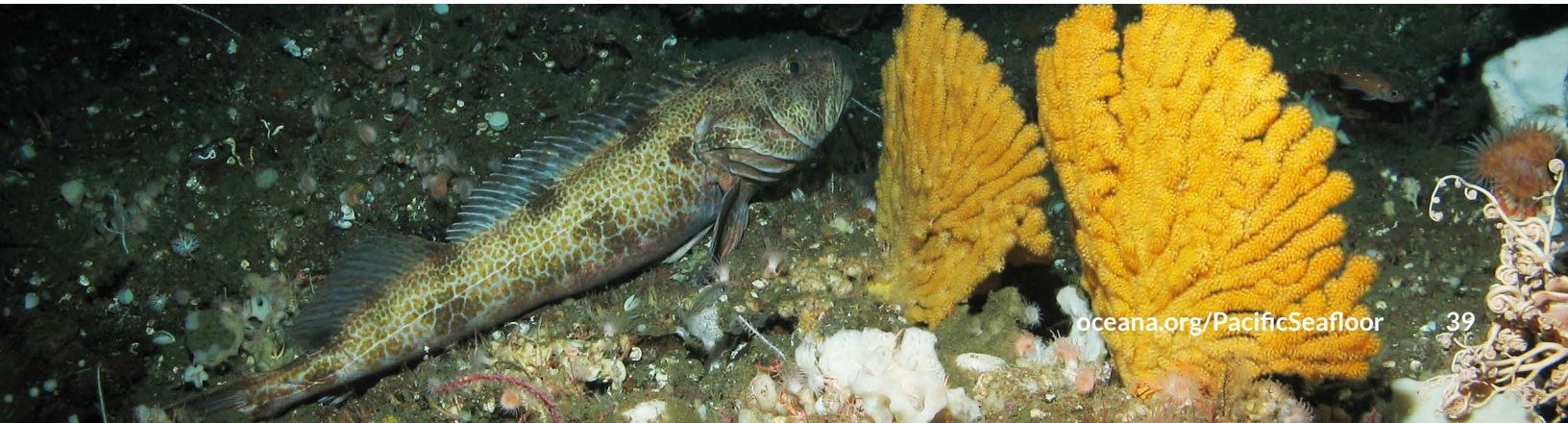
Gray gorgonian corals (*Plumarella sp.*) with rockfish and an orange gorgonian coral (*Adelogorgia phyllosclera*) found in the Oceana EFH proposal area, south of Santa Rosa Island.

APPENDICES

APPENDIX A: Table of start and end coordinates for each analyzed transect.

Site	TransectID	Start Lat	Start Lon	End Lat	End Lon
SE Santa Rosa	SESR-1-b	33.88873208	-119.911876	33.89028745	-119.911311
SE Santa Rosa	SESR-1-c	33.88886079	-119.9080285	33.88865557	-119.9075135
SE Santa Rosa	SESR-1-a	33.88702285	-119.9085018	33.88829904	-119.9107633
Anacapa DR	ADR-1-a	33.97740742	-119.4048535	33.97732768	-119.4066937
Anacapa DR	ADR-2-a	33.97852503	-119.4086452	33.97958121	-119.4093187
W Santa Barbara	WSB-5-a	33.47955466	-119.1462378	33.47872011	-119.1437867
W Santa Barbara	WSB-5-b	33.47860279	-119.1430663	33.478148	-119.1405657
W Santa Barbara	WSB-6-b	33.48696949	-119.2073866	33.48577093	-119.2063201
W Santa Barbara	WSB-6-c	33.48464124	-119.2062952	33.48296122	-119.2044324
W Santa Barbara	WSB-6-d	33.48225412	-119.2039603	33.48014788	-119.2028522
W Santa Barbara	WSB-6-a	33.49008253	-119.2058367	33.48813071	-119.2076495
W Santa Barbara	WSB-1-a	33.49279854	-119.1341597	33.49109802	-119.1331036
W Santa Barbara	WSB-1-b	33.49119242	-119.132573	33.48964863	-119.1315828
W Santa Barbara	WSB-4-a	33.48181518	-119.148465	33.4811477	-119.1468137
W Santa Barbara	WSB-4-b	33.48105358	-119.1465378	33.4802162	-119.1455654
W Santa Barbara	WSB-4-c	33.4802579	-119.1449724	33.47988814	-119.1440318
S Santa Barbara	SSB-1-a	33.40703744	-119.1354126	33.40574421	-119.133425
S Santa Barbara	SSB-1-b	33.40536544	-119.1320221	33.40393756	-119.1308265
S Santa Barbara	SSB-1-c	33.40298562	-119.1299172	33.40186821	-119.1285594
Butterfly Bank W	WBB-2-a	32.37161291	-118.4758973	32.37401972	-118.4749094
Butterfly Bank W	WBB-2-b	32.3747324	-118.4745903	32.37633754	-118.4738562
Butterfly Bank W	WBB-2-c	32.37669753	-118.4737028	32.37827167	-118.472955
Butterfly Bank W	WBB-3-a	32.37815887	-118.4716697	32.37660989	-118.4694546
Butterfly Bank E	EBB-1-a	32.35462709	-118.3047882	32.35613277	-118.3047511
Butterfly Bank E	EBB-1-b	32.35713963	-118.3047851	32.35871724	-118.3047491

