North Central California Coast Marine Protected Areas Baseline Characterization and Monitoring of Mid-Depth Rock and Soft-Bottom Ecosystems (20 – 116 m)

Final Report to California Sea Grant

Project # R/MPA-8; Grant Number: 09-015

25 February 2014

Submitted by:

James Lindholm - Institute for Applied Marine Ecology at California State University Monterey Bay
Jessica Flower Moye - Institute for Applied Marine Ecology at California State University Monterey Bay
Donna Kline - Institute for Applied Marine Ecology at California State University Monterey Bay
Heather Kelley- Institute for Applied Marine Ecology at California State University Monterey Bay
Dirk Rosen - Marine Applied Research and Exploration

Acknowledgements

Generous support for this research provided by:

California Ocean Protection Council
California Sea Grant (Project No. R/MPA-8; JBL Award No. 09-015)
California MPA Monitoring Enterprise
National Park Service (Project No. R/CESUMPA-20; JBL Grant Number: J8C07110002)
Undergraduate Research Opportunities Center at California State University Monterey Bay
James W. Rote Professorship of Marine Science and Policy at CSU, Monterey Bay
Unspecified donors to Marine Applied Research and Exploration
MPA Monitoring Enterprise
Campbell Foundation
Firedoll Foundation, Dirk and Charlene
Kabcenell Foundation
Larry L. Hillblom Foundation
Hobson Family Foundation
Springcreek Foundation
The Nature Conservancy
F/V *Donna Kathleen* and the Maricich Family
Jeffrey Kline Family
David and Lucile Packard Foundation

Key field and lab support:

Adam Alfasso, Patricia Chang-Terry, Megan Bassett, Chris Carpenter, AJ Cecchettini, Allison N. Cramer, Christian Denney, Nick Donlou, Bryon Downey, Molly Fredle, Steve Holz, David Jeffrey, Matthew Jew, Heather Kelley, Ashley Knight, Andy Lauermann, Andrea Launer, Bob Lea, Stephen Loiacono, Elizabeth Ramsay, AJ Reiter, Carley Turner, Jessica Watson, Yuko Yokozawa

Key Partnerships:

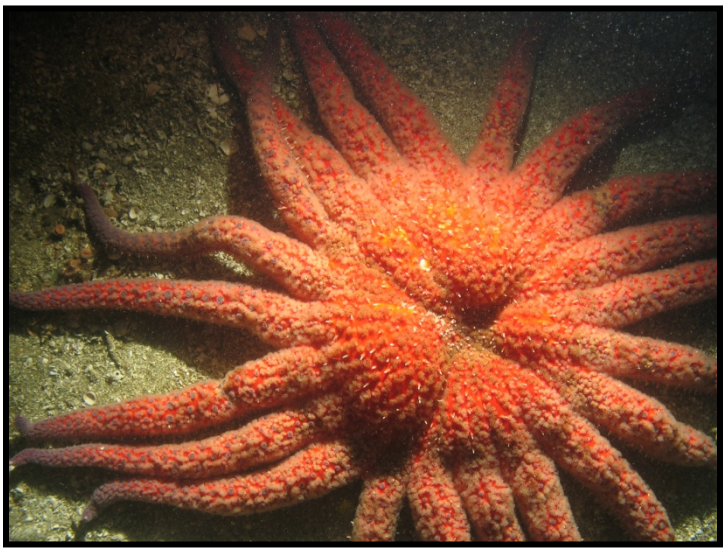
Dr. Mary Gleason - The Nature Conservancy - California Marine Program
Dr. William Head and Jessica Brown - Undergraduate Research Opportunities Center at California State University Monterey Bay
Local fishermen – Tim Maricich and the crew of the F/V *Donna Kathleen*
UC Davis, Bodega Marine Laboratory and Bodega Marine Reserve
Bodega Bay Harbormaster
Pillar Point Harbormaster
Point Arena Harbormaster

.

Table of Contents

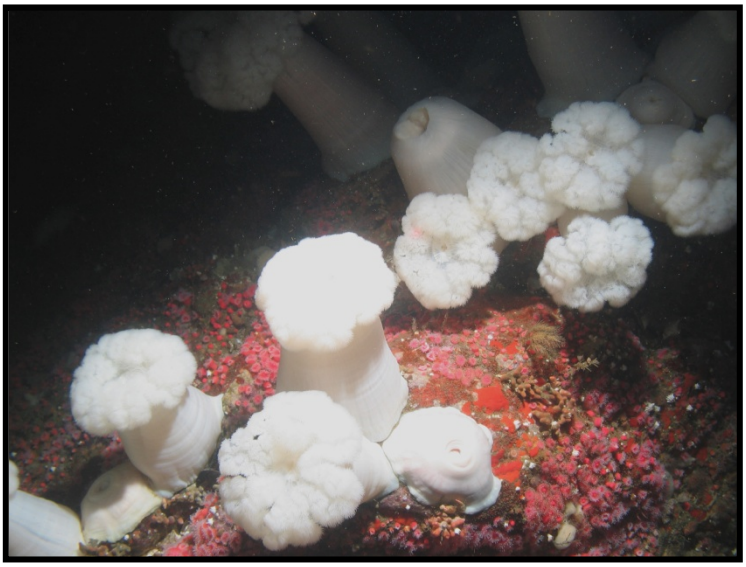
Executive Summary

Objectives - This report summarizes the results of a multi-year study (April 2010 – April 2013) to characterize deep benthic rock and soft-bottom communities (20 -116 m) in the California Marine Life Protection Act's North Central Coast (NCC) Study Region. Our specific objective was to characterize the seafloor habitats and associated biological communities within and adjacent to the State Marine Reserves (SMRs) and Conservation Areas (SMCAs) at the time of implementation.



Study Sites - Four locations were selected to broadly represent the distinct biogeographic zones within the NCC region (listed from north to south): 1) Point Arena SMR and SMCA, 2) Bodega Head SMR and SMCA, 3) Southeast Farallon Island SMR and SMCA, and 4) Montara SMR and Pillar Point SMCA (Fig. 1). The SMR and SMCA at Point Reyes were added as a fifth location in Year 2 with separate funding from the National Park Service.

The NCC Region encompasses a linear coastline of 763 kilometers ranging from Alder Creek near Point Arena south to Pigeon Point, and extending from the high tide line to three nautical miles off shore. An additional 151 square kilometers of state waters are found surrounding the Farallon Islands, located approximately 45 kilometers off shore of the San Francisco Bay.



While much of the seafloor in the region is comprised of unconsolidated sediments (sand or mud), there are also rocky reefs, pinnacles, and outcrops located throughout. The region falls within the California Current Large Marine Ecosystem and includes a persistent upwelling center at Point Arena, the outflow of the largest estuary on the West Coast (San Francisco Bay), as well as the highly productive and biologically rich Gulf of the Farallones.

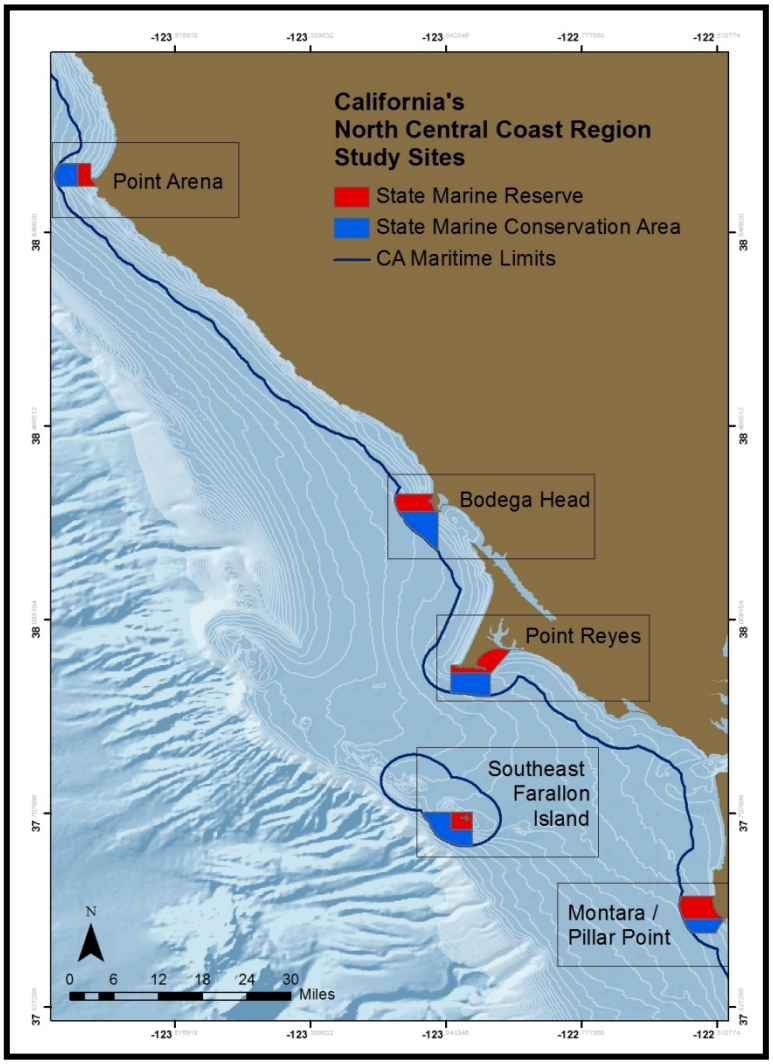


Figure 1. Map of the North Central Coast Study Region including the State Marine Reserves (Red) and Conservation Areas (Blue).

Results - Our approach to characterization involved the collection of videographic and still photographic imagery at each location using a remotely operated vehicle (ROV). Data extracted from this permanent image archive were used to summarize the ecological conditions inside SMRs and SMCAs, and at comparable sites distant from both, over a one-year baseline from July 2010 – August 2011. During that baseline period we conducted a total of 82 ROV transects across the five geographic locations, totaling 21,444 still photographs and over 154 hours each of forward and downward video. We observed a total of 8,405 fish across habitats ranging from unconsolidated sediments to rocky reefs, and the transitional areas in between. At the northernmost site (Point Arena), Kelp Greenlings were the most abundant of the 810 fish we observed there, though sampling was constrained by weather in both 2010 and 2011. In the south (Pillar Point), Lingcod dominated the 665 fish observed there despite very challenging visibility. We observed the most fish (3,009) at the Southeast Farralon Islands, where visibility was generally excellent and Rosy Rockfish were the most numerous. We also observed thousands of invertebrates, both mobile and sessile, across the study area.

Anticipating the challenge of sustaining a long-term monitoring effort well beyond the baseline provided here, we propose the following list of species/taxonomic groups for inclusion in a video-based monitoring program:

Fishes – Vermilion Rockfish
Lingcod
Sebastomus Rockfishes
Canary Rockfish
Olive/Yellowtail Rockfishes
Blue Rockfish
Kelp Greenling

Invertebrates – Dungeness Crab
Red Rock Crab
Metridium
Red Gorgonian
Sea Whip/Pen

The list is a first pass at a group of species and species complexes, including fishes as well as mobile and sessile invertebrates, which are capable of being monitored using videographic techniques and were observed during the baseline characterization effort in the North Central Coast. While we expect that many scientists could reach agreement on some of the organisms on this list, it is also likely that much discussion could be engendered to flesh this group out further. What we provide here is intended as a point of departure for discussion as each of the MLPA regions moves beyond baseline characterization.

Final Thoughts - Participants in the project represented a broad collaborative partnership among academia, non-profits, state and federal agencies, and members of the fishing community, constituents that have not always collaborated effectively. All project imagery resides at the Institute for Applied Marine Ecology at California State University Monterey Bay (CSUMB) and at Marine Applied Research and Exploration (MARE). All baseline data collected as part of this project has been uploaded to the MPA Monitoring Enterprise's *Ocean Spaces* website. Multiple on-going analyses are drawing on the project data to explore the distributions and habitat associations of many key taxa.

Methods

Underwater surveys were conducted at each location within the NCC Region using the Vector M4 ROV *Beagle* (owned by The Nature Conservancy and operated by MARE onboard F/V *Donna Kathleen* (Fig. 2). The ROV configuration and sampling protocol were based on previous and on-going studies conducted by the PIs (Lindholm et al. 2004; de Marignac et al. 2009; Tamsett et al. 2010).

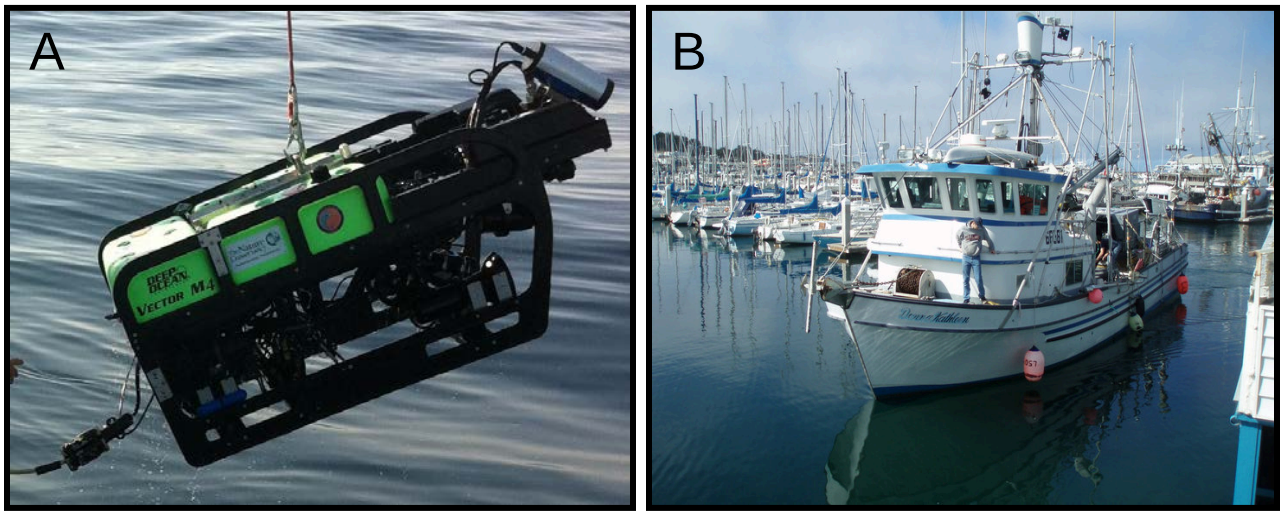
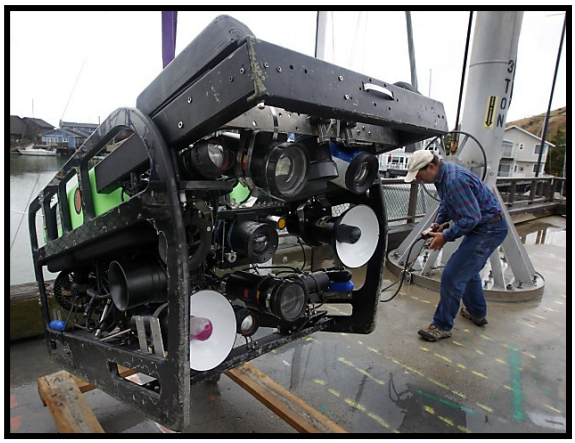


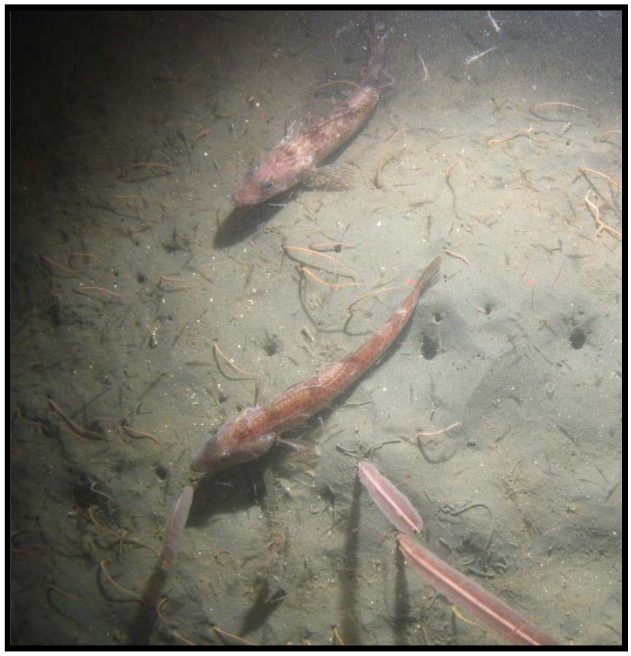
Figure 2. (A) The Vector M4 ROV *Beagle* (B) F/V *Donna Kathleen* served as the support vessel for ROV operations.

The ROV was equipped with five geo-referenced cameras (forward-looking video and HD, down-looking video and digital still, and rear facing video), two Quartz halogen and HMI lights, paired forward- and down-looking lasers, and a strobe for still photos. The ROV was also equipped with an altimeter, forward-facing multibeam sonar, and a CTD. The position of the ROV on the seafloor was maintained by the Trackpoint III® acoustic positioning system with the resulting coordinates logged into Hypack® navigational software. The ROV was 'flown' over the seafloor at a mean altitude of 0.2 m and a speed of approximately 0.6 knots.



Sampling effort was based on relatively long ROV transects distributed across a study site. The distribution of transects was stratified in order to encompass both sedimentary and hard substrate environments and the transitional areas in between. Transect length depended on local conditions and the extent of substrate coverage in the study area, but generally exceeded 1 km.

Continuous video imagery was recorded from forward- and down-looking cameras to digital tape. Forward video was used for data extraction, while down video was used to assist with positive identification of selected fishes and invertebrates. All observations were collected from non-overlapping forward-facing video frames, including species name and number observed, recorded directly into a Microsoft Access database. Fish, mobile invertebrates, and structure-forming invertebrates greater than 10 cm in height were recorded to ensure accurate identification in almost any conditions (e.g. extreme turbidity or current). Paired lasers were placed as close as possible to the organism(s) being recorded for size and geo-referenced location. Organism sizes were estimated to the nearest 5 cm using the paired lasers spaced 10 centimeters apart as a reference.



Identification quality was assessed on a scale from one to five, and represented a measure of confidence for fish observations (one was uncertain and five was certain). Fish identification was confirmed where possible with colleagues and experts on California fishes (primarily Dr. Bob Lea, former CDFW fishery biologist) to ensure data accuracy. Structure-forming invertebrates were defined as organisms present above the substrate that are greater than 10 centimeters in height.