A lingcod (*O. elongatus*) and yellow gorgonians (*Acanthogorgia sp.*) in the West Santa Barbara Island Study Area.



APPENDIX B: Counts and density of species/groupings of fish and invertebrates, and species richness of FMP fish and corals, sponges and pennatulids by study area.

Species observed		Counts		
FMP Fish		Southeast Santa Rosa Is.	Anacapa Deep Ridge	West Santa Barbara Is.
	Fish Transect Area:	4,399 m^2	2,270 m^2	17,900 m^2
Common Name	**Species Name**			
Aurora/splitnose complex	*Sebastes aurora* or *diploproa*	—	1	—
Bank rockfish	*Sebastes rufus*	—	26	11
Blackgill rockfish	*Sebastes melanostomus*	—	4	10
Bocaccio	*Sebastes paucispinis*	1	—	1
Bronzespotted rockfish	*Sebastes gilli*	—	—	1
Cowcod	*Sebastes levis*	—	—	—
Dover sole	*Microstomus pacificus*	—	4	7
Flag rockfish	*Sebastes rubrivinctus*	1	—	—
Greenspotted rockfish	*Sebastes chlorostictus*	17	—	10
Greenstriped rockfish	*Sebastes elongatus*	5	—	2
Halfbanded rockfish	*Sebastes semicinctus*	1981	—	—
Lingcod	*Ophiodon elongatus*	3	—	3
Longnose skate	*Raja rhina*	—	—	1
Mexican rockfish	*Sebastes macdonaldi*	—	—	—
Pacific hake	*Merluccius productus*	—	—	1
Pinkrose rockfish	*Sebastes simulator*	—	—	7
Pygmy rockfish	Sebastes wilsoni	64	—	74
Sebastomus rockfish	*Sebastomus sp.*	41	22	181
Shortbelly rockfish	*Sebastes jordani*	—	—	7
Shortspine thornyhead	*Sebastolobus alascanus*	1	—	—
Small schooling rockfish	10-15cm rockfish sp.	15	—	40
Splitnose rockfish	*Sebastes diploproa*	—	20	34
Spotted ratfish	*Hydrolagus colliei*	2	4	—
Squarespot rockfish	*Sebastes hopkinsi*	3	—	21
Squarespot/Widow complex	*Sebastes hopkinsi* or *entomelas*	8	—	44
Stripetail rockfish	*Sebastes saxicola*	3	—	—
Swordspine rockfish	*Sebastes ensifer*	53	—	650
Thornyhead complex	*Sebastolobus altivelis* or *alascanus or macrochir*	—	2	—
UI rockfish	Unidentified Sebastes sp.	15	12	125
Whitespeckled rockfish	*Sebastes moseri*	—	—	3
YOY rockfish	Young of Year (<10 cm rockfish sp.)	14	—	730
Total		**2227**	**95**	**1963**
Number of Species	FMP Fish	*17*	*9*	*22*