Patch-scale habitat and associated fine-scale habitat directly below fishes was recorded from non-overlapping forward-facing video frames. A habitat patch was defined as continuous, uniform substrate for at least 10 seconds (approximately 2.57 meters, speed was approximately 0.6 knots = 0.2572 meters/seconds) of forward travel in video. Habitat was classified by substrate type, i.e. continuous rock (R), boulder (B), cobble (C) and sand (S) (Tissot et al. 2006; Table 1). A two character code represented primary (50%) and secondary (20%) habitat type at the patch scale and fine scale. For example at the fine scale, if a video frame consisted of 75% continuous rock and 25% sand, the character code was "RS". Relief adjacent to all fishes was classified as flat, crested, degraded crest, low, moderate and high (Greene et al. 1999). Habitat features such as mounds and depressions greater than 10 centimeters in length were also recorded.

Table 1. Substrate type and relief criteria for all habitat types.

Substrate Type	**Criteria**
Continuous Rock (R)	Outcropping or bed of solid rock
Large Rock/Boulder (B)	≥ 20 cm loose, individually distinguishable rocks. These are not connected to ridges. Isolated, and may show evidence or rolling
Small Rock/Cobble (C)	< 20 cm loose, individually distinguishable rocks
Sand (S)	Unconsolidated, small particle size
Substrate Relief	**Criteria**
High	> 2 m vertical relief
Moderate	1-2 m vertical relief
Low	10 cm (laser separation width) -1 m vertical relief
Flat	featureless sand or flat rock
Crested	<10 cm sand waves and/or ripples with defined crests
Degraded Crest	<10 cm sand waves and/or ripples with rounded or degraded crests

Still images provided an opportunity to positively identify fish and invertebrates that were frequently not possible from video alone. Still images were collected manually along each transect at approximately 1-minute

intervals, and more frequently when sudden changes in altitude prevented good photographic coverage. Additional still images were also collected where necessary to document organismal diversity, debris etc.

Fish, mobile invertebrates, sessile invertebrates and habitat coverage were recorded for each still image directly into an *Access* database structure. Each still photograph covered an area of approximately 0.40 m^2 at an altitude of 0.8 meters above the seafloor. Paired parallel lasers were used to indicate a consistent reference for still photographs (to maintain constancy in area of coverage for each image) and to size individual organisms where desired. Still images were processed in *Adobe Photoshop*, overlaid with a 10 x 10 grid so that each cell represented1% of the total image.

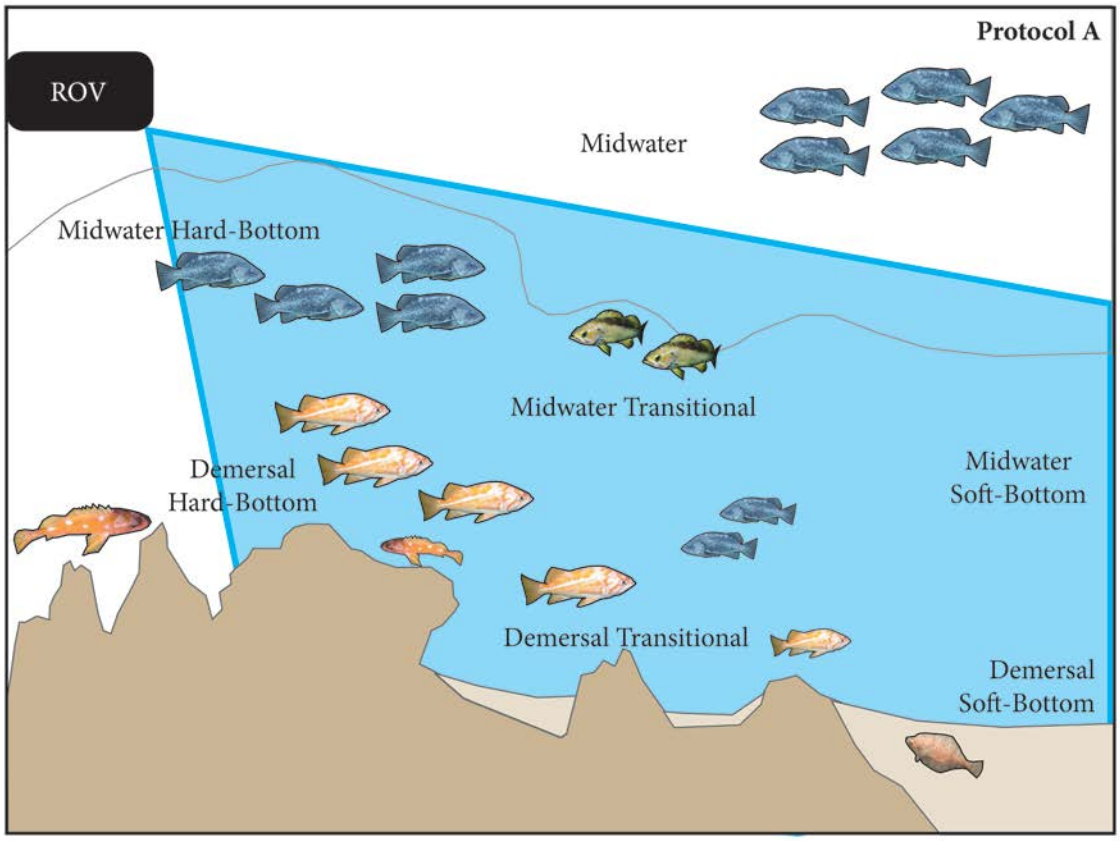


Figure 3. Idealized depiction of fishes and habitats sampled by the ROV.

Only fish with greater than 50% of their body in the image were recorded. Sessile invertebrates were recorded as biogenic structure low or high depending on whether they were less than or greater than 10 centimeters in

height, respectively. Habitat coverage was recorded as the number of visible cells in which the substrate occurred using the criteria from Table 1.

As this was a baseline characterization effort rather than a hypothesis driven research project, we sought to let the data drive the scale of the analyses rather than constraining the analyses to our *a priori* understanding of a particular species' distribution. For on-going analyses of project data (summarized in a separate section below), sub-sampling of transect data occurred post hoc for selected species or taxonomic groups based on their distribution and considering the extent to which spatial autocorrelation influenced the data (Hallenbeck et al. 2012). Consequently, the number of replicates for each analysis depended on the size of the sampling units identified post hoc within known habitat and depth zones.

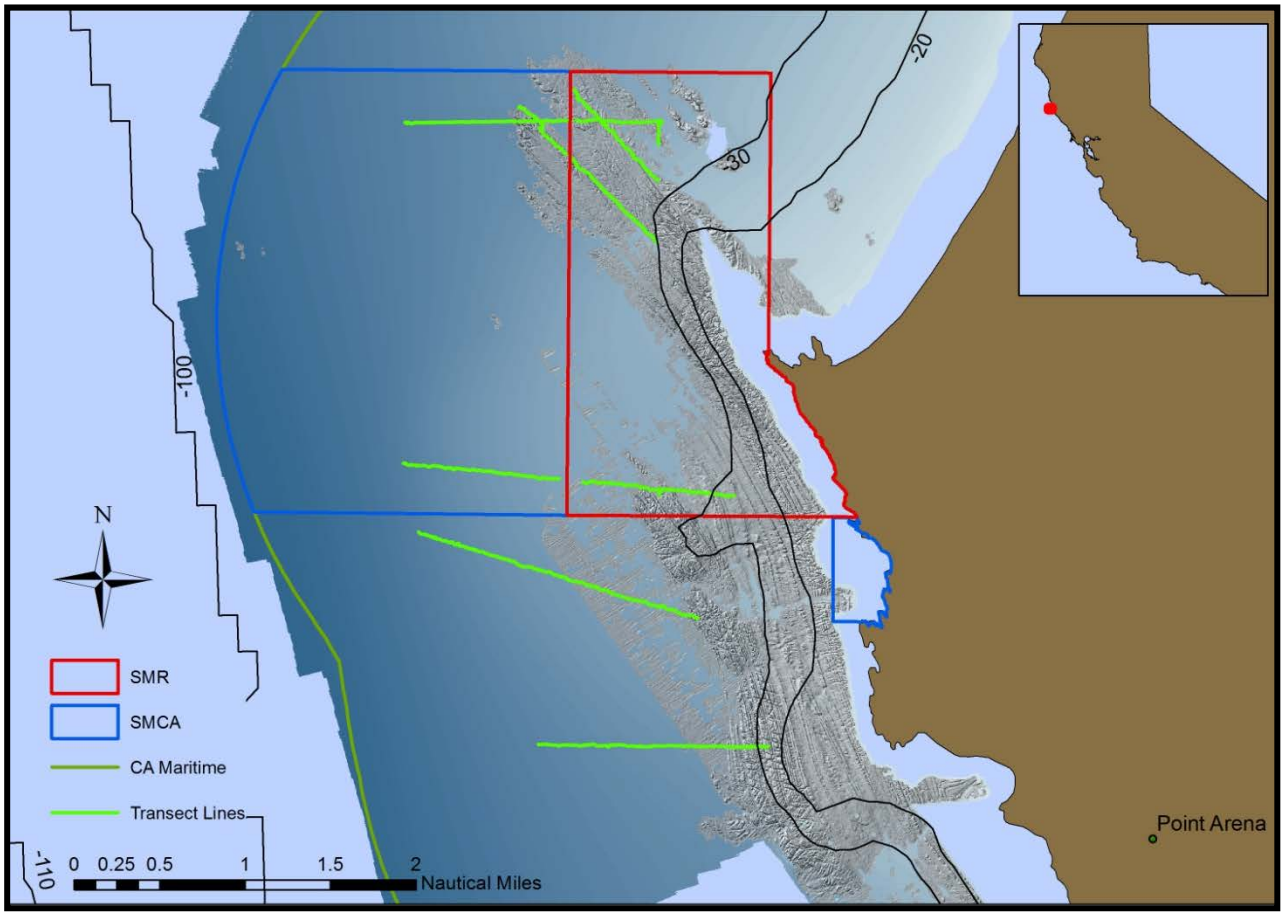


Figure 4. Map of ROV transects conducted at Point Arena, including MPA boundaries, 20 and 30 meter isobaths, and sun-illuminated topographic map of the seafloor.

Classification of Seafloor Habitats - Habitat types were classified at each site using both sun-illuminated topographic maps created as part of the California State Mapping Project and additional data extracted from down-looking video imagery from the ROV. Habitat polygons were created in ArcGIS to capture habitats both within each MPA as well as areas adjacent to the MPAs. At Point Arena they were classified as *Hard* (38% of the total area surveyed), which included large boulders, moderate rocky outcrops, and some cobbles; *Mixed* (9% of the total area surveyed), including a combination of unconsolidated soft sediments with boulder, cobbles, or rock; and *Soft* sediment (53% of the total area surveyed; Fig. 5).

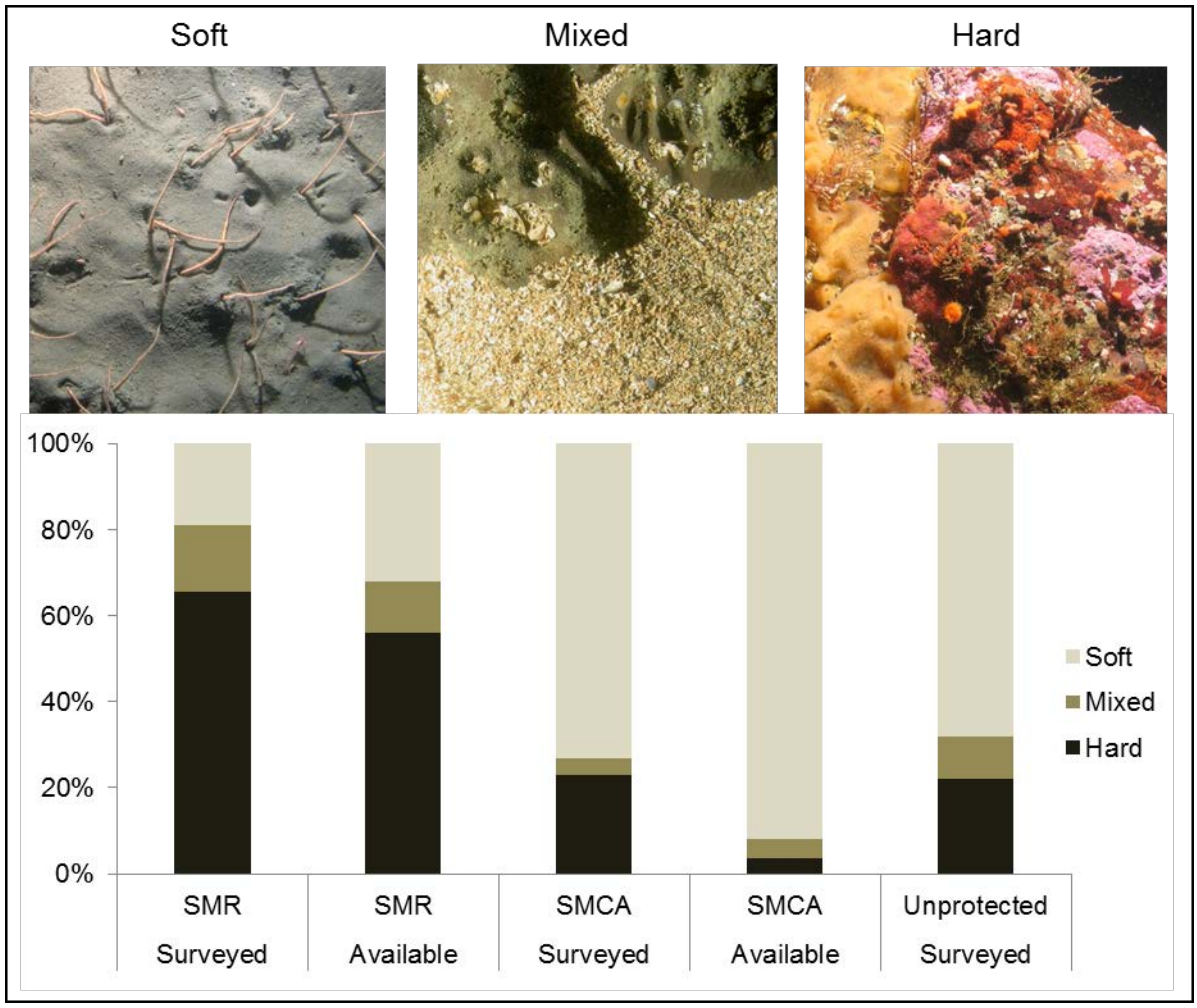


Figure 5. Substrate categories for Point Arena, including the percentage of each broad substrate type surveyed by the ROV (Soft, Mixed, Hard) and the total amount of each available inside the SMR, the SMCA, and at the unprotected reference sites.

Fishes at Point Arena

A total of 810 individual fish were observed at Point Arena across 26 species, species groups, or morphological categories (Table 2). Counts of fishes identified to species ranged from a low of 1 fish (Brown Rockfish) to a high of 157 fish (Kelp Greenling). Flatfishes were abundant in the area but visibility limited our ability to identify most individuals beyond morphology.

Table 2. Count, relative abundance, density, and size frequency for observed fishes at Point Arena. Primary (******) and secondary (*****) species requested in NCC Monitoring Plan.

Point Arena Fishes	Count	Relative Abundance	Density ($x10^{-4}$ m^2 ± 1SD)	Size frequency				
				10-20cm	20-30cm	30-40cm	40-50cm	+50 cm
Species								
Black Rockfish *	3	0.004	0.07 ± 0.16	0.33	0.33	0.33	-	-
Blue Rockfish *	50	0.062	1.16 ± 1.65	0.48	0.50	0.02	-	-
Brown Rockfish *	1	0.001	0.01 ± 0.04	-	1	-	-	-
Canary Rockfish *	43	0.053	1.31 ± 1.53	0.51	0.42	0.07	-	-
China Rockfish *	11	0.014	0.30 ± 0.34	-	0.82	0.18	-	-
Copper Rockfish *	14	0.017	0.41 ± 0.41	-	0.29	0.57	0.14	-
Gopher Rockfish *	6	0.007	0.09 ± 0.19	-	0.83	0.17	-	-
Halfbanded Rockfish *	-	-	-	-	-	-	-	-
Quillback Rockfish *	9	0.011	0.40 ± 0.80	0.11	0.44	0.44	-	-
Rosy Rockfish *	3	0.004	0.15 ± 0.49	0.67	0.33	-	-	-
Vermilion Rockfish **	21	0.026	0.80 ± 1.59	0.05	0.24	0.38	0.33	-
Yelloweye Rockfish **	4	0.005	0.16 ± 0.21	0.25	-	0.25	0.50	-
Cabezon	3	0.004	0.10 ± 0.33	-	-	0.67	-	-
Eelpout	2	0.002	0.10 ± 0.33	1	-	-	-	-
Kelp Greenling	158	0.196	5.11 ± 5.79	0.13	0.65	0.21	0.01	-
Lingcod **	47	0.058	1.45 ± 1.43	0.26	0.34	0.21	0.02	0.15
Longspine Combfish	-	-	-	-	-	-	-	-
North Pacific Argentine	-	-	-	-	-	-	-	-
Painted Greenling	-	-	-	-	-	-	-	-
Pink Seaperch	-	-	-	-	-	-	-	-
Poacher	-	-	-	-	-	-	-	-
Ronquil	1	0.001	0.03 ± 0.11	1	-	-	-	-
Sculpin	4	0.005	0.10 ± 0.16	0.75	-	-	-	-
Starry Skate	-	-	-	-	-	-	-	-
English Sole *	2	0.002	0.05 ± 0.10	0.50	0.50	-	-	-
Pacific Halibut *	-	-	-	-	-	-	-	-
Pacific Sanddab *	1	0.001	0.03 ± 0.08	1	-	-	-	-
Petrale Sole *	-	-	-	-	-	-	-	-
Rex Sole *	-	-	-	-	-	-	-	-
Slender Sole *	-	-	-	-	-	-	-	-
Speckled Sanddab *	-	-	-	-	-	-	-	-
Starry Flounder **	-	-	-	-	-	-	-	-
Species Complex								
Olive/Yellowtail complex*	36	0.045	1.31 ± 2.08	0.89	0.11	-	-	-
Vermilion/Canary/ Yelloweye complex *	8	0.010	0.32 ± 0.52	0.13	0.25	0.25	0.38	-
Sebastomus **	9	0.40	8.02 ± 0.97	0.56	0.11	0.11	-	-
Other								
Pleuronectiformes *	131	0.162	3.07 ± 4.13	0.90	0.09	-	-	-
Sebastes spp. *	104	0.129	2.77 ± 3.99	0.57	0.13	0.05	-	-
Unidentified fishes	136	0.169	3.59 ± 2.28	0.78	0.06	0.01	0.02	0.01

Fishes in Mid-Depth Rock and Soft Bottom Ecosystems

The majority of fishes found over hard substrates at Point Arena were Rockfishes (*Sebastes spp.*) and Roundfishes (Fig. 6). The Roundfishes and Other Fishes categories were broad categories used to bin organisms that were observed, but not identified, usually due to poor visibility. Roundfishes included all non-flat fishes that were not identifiable further, while Other Fishes was even more general and could include any species of fish found in the area. In the soft substrate, Flatfishes comprised approximately 50% of the fish observations.

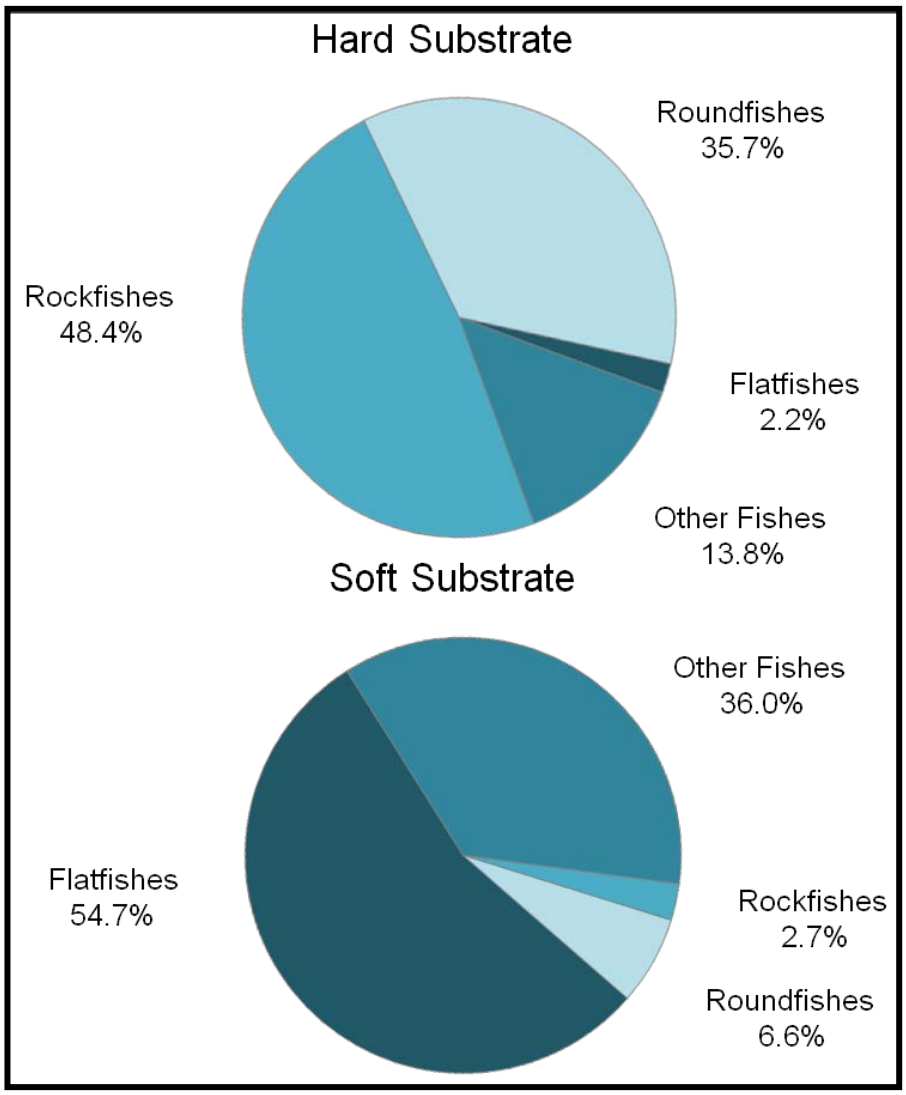


Figure 6. The fish observed at Point Arena expressed as a percentage of the major categories of fishes found over Hard Substrate (top) and Soft Substrate (bottom).

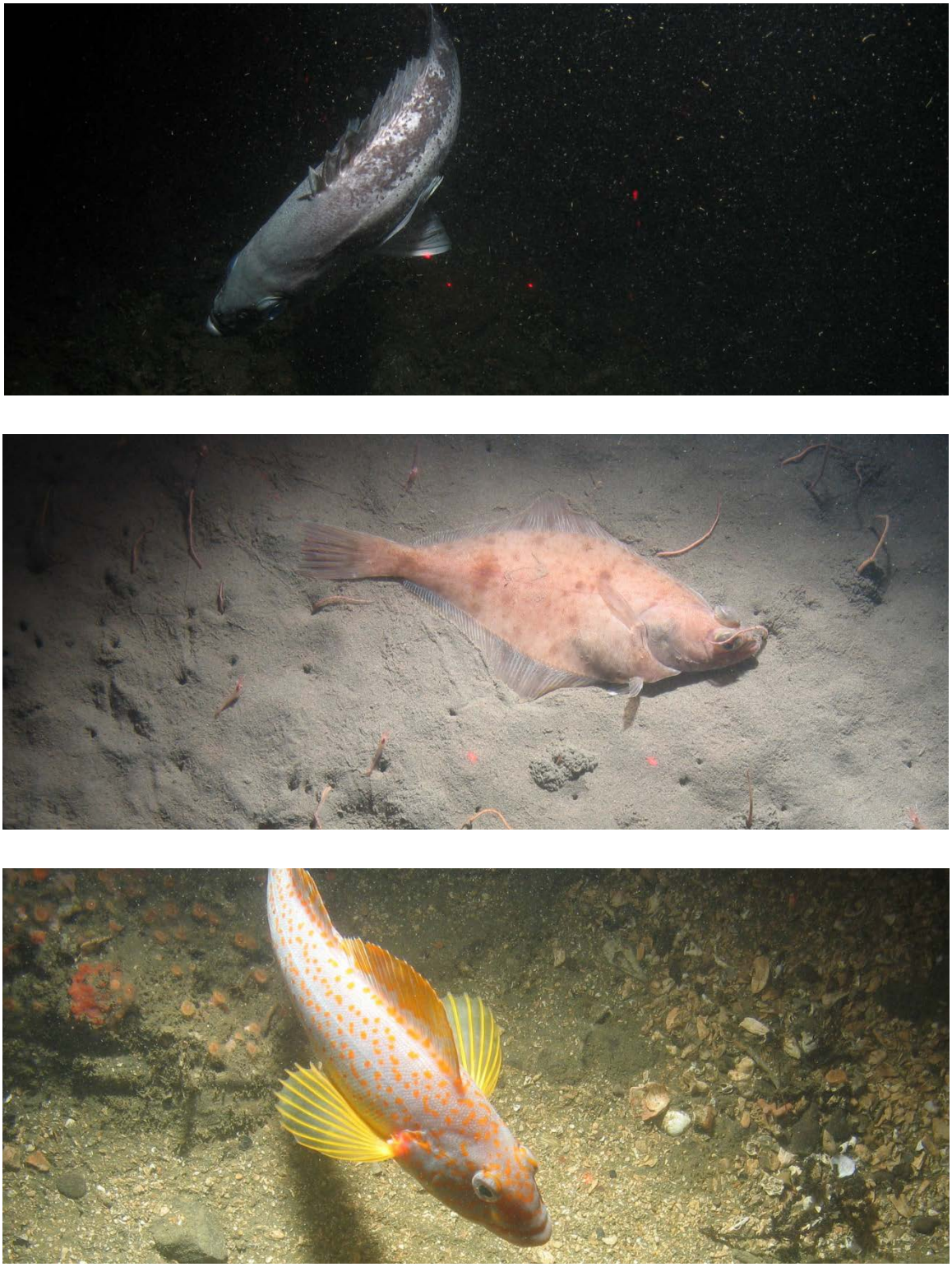


Figure 7. Fishes of Point Arena occurring over hard substrates (top, Black Rockfish), soft substrates (middle, English Sole), and mixed substrates (bottom, female Kelp Greenling).

Mobile Invertebrates in Mid-Depth Rock and Soft Bottom Ecosystems

Sea Cucumbers and Sea Stars made up the majority of mobile invertebrates found over hard substrates of the Point Arena study sites (Fig. 8). Zero crabs were observed over hard substrates in these areas. Within soft substrates, Sea Stars occurred more than any other invertebrate (over 85% of observations). Dungeness Crabs accounted for only 6% of the observations over soft substrate.

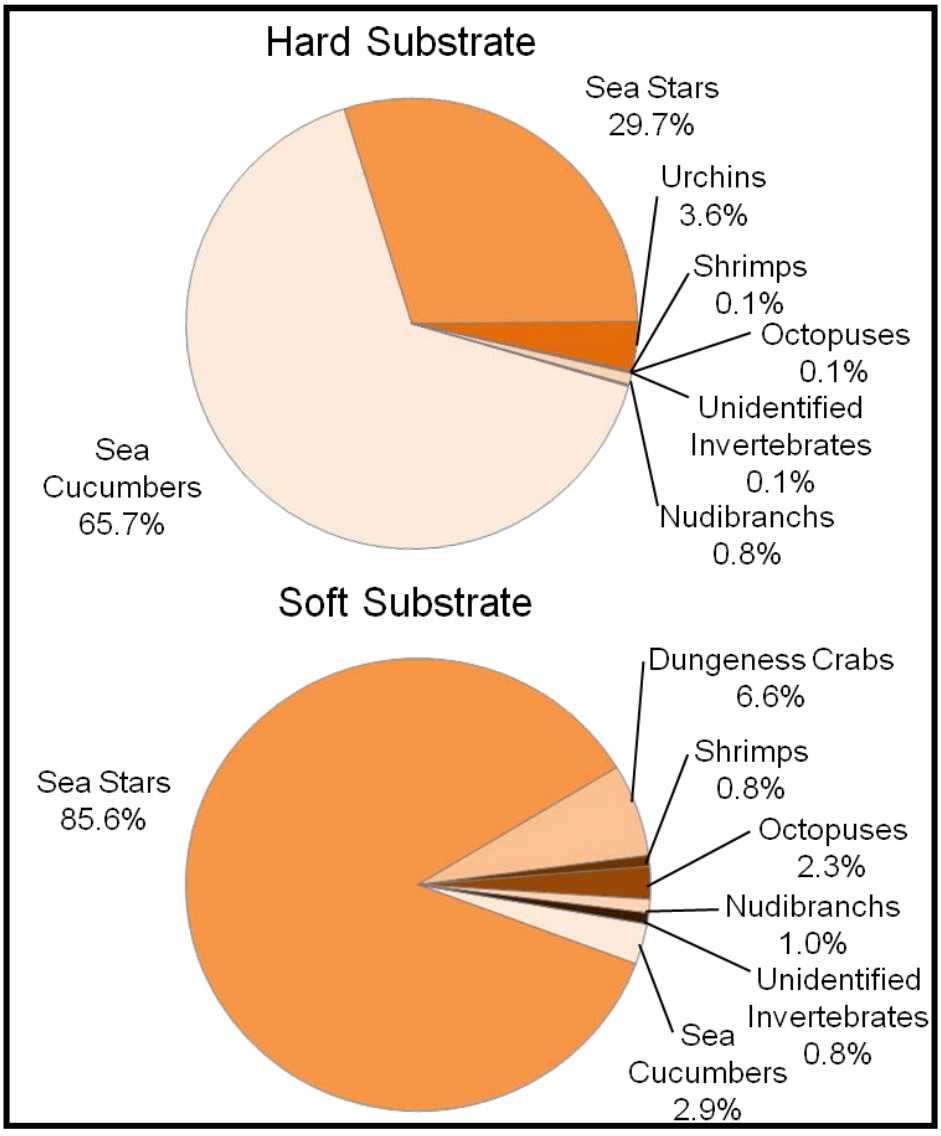


Figure 8. Mobile invertebrates observed at Point Arena expressed as a percentage of the major categories of fishes found over Hard Substrate (top) and Soft Substrate (bottom).

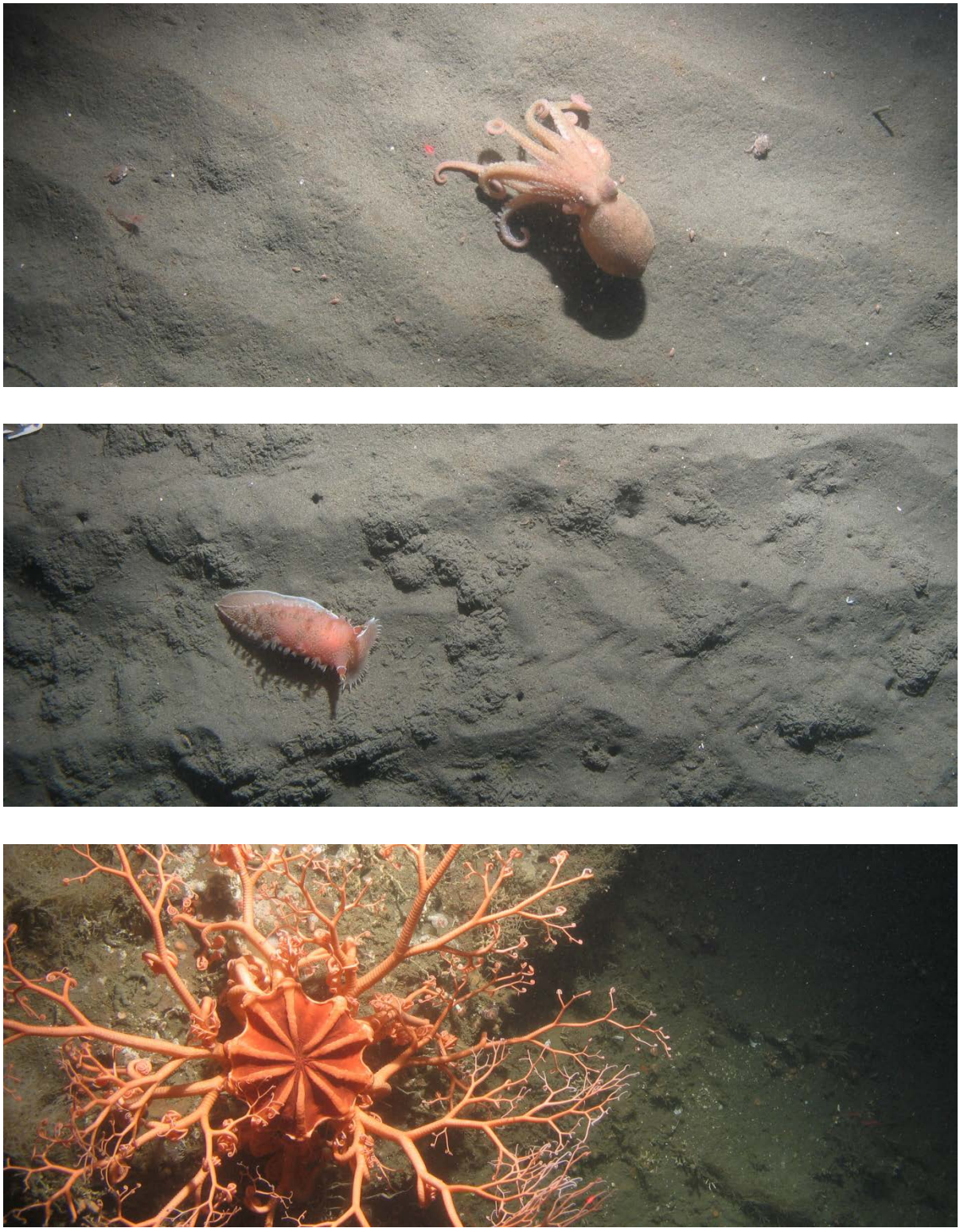


Figure 9. Mobile invertebrates observed in Point Arena over soft substrate (top, Octopus; middle, Nudibranch) and hard substrate (bottom, Basket Star).

Structure-Forming Invertebrates in Mid-Depth Rock and Soft Bottom Ecosystems

Metridium (~ 66%) and Gorgonians (~ 21%) comprised the majority of structure-forming invertebrates observed over hard substrate at Point Arena (Fig. 10). Over soft substrate, Orange Sea Pens totaled 49% of the observations, which is approximately 250% higher than their occurrence at any other location in the study region.

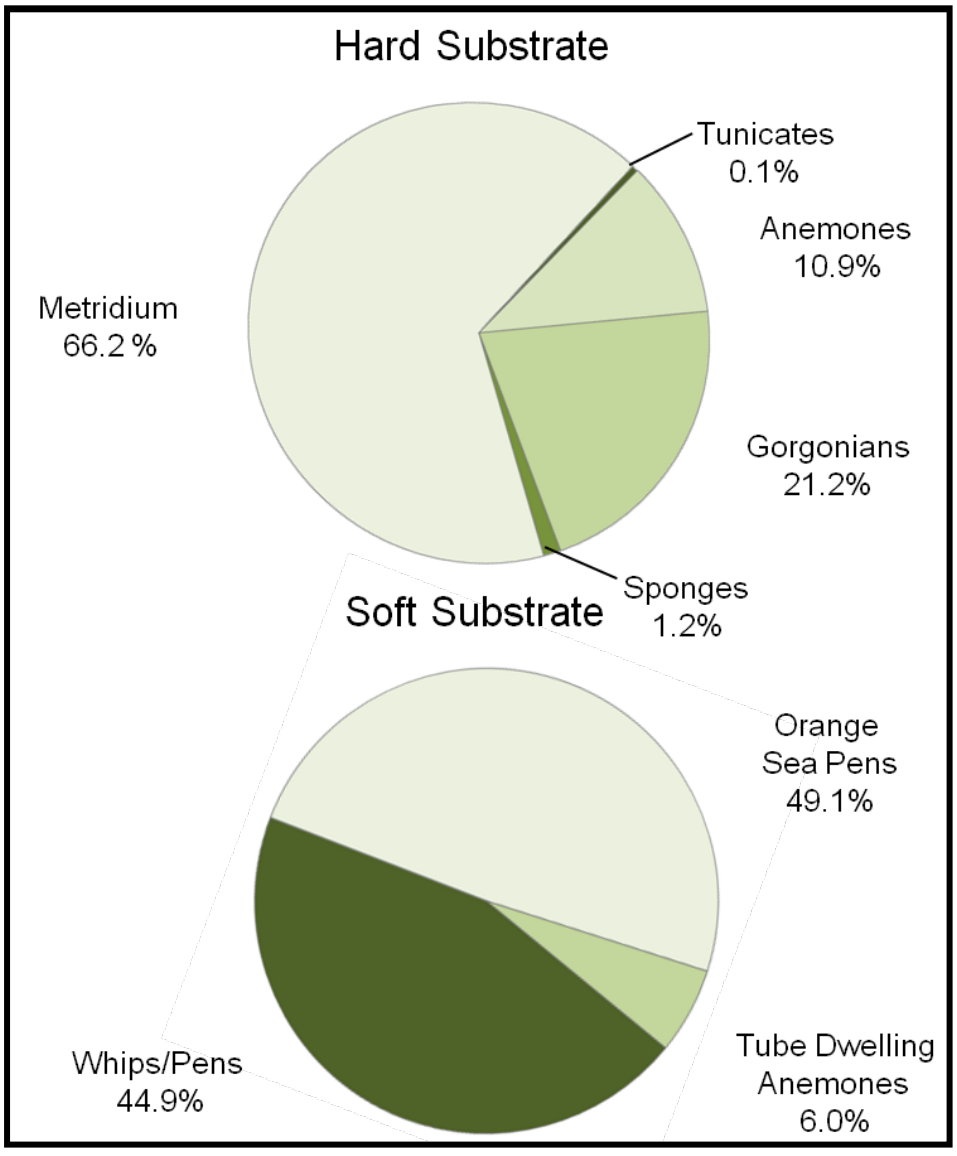


Figure 10. Structure-forming invertebrates observed at Point Arena expressed as a percentage of the major categories of fishes found over Hard Substrate (top) and Soft Substrate (bottom).