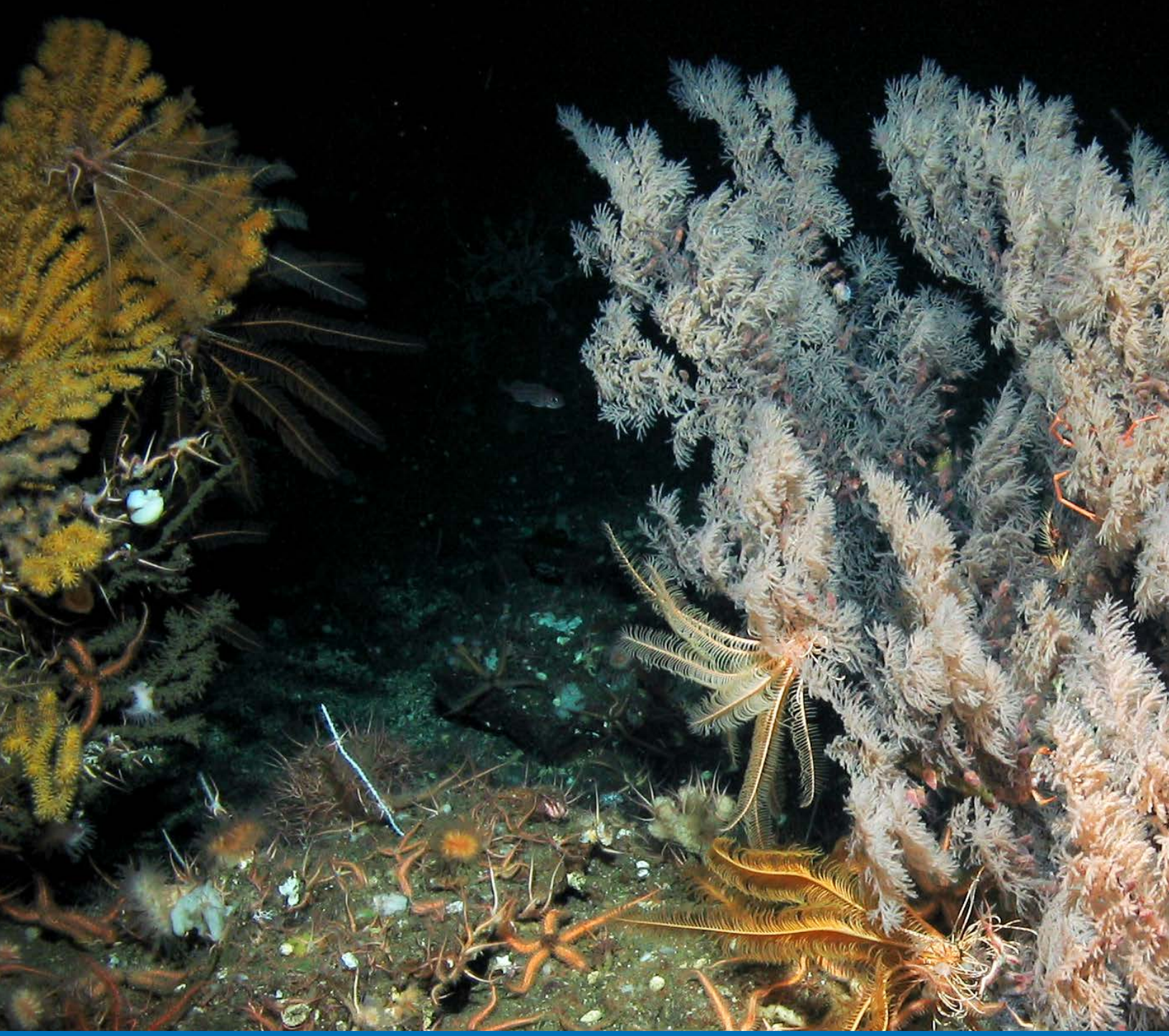
Density (count/100m²)							
South Santa Barbara Is. 5,477 m²	Butterfly Bank 9,450 m²	*Total Observations*	Southeast Santa Rosa Is. 4,399 m²	Anacapa Deep Ridge 2,270 m²	West Santa Barbara Is. 17,900 m²	South Santa Barbara Is. 5,477 m²	Butterfly Bank 9,450 m²
—	20	21	—	0.04	—	—	0.21
15	40	92	—	1.15	0.06	0.27	0.42
—	1	15	—	0.18	0.06	—	0.01
—	—	2	0.02	—	0.01	—	—
—	—	1	—	—	0.01	—	—
17	—	17	—	—	—	0.31	—
—	—	11	—	0.18	0.04	—	—
—	1	2	0.02	—	—	—	0.01
1	—	28	0.39	—	0.06	0.02	—
20	—	27	0.11	—	0.01	0.37	—
—	—	1981	45.03	—	—	—	—
—	—	6	0.07	—	0.02	—	—
—	—	1	—	—	0.01	—	—
1	—	1	—	—	—	0.02	—
—	—	1	—	—	0.01	—	—
—	—	7	—	—	0.04	—	—
—	—	138	1.45	—	0.41	—	—
71	93	408	0.93	0.97	1.01	1.30	0.98
44	—	51	—	—	0.04	0.80	—
—	1	2	—	—	—	0.02	0.01
—	—	55	0.34	—	0.22	—	—
—	15	69	—	0.88	0.19	—	0.16
—	3	9	0.05	0.18	—	—	0.03
—	—	24	0.07	—	0.12	—	—
—	—	52	0.18	—	0.25	—	—
—	—	3	0.07	—	—	—	—
18	—	721	1.20	—	3.63	0.33	—
—	3	5	—	0.09	—	—	0.03
25	45	222	0.34	0.53	0.70	0.46	0.48
—	—	3	—	—	0.02	—	—
7	—	751	0.32	—	4.08	0.13	—
219	**222**	**4726**	**50.63**	**4.19**	**10.97**	**4.00**	**2.35**
10	*10*	**31**					