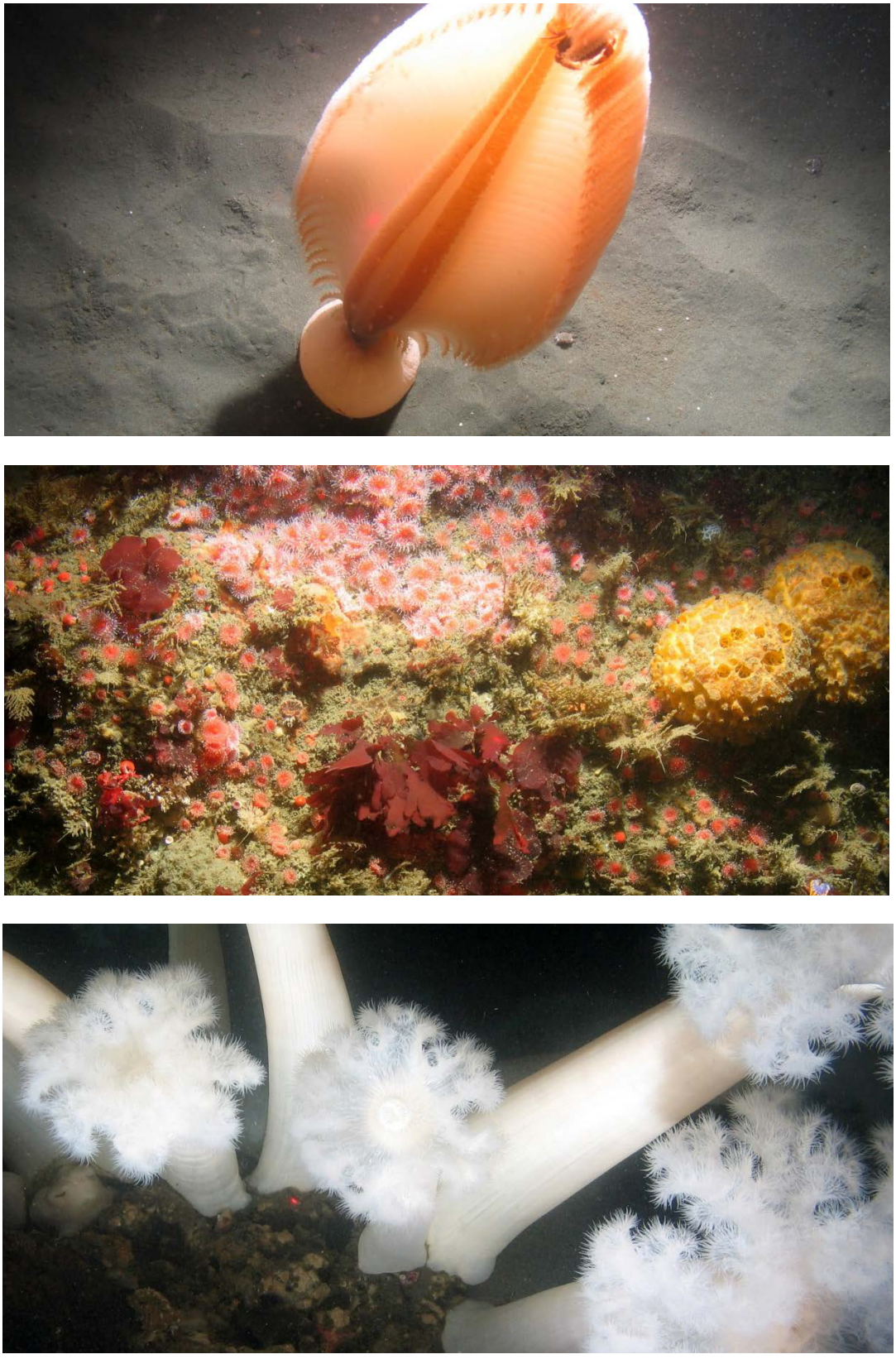


Figure 11. Sessile invertebrates occurring at Point Arena over soft substrate (top, Orange Sea Pen) and hard substrates (middle, Strawberry Anemones and Orange Puffball Sponge; bottom, Metridium).

Fish and Invertebrate Associations with the Seafloor

Summary data from 2011 indicate that overall, fishes were observed in low numbers, most occurring as individuals over all substrate types. Epibenthic fishes were most commonly observed over mixed substrate, especially those that were combined rock or boulder and sand – transitional areas between hard and soft sediments. Benthic fishes were observed on all substrate types primarily singularly and flatfishes were observed strictly on sand. Both mobile and sessile invertebrates occurred over all substrates but were represented by different species in different habitats.

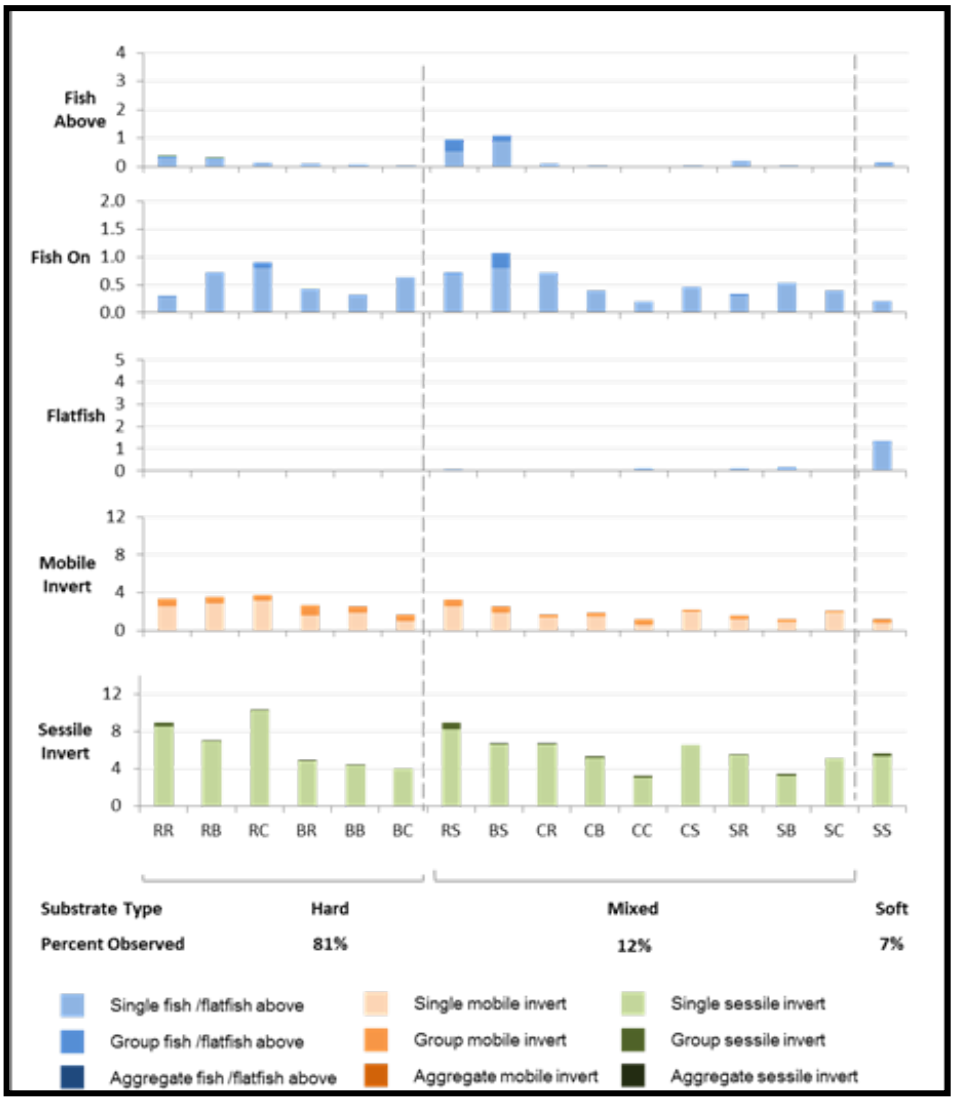


Figure 12. Fishes, mobile invertebrates, and sessile invertebrates at Point Arena expressed as a percentage of all observations over Hard, Mixed, and Soft substrates.

Variability within the One-Year Baseline

This project, as described above, was conceived and implemented as a one-year baseline against which any future changes in these ecosystems could be evaluated. Our sampling with the ROV at Point Arena (Figure 4, above) in 2010 and 2011 was not intended to flesh out any differences between the two sampling periods, insofar as different areas were transected from one year to another. Further, given that our sampling was conducted essentially at the moment of designation for the NCC MPAs, we were not focused on any "MPA effects" at this state, but rather the fullest characterization possible. Below we have included a brief summary of the variability in our observations of selected organisms and habitat attributes between years.

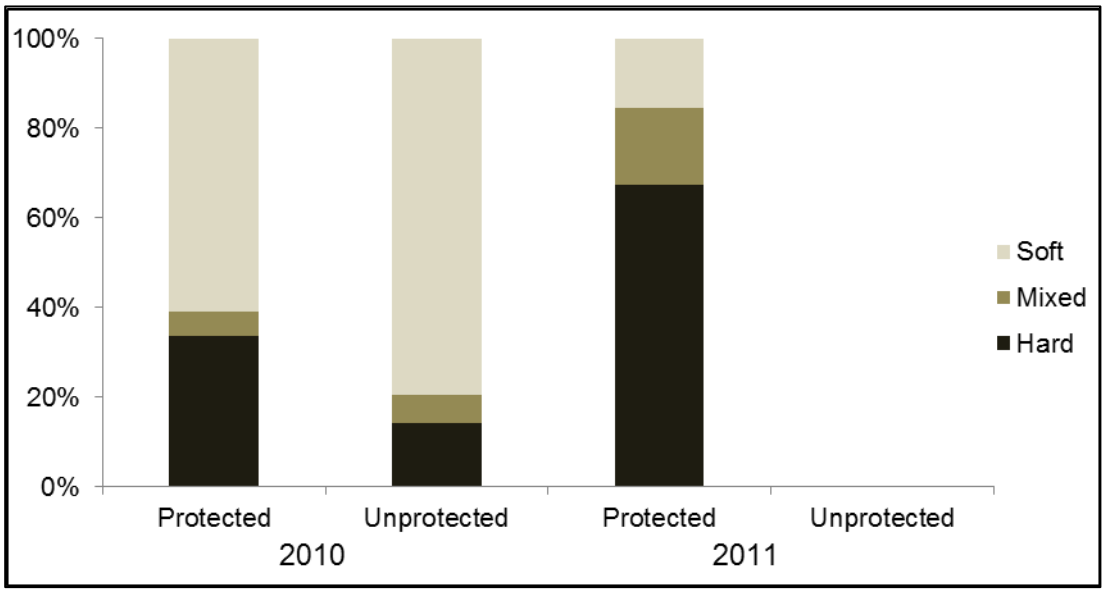


Figure 13. Variability in seafloor habitats sampled by the ROV between the 2010 and 2011 study years at Point Arena.

Table 3. Variability between years and density in protected and unprotected areas for observed fishes at Point Arena. Primary (******) and secondary (*****) species requested in NCC Monitoring Plan.

Point Arena Fishes	Density 2010 ($x10^{-4}$ m^2)	Density 2011 ($x10^{-4}$ m^2)	Initial Variability 2010 to 2011	Density in Protected Areas 2010 & 2011 ($x10^{-4}$ m^2)	Density in Unprotected Areas 2010 & 2011 ($x10^{-4}$ m^2)
Species					
Black Rockfish *	0.087	-	NA	-	0.242
Blue Rockfish *	1.219	1.025	-16%	0.369	3.140
Brown Rockfish *	0.029	-	NA	0.034	-
Canary Rockfish *	0.725	2.306	218%	1.441	-
China Rockfish *	0.203	0.513	153%	0.235	0.322
Copper Rockfish *	0.232	0.769	231%	0.436	0.081
Gopher Rockfish *	0.174	-	NA	0.134	0.161
Halfbanded Rockfish *	-	-	-	-	-
Quillback Rockfish *	0.029	1.025	3434%	0.302	-
Rosy Rockfish *	-	0.384	NA	0.101	-
Vermilion Rockfish **	0.145	2.050	1314%	0.637	0.161
Yelloweye Rockfish **	0.029	0.384	1224%	0.134	-
Cabezon	-	0.384	NA	0.101	-
Eelpout	-	0.256	NA	0.067	-
Kelp Greenling	1.857	12.044	549%	4.858	1.047
Lingcod **	0.667	3.075	361%	1.374	0.483
Longspine Combfish	-	-	-	-	-
North Pacific Argentine	-	-	-	-	-
Painted Greenling	-	-	-	-	-
Pink Seaperch	-	-	-	-	-
Poacher	-	-	-	-	-
Ronquil	-	0.128	NA	0.034	-
Sculpin	0.087	0.128	47%	0.034	0.242
Starry Skate	-	-	-	-	-
English Sole *	0.058	-	NA	0.034	0.081
Pacific Halibut *	-	-	-	-	-
Pacific Sanddab *	0.029	-	NA	-	-
Petrale Sole *	-	-	-	-	-
Rex Sole *	-	-	-	-	-
Slender Sole *	-	-	-	-	-
Speckled Sanddab *	-	-	-	-	-
Starry Flounder **	-	-	-	-	-
Species Complex					
Olive/Yellowtail complex*	0.203	3.716	1731%	1.206	-
Vermilion/Canary/ Yelloweye complex *	0.986	3.331	238%	2.446	0.242
Sebastomus **	0.029	1.409	4759%	0.369	0.081
Other					
Pleuronectiformes *	3.743	0.145	-96%	1.876	6.279
Sebastes spp. *	5.106	18.707	266%	8.711	4.991
Unidentified fishes	2.582	6.022	133%	3.618	2.254

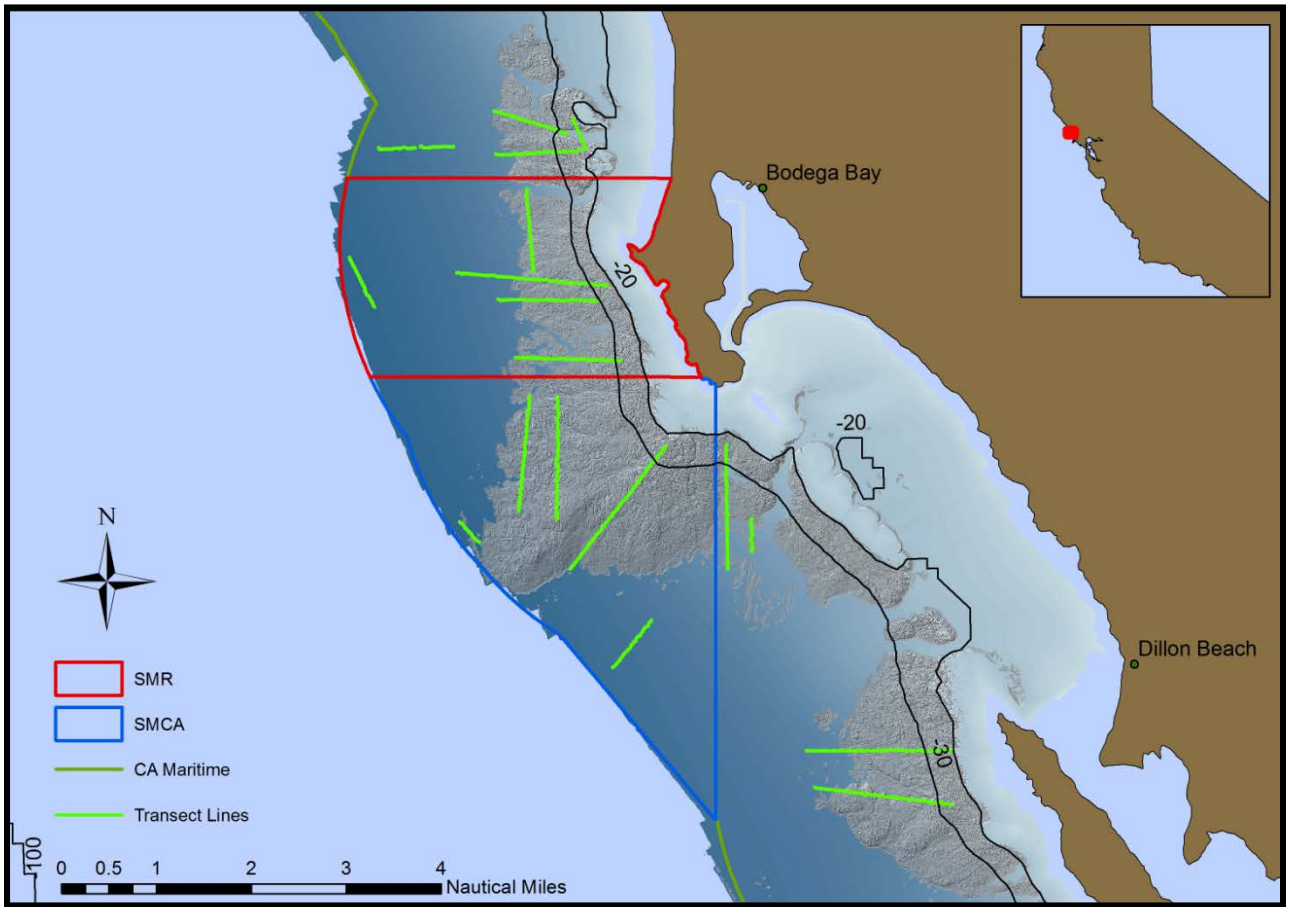


Figure 14. Map of ROV transects conducted at Bodega Head, including MPA boundaries, 20 and 30 meter isobaths, and sun-illuminated topographic map of the seafloor.

Classification of Seafloor Habitats - Habitat types were classified at each site using both sun-illuminated topographic maps created as part of the California State Mapping Project and additional data extracted from down-looking video imagery from the ROV. Habitat polygons were created in ArcGIS to capture habitats both within each MPA as well as areas adjacent to the MPAs. At Bodega Head they were classified as *Hard* (48% of the total area surveyed), which included large boulders, moderate rocky outcrops, and some cobbles; *Mixed* (16% of the total area surveyed), including a combination of unconsolidated soft sediments with boulder, cobbles, or rock; and *Soft* sediment (36% of the total area surveyed; Fig. 15).

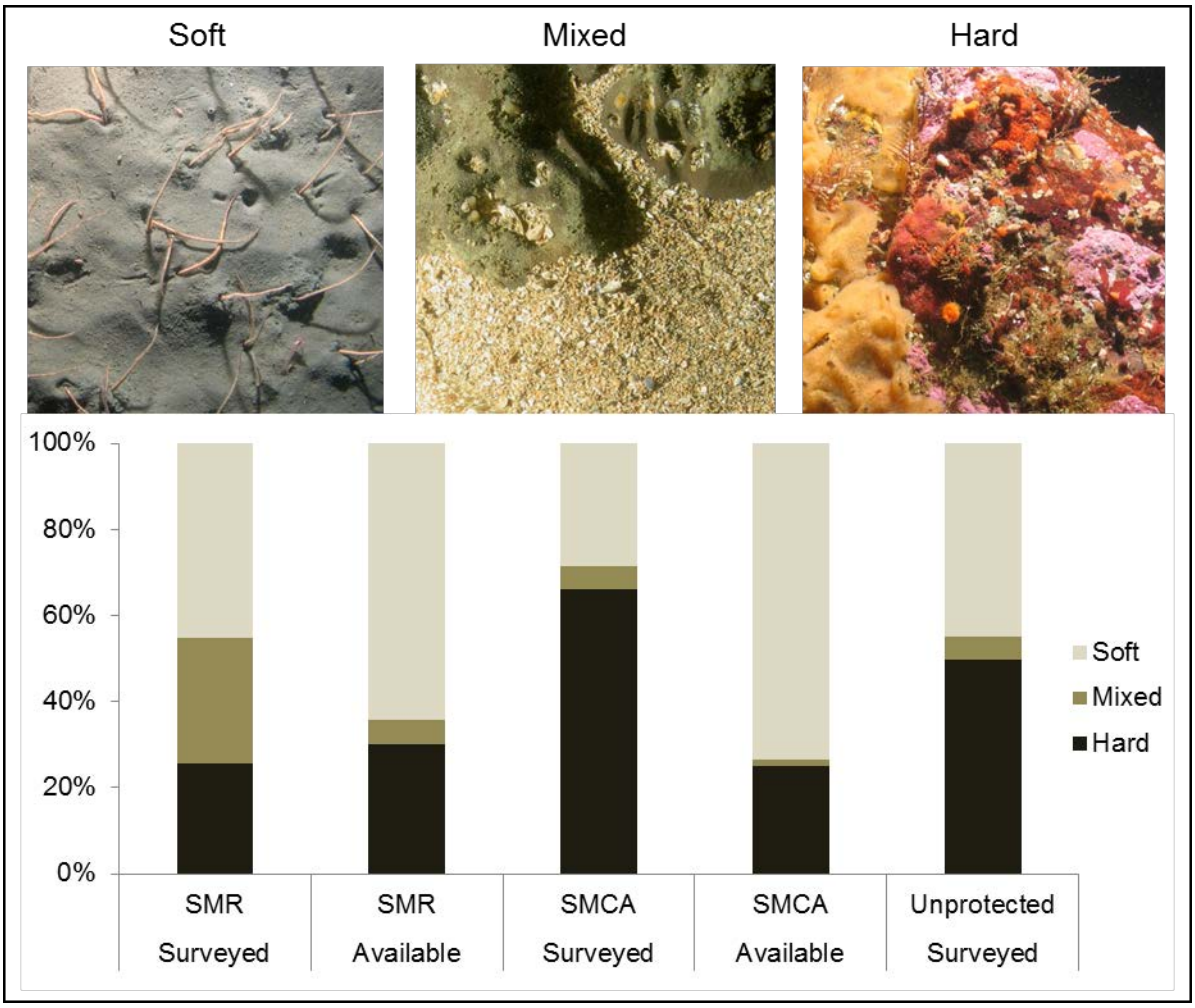


Figure 15. Substrate categories for Bodega Head, including the percentage of each broad substrate type surveyed by the ROV (Soft, Mixed, Hard) and the total amount of each available inside the SMR, the SMCA, and at the unprotected reference sites.

Fishes at Bodega Head

A total of 2,425 individual fishes were observed at Bodega Head across 26 species, species groups, or morphological categories (Table 4). Counts of fishes identified to species ranged from a low of 1 fish (Copper Rockfish) to a high of 354 fish (Kelp Greenling). Flatfishes were abundant in the area but visibility limited our ability to identify most individuals.

Table 4. Count, relative abundance, density, and size frequency for observed fishes at Bodega Head. Primary (**) and secondary (*) species requested in NCC Monitoring Plan.

Bodega Head Fishes	Count	Relative Abundance	Density ($x10^{-4}$ m^2 ± 1SD)	Size frequency				
				10-20cm	20-30cm	30-40cm	40-50cm	+50 cm
Species								
Black Rockfish *	-	-	-	-	-	-	-	-
Blue Rockfish *	5	0.002	0.06 ± 0.10	0.80	0.20	-	-	-
Brown Rockfish *	44	0.017	0.46 ± 0.61	0.41	0.57	0.02	-	-
Canary Rockfish *	214	0.084	2.21 ± 2.60	0.64	0.34	0.01	-	-
China Rockfish *	13	0.005	0.11 ± 0.23	0.08	0.77	0.15	-	-
Copper Rockfish *	3	0.001	0.03 ± 0.07	0.33	0.67	-	-	-
Gopher Rockfish *	21	0.008	0.16 ± 0.23	0.14	0.71	0.14	-	-
Halfbanded Rockfish *	-	-	-	-	-	-	-	-
Quillback Rockfish *	5	0.002	0.05 ± 0.11		0.80	0.20	-	-
Rosy Rockfish *	31	0.012	0.23 ± 0.53	0.84	0.16	-	-	-
Vermilion Rockfish **	5	0.002	0.03 ± 0.08	0.20	0.20	0.60	-	-
Yelloweye Rockfish **	3	0.001	0.03 ± 0.08		0.67	0.33	-	-
Cabezon	7	0.003	0.07 ± 0.17	1	-	-	-	-
Eelpout	6	0.002	0.12 ± 0.37	1	-	-	-	-
Kelp Greenling	356	0.140	3.34 ± 3.03	0.13	0.62	0.24	0.01	-
Lingcod **	250	0.098	2.53 ± 2.17	0.34	0.36	0.21	0.06	0.04
Longspine Combfish	2	0.001	0.02 ± 0.06	1	-	-	-	-
North Pacific Argentine	-	-	-	-	-	-	-	-
Painted Greenling	-	-	-	-	-	-	-	-
Pink Seaperch	29	0.011	0.37 ± 0.50	1	-	-	-	-
Poacher	1	0.000	0.01 ± 0.04	1	-	-	-	-
Ronquil	-	-	-	-	-	-	-	-
Sculpin	70	0.028	0.94 ± 1.14	0.99	-	-	-	-
Starry Skate	1	0.000	0.01 ± 0.03	-	-	-	-	-
English Sole *	3	0.001	0.03 ± 0.10	1	-	-	-	-
Pacific Halibut *	-	-	-	-	-	-	-	-
Pacific Sanddab *	-	-	-	-	-	-	-	-
Petrale Sole *	1	0.000	0.01 ± 0.04	1	-	-	-	-
Rex Sole *	1	0.000	0.02 ± 0.07	1	-	-	-	-
Slender Sole *	5	0.002	0.06 ± 0.16	1	-	-	-	-
Speckled Sanddab *	1	0.000	0.01 ± 0.04	1	-	-	-	-
Starry Flounder **	-	-	-	-	-	-	-	-
Species Complex								
Olive/Yellowtail complex*	215	0.084	2.21 ± 2.83	0.65	0.30	0.04	-	-
Vermilion/Canary/ Yelloweye complex *	5	0.002	0.03 ± 0.08	0.2	0.6	0.2	-	-
Sebastomus **	55	0.022	0.57 ± 1.12	0.93	0.07	-	-	-
Other								
Pleuronectiformes *	741	0.291	14.57 ± 25.29	0.98	0.01	-	-	-
Sebastes spp. *	245	0.096	3.25 ± 6.15	0.72	0.11	0.03	-	-
Unidentified fishes	207	0.081	2.64 ± 2.36	0.79	0.07	0.04	0.01	-

Fishes in Mid-Depth Rock and Soft Bottom Ecosystems

The majority of fishes found in the hard substrate habitat of Bodega Head were Rockfishes (*Sebastes spp.*) and Roundfishes (Fig. 16). The Roundfishes and Other Fishes categories were broad categories used to bin organisms that were observed, but not identified, usually due to poor visibility. Roundfishes included all non-flat fishes that were not identifiable further, while Other Fishes was even more general and could include any species of fish found in the area. In the soft substrate, Flatfishes comprised 76% of the fish observations.

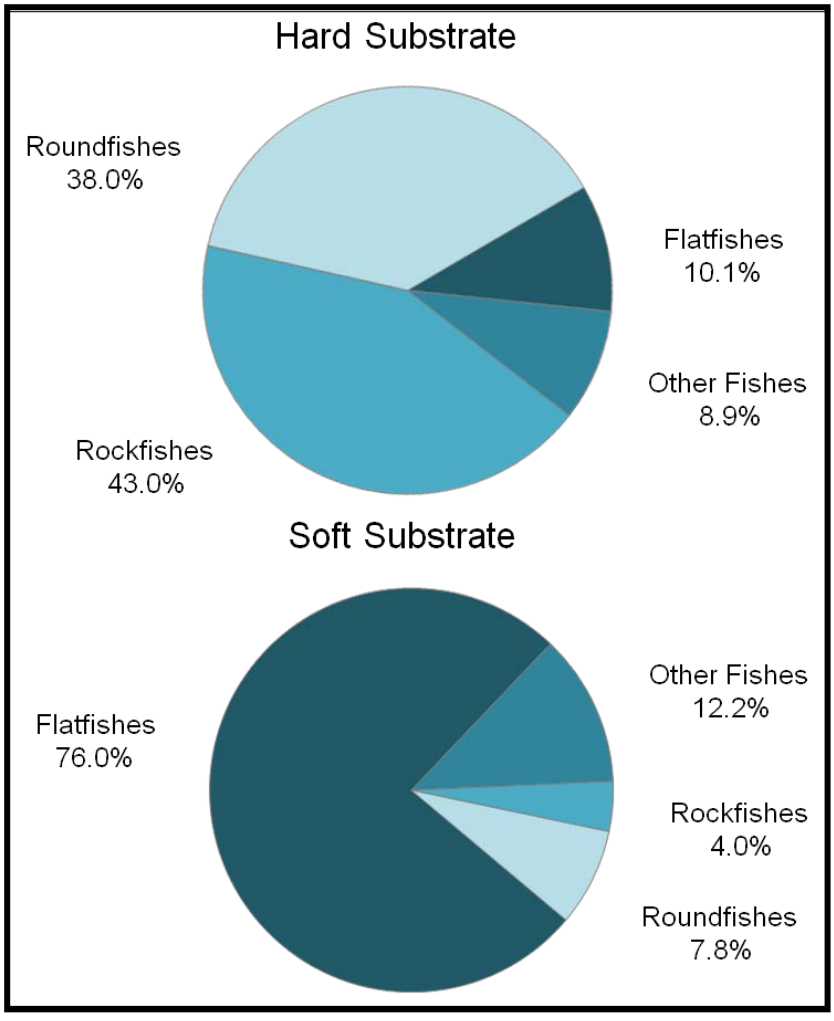


Figure 16. The fish observed at Bodega Head expressed as a percentage of the major categories of fishes found over Hard Substrate (top) and Soft Substrate (bottom).

Figure 17. Fishes occurring in Bodega Head over hard substrates (top, Quillback Rockfish; middle, Rosy Rockfish) and soft substrates (bottom, Eelpout).

Mobile Invertebrates in Mid-Depth Rock and Soft Bottom Ecosystems

Sea Cucumbers and Sea Stars made up the majority of mobile invertebrates found over hard substrates of the Bodega Head study sites (Fig. 18). Dungeness Crabs only accounted for 0.4% of observations over hard substrates in these areas. Within soft substrates, Shrimps occurred more than any other invertebrate (47% of observations). Dungeness Crabs accounted for 20% of the observations over soft substrate.

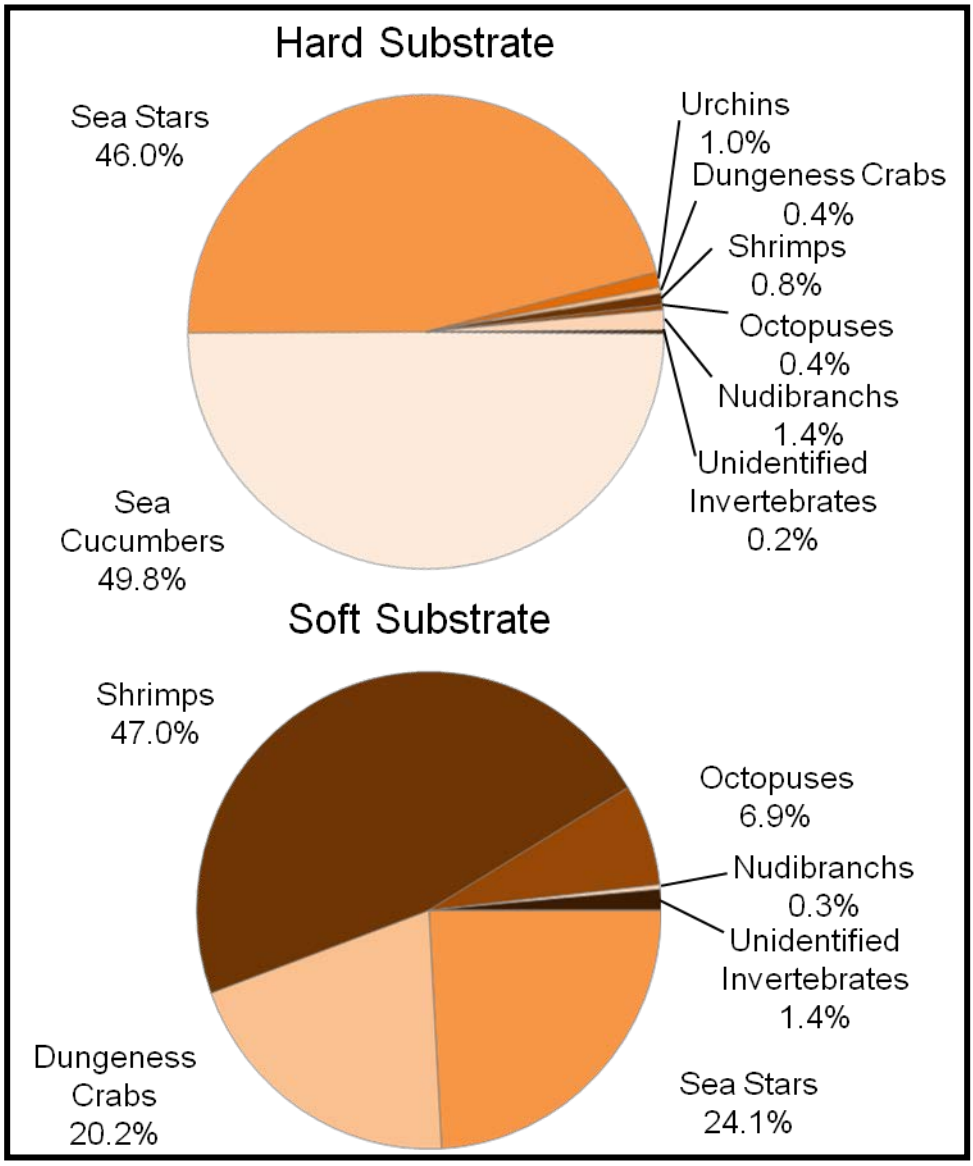


Figure 18. Mobile invertebrates observed at Bodega Head expressed as a percentage of the major categories of fishes found over Hard Substrate (top) and Soft Substrate (bottom).