Species observed		Counts	
Other Fish		Southeast Santa Rosa Is.	Anacapa Deep Ridge
	Fish Transect Area:	4,399 m^2	2,270 m^2
Common Name	**Species Name**		
Combfish complex	*Zaniolepis frenata* or *latipinnis*	71	3
Pacific hagfish	*Eptatretus stoutii*	—	1
Pink surfperch	*Zalembius rosaceus*	3	—
UI cod	Unidentified Gadidae	—	—
UI eel pout etc.	Unidentified Zoarcidae, Blennidae, Pholididae or Stichaeidae	9	3
UI flatfish	Unidentified Pleuronectidae	18	10
UI grenadier	Unidentified Macrouridae	—	—
UI poacher	Unidentified Agonidae	—	19
UI ray/skate	Unidentified ray or skate	1	—
UI sanddab	Unidentified *Citharichthys sp.*	2	—
UI sculpin	Unidentified Cottidae	—	2
UI small benthic fish	Unidentified small benthic fish	6	4
Wolf Eel	*Anarrhichthys ocellatus*	1	—
Total		**111**	**42**
Corals, Sponges, Pennatulids		Southeast Santa Rosa Is.	Anacapa Deep Ridge
	Invert Transect Area:	2,860 m^2	1,476 m^2
Common Name	**Species Name**		
Black coral	*Antipathes sp.*	—	10
Bubblegum coral	*Paragorgia sp.*	—	7
Gray gorgonian	*Plumarella sp.*	—	4
Gray moon sponge	*Spheciospongia confoederata*	—	—
Mushroom soft coral	*Anthomastus ritteri*	—	—
Orange puffball sponge	*Tethya aurantia*	—	—
Red gorgonian	*Lophogorgia chilensis*	—	—
Red Swiftia gorgonian	*Swiftia sp.*	8	38
Sea whip	*Halipteris californica*	7	—
UI boot sponge	Unidentified Porifera	—	3
UI branched sponge	Unidentified Porifera	6	—
UI gorgonian	Unidentified Gorgonacea	—	—
UI hairy boot sponge	Unidentified Porifera	—	—
UI laced sponge	Unidentified Porifera	—	—
UI large yellow sponge	Unidentified Porifera	—	—
UI lobed sponge	Unidentified Porifera	33	19
UI nipple sponge	Unidentified Porifera	—	—
UI orange gorgonian	Unidentified orange Gorgonacea	—	10
UI sea pen	*Virgularia sp.*	—	5
UI trumpet sponge	Unidentified Porifera	—	—
UI vase sponge	Unidentified Porifera	—	1
White sea pen	*Stylatula elongata*	—	1
Yellow gorgonian	*Acanthogorgia sp.*	8	—
Total		**62**	**98**
Number of species	Corals, Sponges, Pennatulids	*5*	*10*