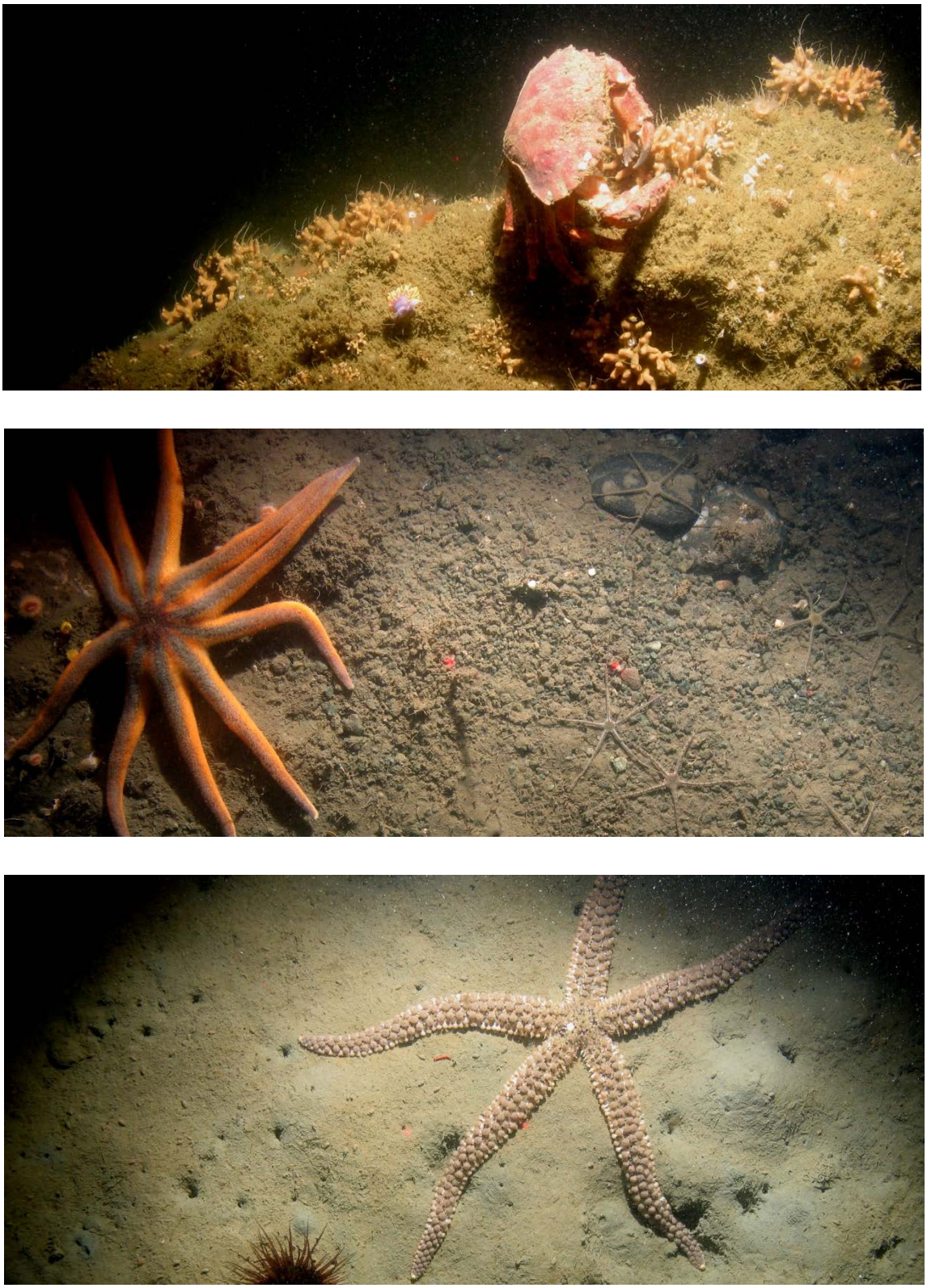


Figure 19. Mobile invertebrates of Bodega Head occurring over hard substrate (top, Red Rock Crab), mixed substrate (middle, Stimpson's Sun Star), and soft substrate (bottom, Fish-eating Star).

Structure-Forming Invertebrates in Mid-Depth Rock and Soft Bottom Ecosystems

Metridium (over 73%) and Anemones (over 24%) comprised the majority of structure-forming invertebrates observed over hard substrate at Bodega Head (Fig. 20). Over soft substrate, Sea Whips/Pens made up the majority of observations (over 95%).

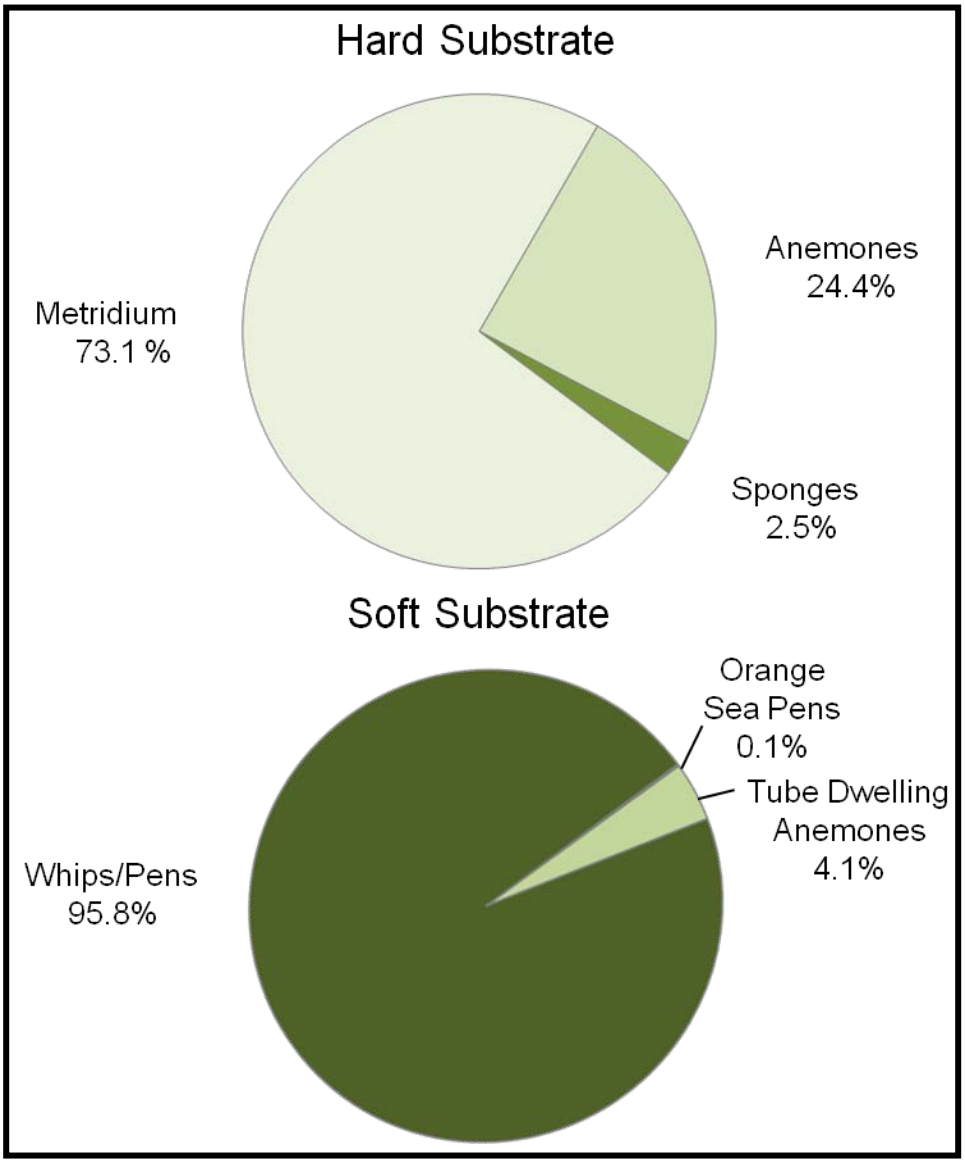


Figure 20. Structure-forming invertebrates observed at Bodega Head expressed as a percentage of the major categories of fishes found over Hard Substrate (top) and Soft Substrate (bottom).

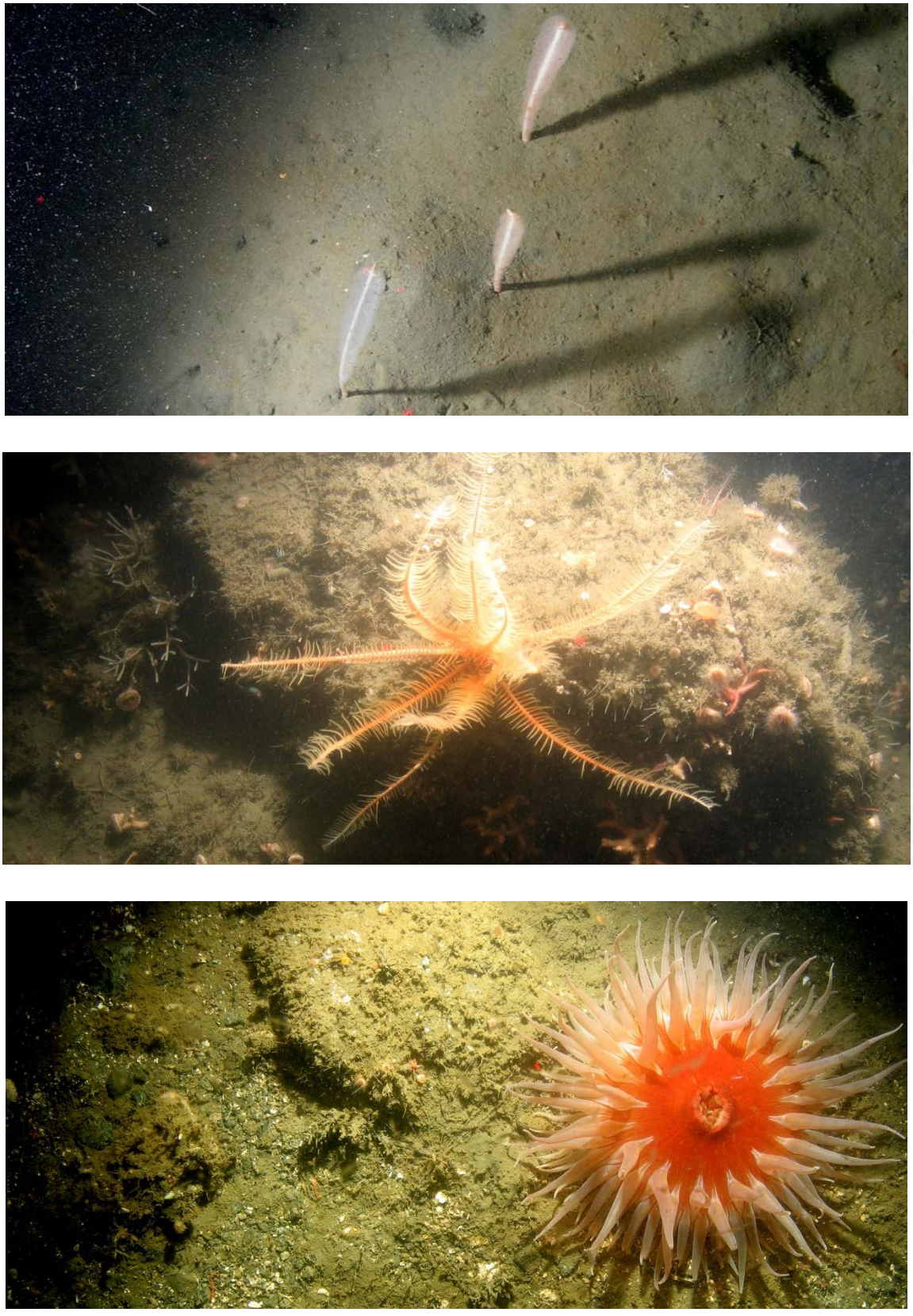


Figure 21. Sessile invertebrates at Bodega Head occurring over soft substrate (top, Sea Whips/Pens) and hard substrate (middle, Crinoid; bottom, Anemone).

Fish and Invertebrate Associations with the Seafloor

Summary data from 2011 indicate that overall, fishes were observed in low numbers, most occurring as individuals over all substrate types with the exception of boulder-rock where groups of epibenthic fishes were most commonly observed. Epibenthic fishes were less frequently observed than were benthic fishes. Benthic fishes were observed on all substrate types primarily singularly though groups were observed on mixed sand-boulder substrate. Flatfishes were observed strictly on sand and sand combination substrates. Both mobile and sessile invertebrates occurred variably over all substrates. Large aggregations of newly recruited crabs were commonly observed on sand and mixed habitats. Ophiuroid and gastropod groups and aggregations were observed on hard substrates.

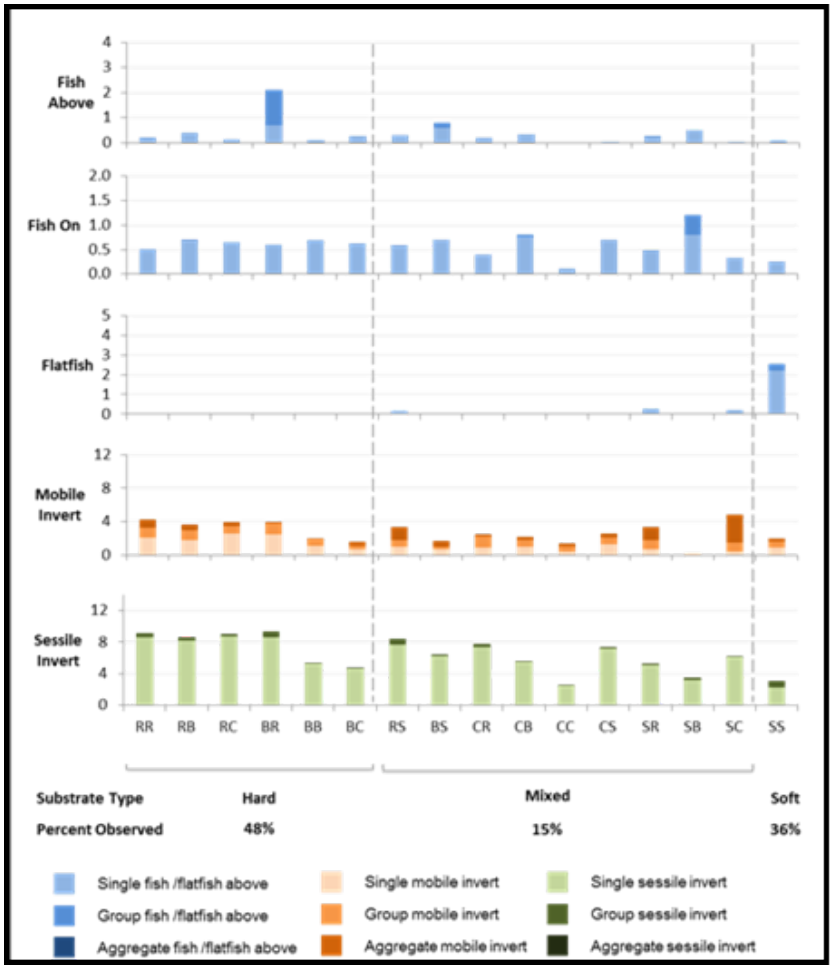


Figure 22. Fishes, mobile invertebrates, and sessile invertebrates at Bodega Head expressed as a percentage of all observations over Hard, Mixed, and Soft substrates.

Variability within the One-Year Baseline

This project, as described above, was conceived and implemented as a one-year baseline against which any future changes in these ecosystems could be evaluated. Our sampling with the ROV at Bodega Head (Figure 14, above) in 2010 and 2011 was not intended to flesh out any differences between the two sampling periods, insofar as different areas were transected from one year to another. Further, given that our sampling was conducted essentially at the moment of designation for the NCC MPAs, we were not focused on any "MPA effects" at this state, but rather the fullest characterization possible. Below we have included a brief summary of the variability in our observations of selected organisms and habitat attributes between years.

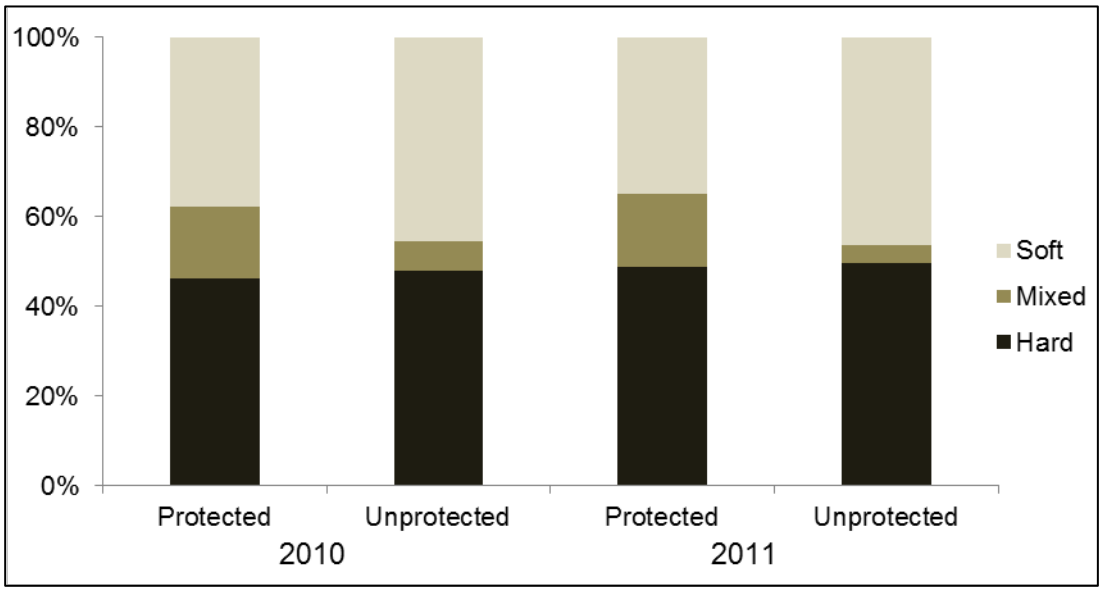


Figure 23. Variability in seafloor habitats sampled by the ROV between the 2010 and 2011 study years at Bodega Head.

Table 5. Variability between years and density in protected and unprotected areas for observed fishes at Bodega Head. Primary (**) and secondary (*) species requested in NCC Monitoring Plan.

Bodega Head Fishes	Density 2010 ($x10^{-4}$ m^2)	Density 2011 ($x10^{-4}$ m^2)	Initial Variability 2010 to 2011	Density in Protected Areas 2010 & 2011 ($x10^{-4}$ m^2)	Density in Unprotected Areas 2010 & 2011 ($x10^{-4}$ m^2)
Species					
Black Rockfish *	-	-	-	-	-
Blue Rockfish *	-	0.084	NA	0.062	0.028
Brown Rockfish *	0.166	0.570	243%	0.684	0.153
Canary Rockfish *	1.128	2.446	117%	3.376	0.711
China Rockfish *	0.133	0.084	-37%	0.207	0.042
Copper Rockfish *	0.017	0.034	100%	0.062	-
Gopher Rockfish *	0.216	0.134	-38%	0.186	0.167
Halfbanded Rockfish *	-	-	-	-	-
Quillback Rockfish *	0.050	0.034	-32%	0.021	0.056
Rosy Rockfish *	0.050	0.469	838%	0.435	0.139
Vermilion Rockfish **	0.050	0.034	-32%	0.021	0.056
Yelloweye Rockfish **	0.033	0.017	-48%	0.062	-
Cabezon	-	0.117	NA	0.145	-
Eelpout	-	0.101	NA	0.104	0.014
Kelp Greenling	2.686	3.250	21%	5.075	1.548
Lingcod **	1.426	2.747	93%	2.796	1.603
Longspine Combfish	-	0.034	NA	0.041	-
North Pacific Argentine	-	-	-	-	-
Painted Greenling	-	-	-	-	-
Pink Seaperch	0.116	0.369	218%	0.476	0.084
Poacher	-	0.017	NA	0.021	-
Ronquil	-	-	-	-	-
Sculpin	0.199	0.972	388%	1.015	0.293
Starry Skate	-	0.017	NA	0.021	-
English Sole *	-	0.050	NA	0.062	-
Pacific Halibut *	-	-	-	-	-
Pacific Sanddab *	-	-	-	-	-
Petrale Sole *	-	0.017	NA	0.021	-
Rex Sole *	-	0.017	NA	0.021	-
Slender Sole *	-	0.084	NA	0.104	-
Speckled Sanddab *	-	0.017	NA	0.021	-
Starry Flounder **	-	-	-	-	-
Complex					
Olive/Yellowtail complex*	0.813	2.781	242%	3.542	0.613
Vermilion/Canary/ Yelloweye complex *	0.133	2.496	1777%	3.521	0.795
Sebastomus **	0.199	1.240	523%	1.367	0.279
Other					
Pleuronectiformes *	1.758	10.821	516%	8.078	5.047
Sebastes spp. *	4.063	10.265	153%	12.221	3.820
Unidentified fishes	1.575	1.876	19%	2.921	0.920

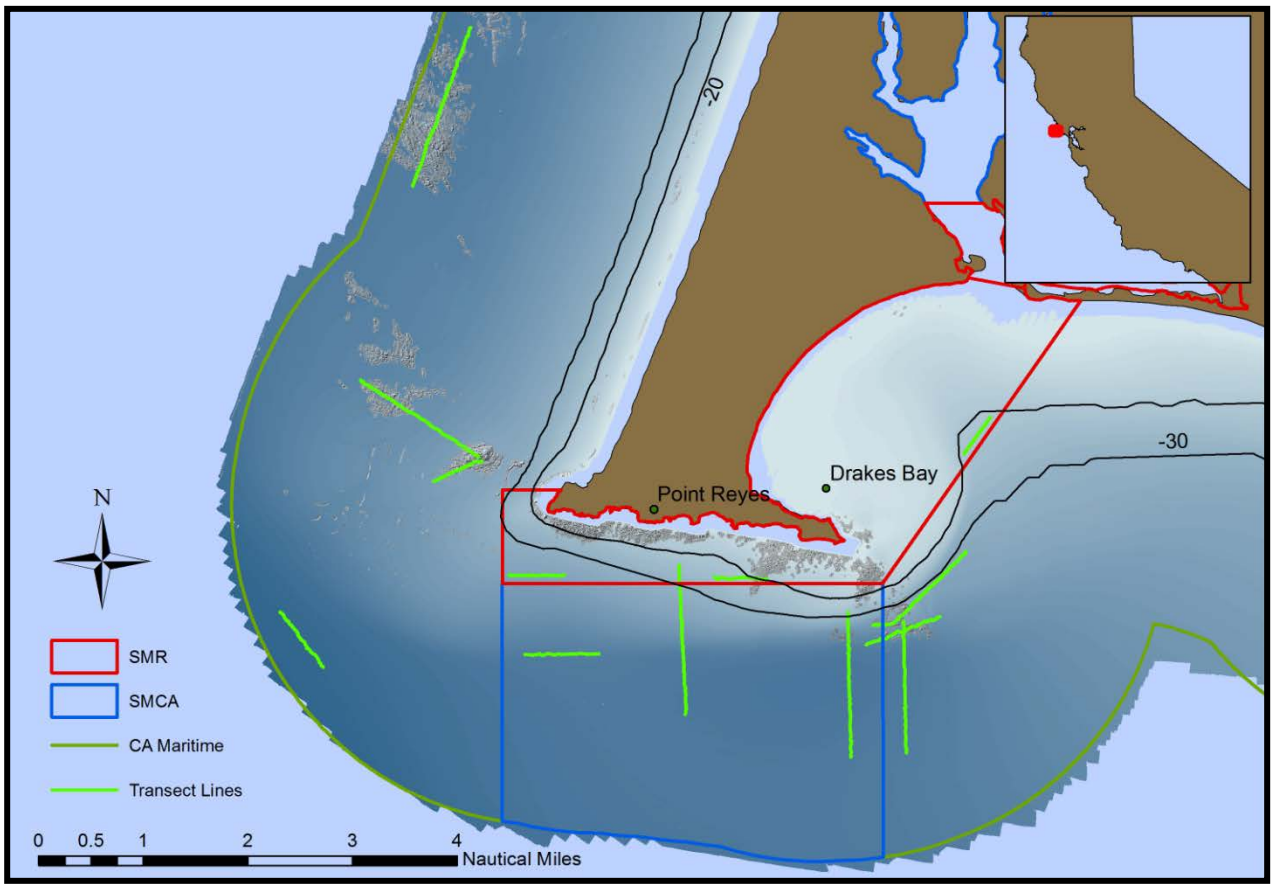


Figure 24. Map of ROV transects conducted at Point Reyes, including MPA boundaries, 20 and 30 meter isobaths, and sun-illuminated topographic map of the seafloor.

Classification of Seafloor Habitats - Habitat types were classified at each site using both sun-illuminated topographic maps created as part of the California State Mapping Project and additional data extracted from down-looking video imagery from the ROV. Habitat polygons were created in ArcGIS to capture habitats both within each MPA as well as areas adjacent to the MPAs. At Point Reyes they were classified as *Hard* (16% of the total area surveyed), which included moderate rocky outcrops, and some cobbles; *Mixed* (7% of the total area surveyed), including a combination of unconsolidated soft sediments with boulder, cobbles, or rock; and *Soft* sediment (77% of the total area surveyed; Fig. 25).

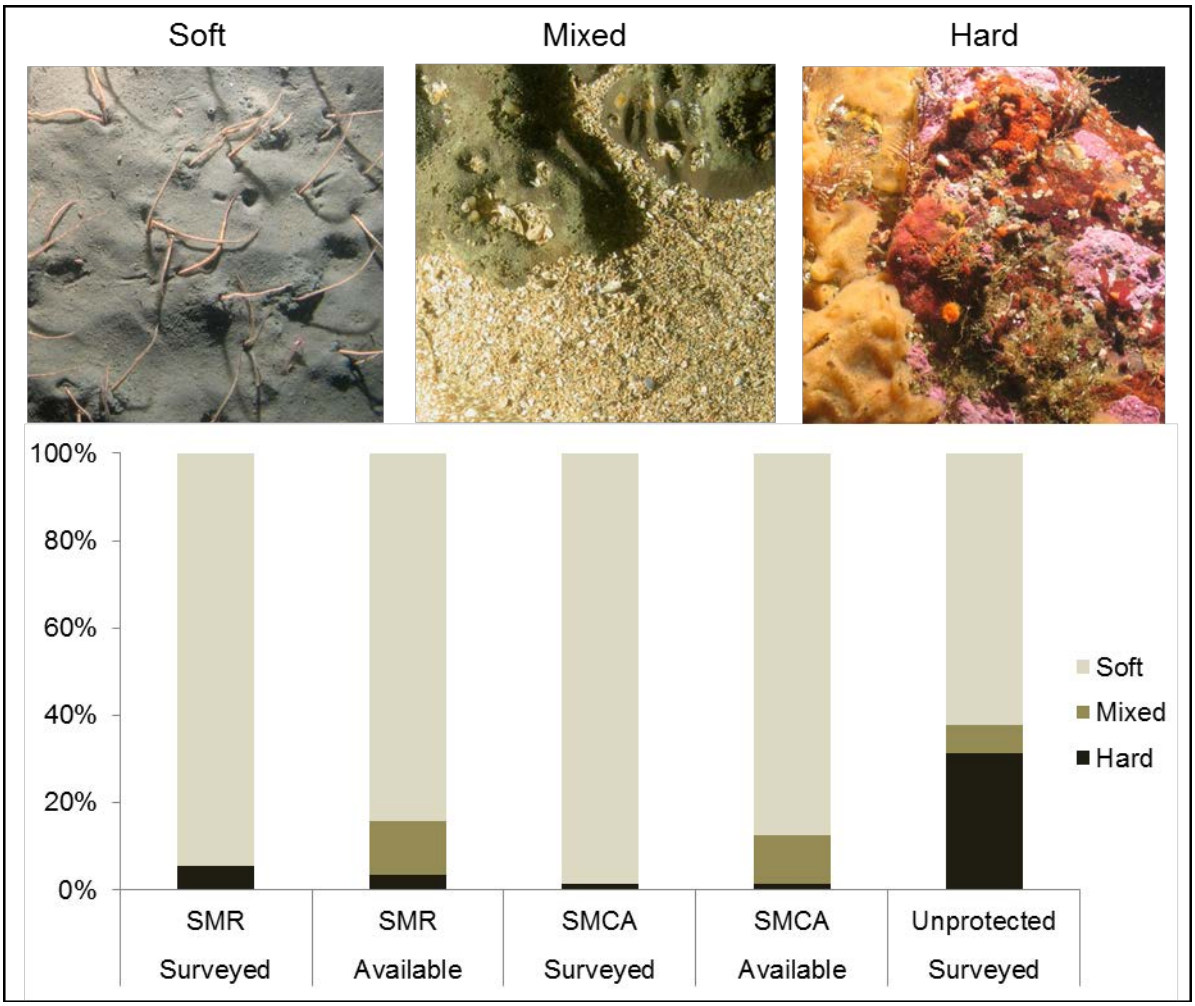


Figure 25. Substrate categories for Point Reyes, including the percentage of each broad substrate type surveyed by the ROV (Soft, Mixed, Hard) and the total amount of each available inside the SMR, the SMCA, and at the unprotected reference sites.

Fishes at Point Reyes

A total of 1,496 individual fishes were observed at Point Reyes across 26 species, species groups, or morphological categories (Table 6). Counts of fishes identified to species ranged from a low of 1 fish (Yelloweye Rockfish) to a high of 74 fish (Canary Rockfish). Flatfishes were abundant in the area but visibility limited our ability to identify most individuals.

Table 6. Count, relative abundance, density, and size frequency for observed fishes at Point Reyes. Primary (******) and secondary (*****) species requested in NCC Monitoring Plan.

Point Reyes Fishes	Count	Relative Abundance	Density ($x10^{-4}$ m^2 ± 1SD)	Size frequency				
				10-20cm	20-30cm	30-40cm	40-50cm	+50 cm
Species								
Black Rockfish *	6	0.004	0.15 ± 0.57	-	0.67	0.33	-	-
Blue Rockfish *	63	0.038	1.60 ± 6.04	0.83	0.16	0.02	-	-
Brown Rockfish *	19	0.012	0.17 ± 0.36	0.37	0.37	0.26	-	-
Canary Rockfish *	80	0.049	0.86 ± 1.49	0.48	0.43	0.10	-	-
China Rockfish *	7	0.004	0.08 ± 0.23	-	1	-	-	-
Copper Rockfish *	-	-	-	-	-	-	-	-
Gopher Rockfish *	7	0.004	0.13 ± 0.45	-	0.86	0.14	-	-
Halfbanded Rockfish *	-	-	-	-	-	-	-	-
Quillback Rockfish *	4	0.002	0.01 ± 0.04	-	0.50	0.50	-	-
Rosy Rockfish *	11	0.007	0. 04 ± 0.13	0.09	0.91	-	-	-
Vermilion Rockfish **	10	0.006	0.12 ± 0.35	-	0.20	0.60	0.20	-
Yelloweye Rockfish **	1	0.001	0.00 ± 0.01	-	1	-	-	-
Cabezon	-	-	-	-	-	-	-	-
Eelpout	18	0.011	0.22 ± 0.43	1	-	-	-	-
Kelp Greenling	40	0.024	0.38 ± 1.04	0.03	0.70	0.28	-	-
Lingcod **	64	0.039	0.97 ± 1.74	0.20	0.33	0.23	0.03	0.20
Longspine Combfish	1	0.001	0.00 ± 0.01	1	-	-	-	-
North Pacific Argentine	-	-	-	-	-	-	-	-
Painted Greenling	-	-	-	-	-	-	-	-
Pink Seaperch	-	-	-	-	-	-	-	-
Poacher	1	0.001	0.02 ± 0.09	1	-	-	-	-
Ronquil	-	-	-	-	-	-	-	-
Sculpin	14	0.009	0.14 ± 0.23	1	-	-	-	-
Starry Skate	2	0.001	0.01 ± 0.02	-	-	-	0.50	0.50
English Sole *	-	-	-	-	-	-	-	-
Pacific Halibut *	-	-	-	-	-	-	-	-
Pacific Sanddab *	-	-	-	-	-	-	-	-
Petrale Sole *	-	-	-	-	-	-	-	-
Rex Sole *	-	-	-	-	-	-	-	-
Slender Sole *	-	-	-	-	-	-	-	-
Speckled Sanddab *	-	-	-	-	-	-	-	-
Starry Flounder **	-	-	-	-	-	-	-	-
Species Complex								
Olive/Yellowtail complex*	90	0.055	0.81 ± 1.69	0.71	0.27	0.02	-	-
Vermilion/Canary/ Yelloweye complex *	3	0.002	0.06 ± 0.23	-	1	-	-	-
Sebastomus **	4	0.002	0.01 ± 0.05	0.25	0.75	-	-	-
Other								
Pleuronectiformes *	933	0.570	18.44 ± 23.55	0.99	-	-	-	-
Sebastes spp. *	201	0.123	2.69 ± 5.07	0.89	0.07	-	-	-
Unidentified fishes	58	0.035	0.79 ± 0.84	0.64	0.10	0.10	0.02	-

Fishes in Mid-Depth Rock and Soft Bottom Ecosystems

The majority of fishes found over hard substrates at Point Reyes were Rockfishes (*Sebastes* spp.; Fig. 26). The Roundfishes and Other Fishes categories were broad categories used to bin organisms that were observed, but not identified, usually due to poor visibility. Roundfishes included all non-flat fishes that were not identifiable further, while Other Fishes was even more general and could include any species of fish found in the area. In the soft substrate, Flatfishes comprised approximately 85% of all fish observations.

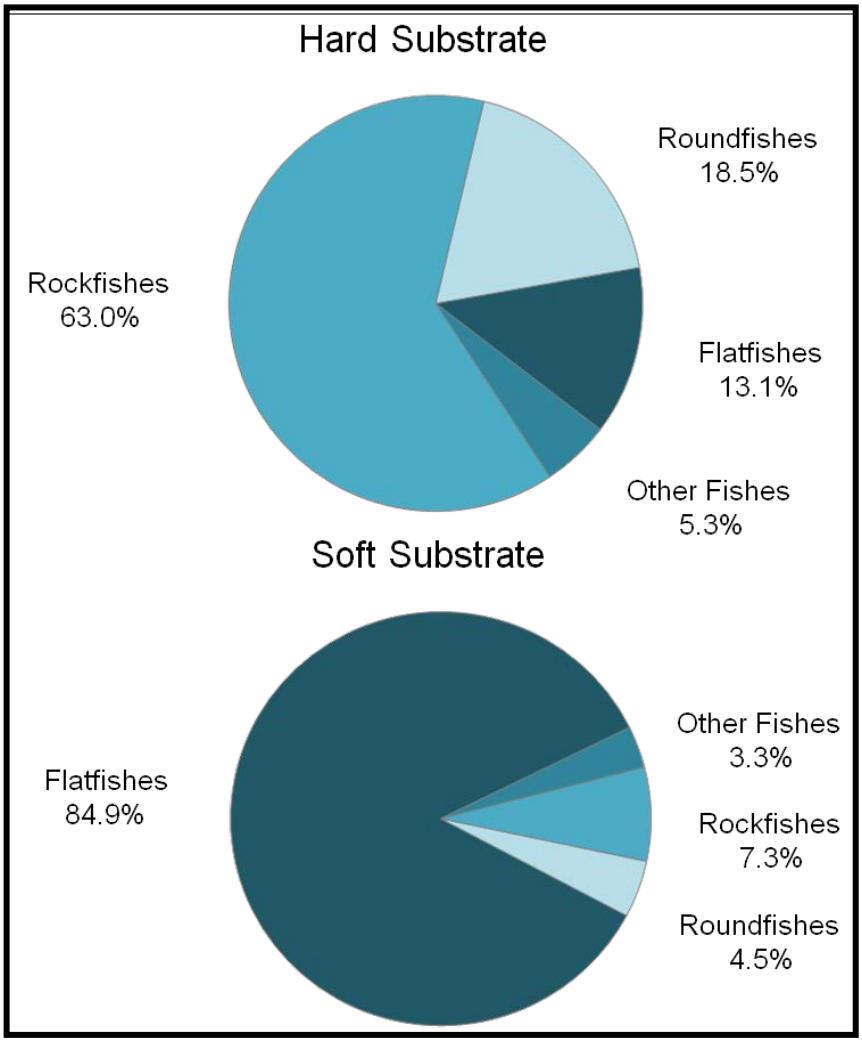


Figure 26. The fish observed at Point Reyes expressed as a percentage of the major categories of fishes found over Hard Substrate (top) and Soft Substrate (bottom).