			Density (count/100m²)					
West Santa Barbara Is. 17,900 m²	South Santa Barbara Is. 5,477 m²	Butterfly Bank 9,450 m²	*Total Observations*	Southeast Santa Rosa Is. 4,399 m²	Anacapa Deep Ridge 2,270 m²	West Santa Barbara Is. 17,900 m²	South Santa Barbara Is. 5,477 m²	Butterfly Bank 9,450 m²
27	21	—	122	1.61	0.13	0.15	0.38	—
2	—	—	3	—	0.04	0.01	—	—
—	—	—	3	0.07	—	—	—	—
—	—	8	8	—	—	—	—	0.08
—	—	—	12	0.20	0.13	—	—	—
6	—	1	35	0.41	0.44	0.03	—	0.01
—	—	2	2	—	—	—	—	0.02
52	—	—	71	—	0.84	0.29	—	—
—	—	—	1	0.02	—	—	—	—
—	—	—	2	0.05	—	—	—	—
10	3	—	15	—	0.09	0.06	0.05	—
38	7	3	58	0.14	0.18	0.21	0.13	0.03
—	—	—	1	0.02	—	—	—	—
135	**31**	**14**	**333**	**2.52**	**1.85**	**0.75**	**0.57**	**0.15**
West Santa Barbara Is. 11,635 m²	**South Santa Barbara Is. 3,560 m²**	**Butterfly Bank 6,322 m²**	***Total Observations***	**Southeast Santa Rosa Is. 2,860 m²**	**Anacapa Deep Ridge 1,476 m²**	**West Santa Barbara Is. 11,635 m²**	**South Santa Barbara Is. 3,560 m²**	**Butterfly Bank 6,322 m²**
19	5	—	34	—	0.68	0.16	0.14	—
9	3	6	25	—	0.47	0.08	0.08	0.09
552	—	—	556	—	0.27	4.74	—	—
1	1	—	2	—	—	0.01	0.03	—
4	20	13	37	—	—	0.03	0.56	0.21
1	—	—	1	—	—	0.01	—	—
1	—	—	1	—	—	0.01	—	—
111	15	94	266	0.28	2.57	0.95	0.42	1.49
—	—	—	7	0.24	—	—	—	—
66	7	56	132	—	0.20	0.57	0.20	0.89
202	20	13	241	0.21	—	1.74	0.56	0.21
3	—	—	3	—	—	0.03	—	—
27	1	403	431	—	—	0.23	0.03	6.37
—	—	633	633	—	—	—	—	10.01
44	—	—	44	—	—	0.38	—	—
724	105	1048	1929	1.15	1.29	6.22	2.95	16.58
1	—	3	4	—	—	0.01	—	0.05
—	1	29	40	—	0.68	—	0.03	0.46
2	—	—	7	—	0.34	0.02	—	—
—	—	14	14	—	—	—	—	0.22
167	6	39	213	—	0.07	1.44	0.17	0.62
7	—	—	8	—	0.07	0.06	—	—
146	3	1	158	0.28	—	1.25	0.08	0.02
2087	**187**	**2352**	**4786**	**2.17**	**6.64**	**17.94**	**5.25**	**37.20**
19	*12*	*13*	**23**					

Species observed		Counts	
Other Macro-Invertebrates		Southeast Santa Rosa Is.	Anacapa Deep Ridge
	Invert Transect Area:	2,860 m^2	1,476 m^2
Common Name	**Species Name**		
Basket star	*Gorgonocephalus eucnemis*	92	22
Benthic siphonophore	*Dromalia alexandri*	—	7
Brown box crab	*Lopholithodes foraminatus*	—	2
California king crab	*Paralithodes californiensis*	—	1
Cookie star	*Ceramaster patagonicus*	18	4
Crested sea star	*Lophaster furcilliger*	—	—
Cushion star	*Pteraster tesselatus*	—	—
Decorator crab	*Loxorhynchus crispatus*	—	—
Deep sea cucumber	*Pannychia moseleyi*	—	—
Fish eating star	*Stylasterias forreri*	5	—
Fragile pink urchin	*Strongylocentrotus fragilis*	1	2667
Henricia complex	*Henricia sp.*	17	1
Long legged sunflower star	*Rathbunaster californicus*	—	—
Pom-pom anemone	*Liponema brevicornis*	—	—
Red octopus	*Octopus rubescens*	—	—
Red sea star	*Mediaster aequalis*	10	—
Rose star	*Crossaster paposus*	—	—
Sand star	*Luidia foliolata*	1	—
Solaster sun star complex	*Solaster sp.*	—	—
Spiny red star	*Hippasteria spinosa*	1	—
Spiny/thorny star complex	*Poraniopsis inflata* or *Hippasteria spinosa*	—	—
Spot prawn	*Pandalus platyceros*	—	16
Squat lobster	*Munida quadrispina*	—	65
Thorny sea star	*Poraniopsis inflata*	—	—
UI anemone	Unidentified Actiniaria	—	—
UI anemone 1	Unidentified Actiniaria	—	—
UI anemone 2	Unidentified Actiniaria	—	—
UI anemone 4	Unidentified Actiniaria	—	6
UI nudibranch	Unidentified Nudibranchia	—	1
UI octopus	Unidentified Octopodidae	—	—
UI prawn	Unidentified Decapoda	—	—
UI sand dwelling anemone	Unidentified Actiniaria	2	—
UI sea star	Unidentified Asteroidea	9	1
UI thin red star	Unidentified Asteroidea	1	1
UI tubeworm	Unidentified Annelida	10	—
UI urchin	Unidentified Echinoidea	—	—
White slipper sea cucumber	*Pusolus sp.*	3	2
White spine sea cucumber	*Parastichopus leukothele*	4	—
White-plumed anemone	*Metridium farcimen*	1	—
Total		**175**	**2796**

			Density (count/100m²)					
West Santa Barbara Is. 11,635 m²	South Santa Barbara Is. 3,560 m²	Butterfly Bank 6,322 m²	*Total Observations*	Southeast Santa Rosa Is. 2,860 m²	Anacapa Deep Ridge 1,476 m²	West Santa Barbara Is. 11,635 m²	South Santa Barbara Is. 3,560 m²	Butterfly Bank 6,322 m²
272	4	63	453	3.22	1.49	2.34	0.11	1.00
7	8	3	25	—	0.47	0.06	0.22	0.05
—	—	—	2	—	0.14	—	—	—
10	2	—	13	—	0.07	0.09	0.06	—
36	34	16	108	0.63	0.27	0.31	0.96	0.25
6	—	2	8	—	—	0.05	—	0.03
1	—	—	1	—	—	0.01	—	—
2	—	—	2	—	—	0.02	—	—
17	—	4	21	—	—	0.15	—	0.06
2	14	3	24	0.17	—	0.02	0.39	0.05
424	285	26	3403	0.03	180.69	3.64	8.01	0.41
26	8	15	67	0.59	0.07	0.22	0.22	0.24
249	21	38	308	—	—	2.14	0.59	0.60
7	4	2	13	—	—	0.06	0.11	0.03
1	—	—	1	—	—	0.01	—	—
1	7	—	18	0.35	—	0.01	0.20	—
1	—	—	1	—	—	0.01	—	—
—	—	—	1	0.03	—	—	—	—
3	—	3	6	—	—	0.03	—	0.05
6	2	10	19	0.03	—	0.05	0.06	0.16
3	—	—	3	—	—	0.03	—	—
2	1	—	19	—	1.08	0.02	0.03	—
672	544	1351	2632	—	4.40	5.78	15.28	21.37
2	14	—	16	—	—	0.02	0.39	—
10	1	6	17	—	—	0.09	0.03	0.09
1	—	—	1	—	—	0.01	—	—
10	3	1	14	—	—	0.09	0.08	0.02
49	4	8	67	—	0.41	0.42	0.11	0.13
—	—	—	1	—	0.07	—	—	—
3	—	2	5	—	—	0.03	—	0.03
—	—	10	10	—	—	—	—	0.16
2	—	—	4	0.07	—	0.02	—	—
27	15	18	70	0.31	0.07	0.23	0.42	0.28
—	—	57	59	0.03	0.07	—	—	0.90
21	22	11	64	0.35	—	0.18	0.62	0.17
1	—	—	1	—	—	0.01	—	—
318	6	1079	1408	0.10	0.14	2.73	0.17	17.07
264	3	63	334	0.14	—	2.27	0.08	1.00
—	—	—	1	0.03	—	—	—	—
2456	**1002**	**2791**	**9220**	**6.12**	**189.43**	**21.11**	**28.15**	**44.15**



Oceana is the largest international advocacy organization dedicated solely to ocean conservation. Oceana is rebuilding abundant and biodiverse oceans by winning science-based policies in countries that control one third of the world's wild fish catch. With over 100 victories that stop overfishing, habitat destruction, pollution and killing of threatened species like turtles and sharks, Oceana's campaigns are delivering results. A restored ocean means that one billion people can enjoy a healthy seafood meal, every day, forever. Together, we can save the oceans and help feed the world.

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A black Christmas tree coral (*Antipathes sp.*) observed on the Oceana Southern California Bight Expedition.