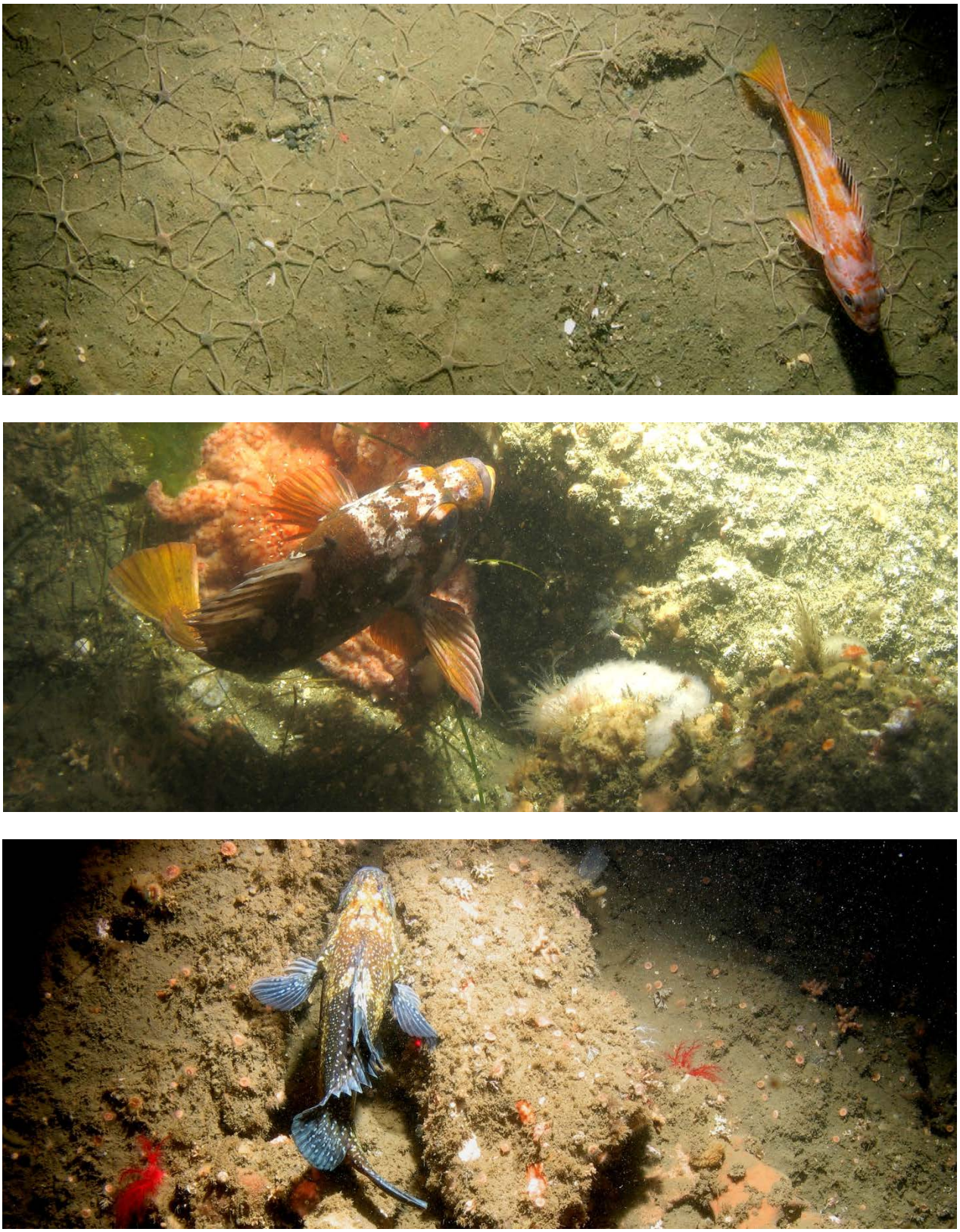


Figure 27. Fishes of Point Reyes occurring over soft substrate (top, juvenile Canary Rockfish) and hard substrate (middle, Gopher Rockfish; bottom, China Rockfish).

Mobile Invertebrates in Mid-Depth Rock and Soft Bottom Ecosystems

Sea Stars and Sea Cucumbers made up the majority of mobile invertebrates observed over the hard substrates of the Point Reyes study sites (Fig. 28). Within hard and soft substrates, Dungeness Crabs totaled the highest proportion of observations (16% and 73%, respectively) than any other geography.

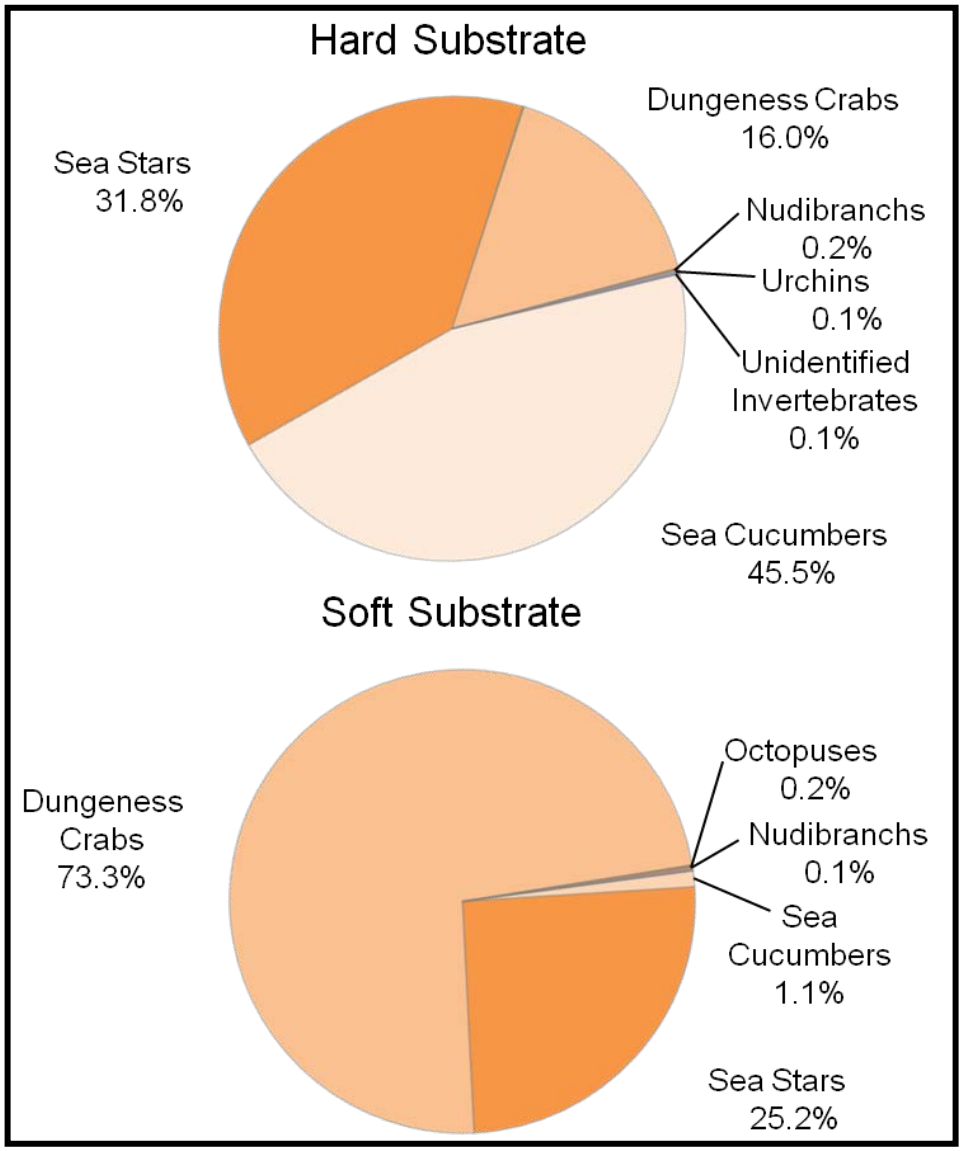


Figure 28. Mobile invertebrates observed at Point Reyes expressed as a percentage of the major categories of fishes found over Hard Substrate (top) and Soft Substrate (bottom).

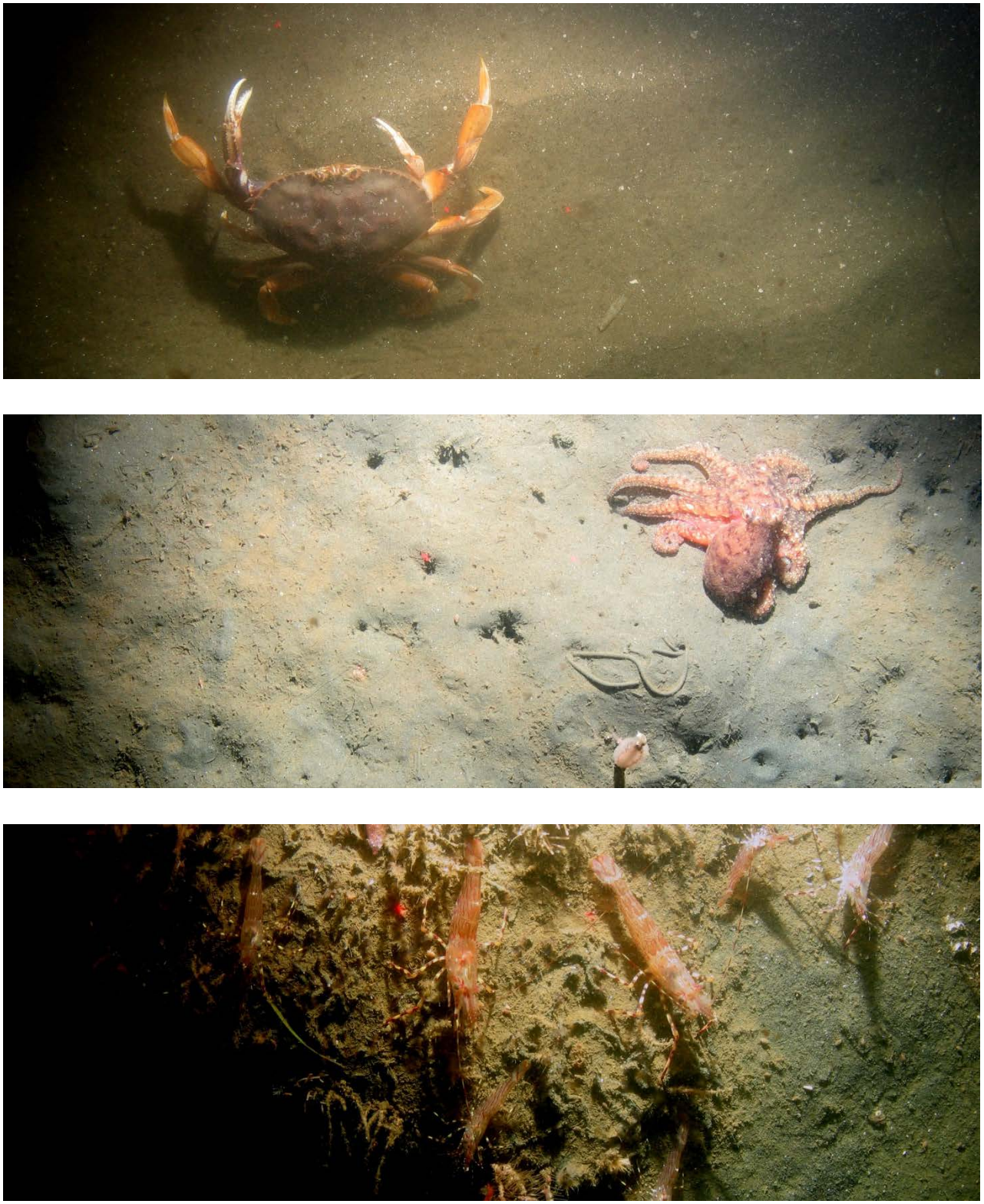


Figure 29. Mobile invertebrates of Point Reyes occurring over soft substrate (top, Dungeness Crab; middle, Red Octopus) and mixed substrate (bottom, Coonstripe Shrimp).

Structure-Forming Invertebrates in Mid-Depth Rock and Soft Bottom Ecosystems

Metridium (84%) and Anemones (over 15%) comprised the majority of the structure-forming invertebrates observed over hard substrate in Point Reyes (Fig. 30). Over soft substrate, Sea Whips/Pens made up the majority of the observations (over 98%).

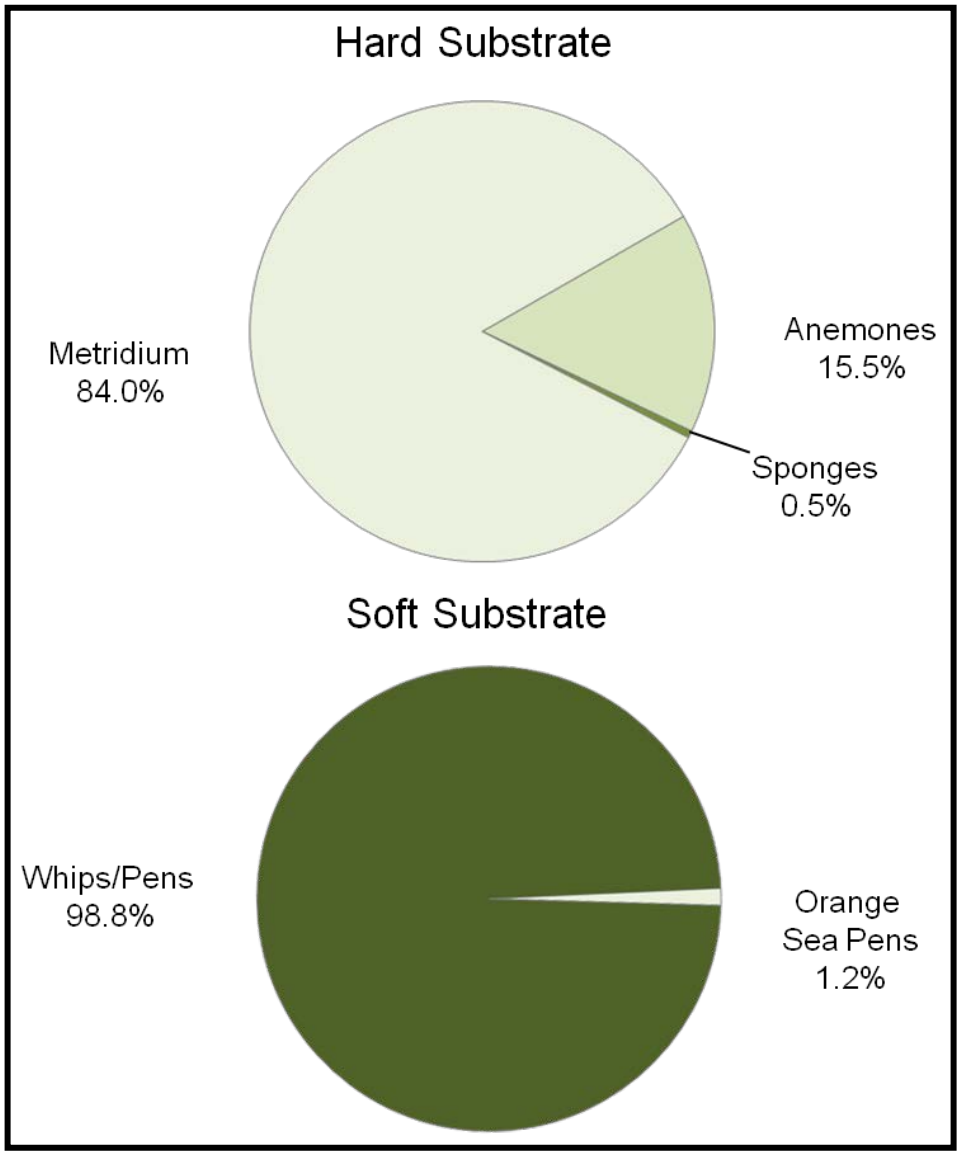


Figure 30. Structure-forming invertebrates observed at Point Reyes expressed as a percentage of the major categories of fishes found over Hard Substrate (top) and Soft Substrate (bottom).

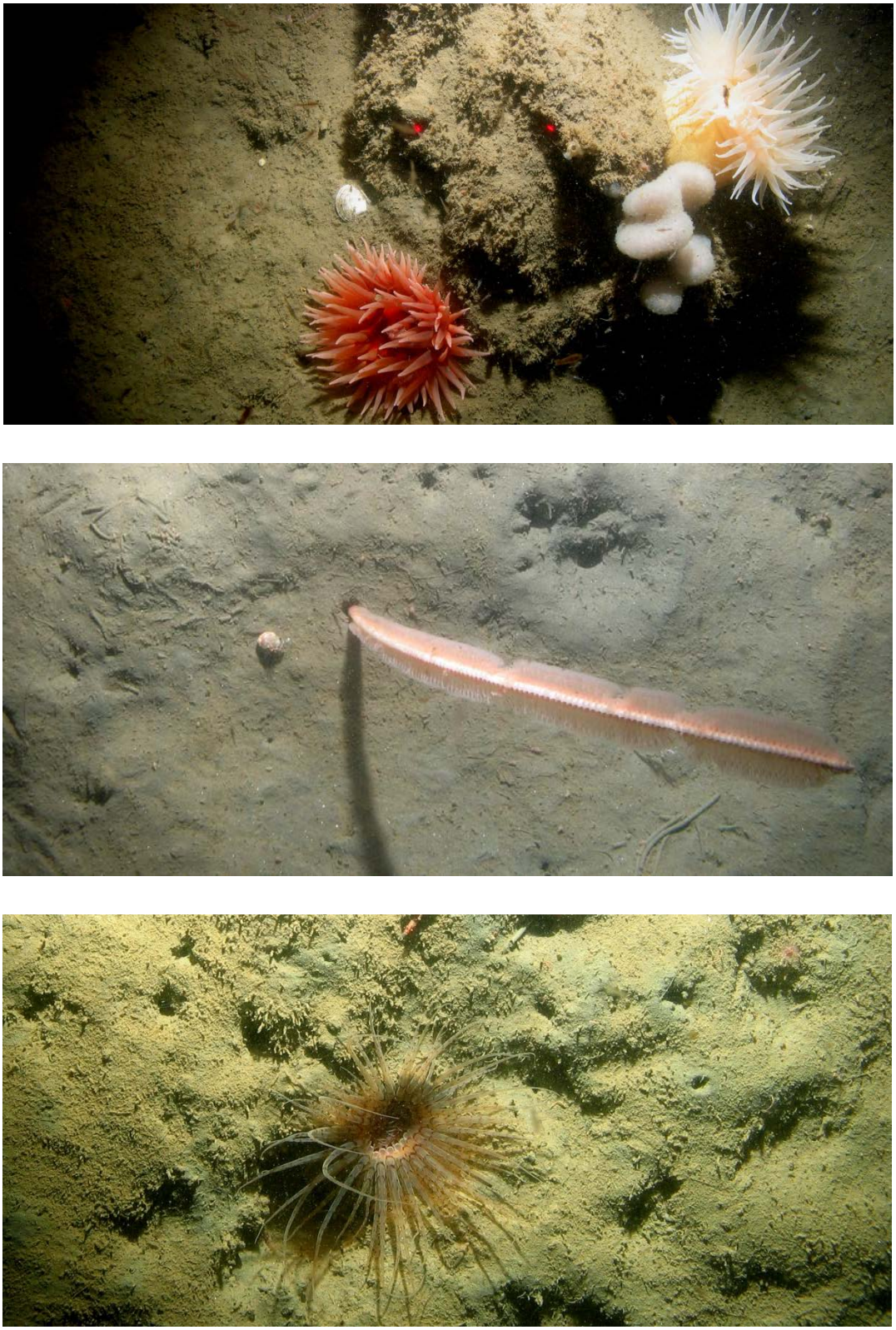


Figure 31. Sessile invertebrates of Point Reyes occurring over mixed substrate (top, Anemones and Sponge) and soft substrate (middle, Sea Whip/Pen; bottom, Anemone).

Fish and Invertebrate Associations with the Seafloor

Summary data from 2011 indicate that overall, fishes were observed in low numbers, most occurring as individuals over all substrate types. Epibenthic fishes were most commonly observed over mixed rock and sand. Benthic fishes were observed on all substrate types primarily singularly and flatfishes were observed strictly on sand. Both mobile and sessile invertebrates occurred over all substrates. A large number of dead Dungeness Crabs were present at the southeast tip of the peninsula, in combination with live adults. Large numbers of new recruit Dungeness Crabs were also observed in shallow sandy areas.

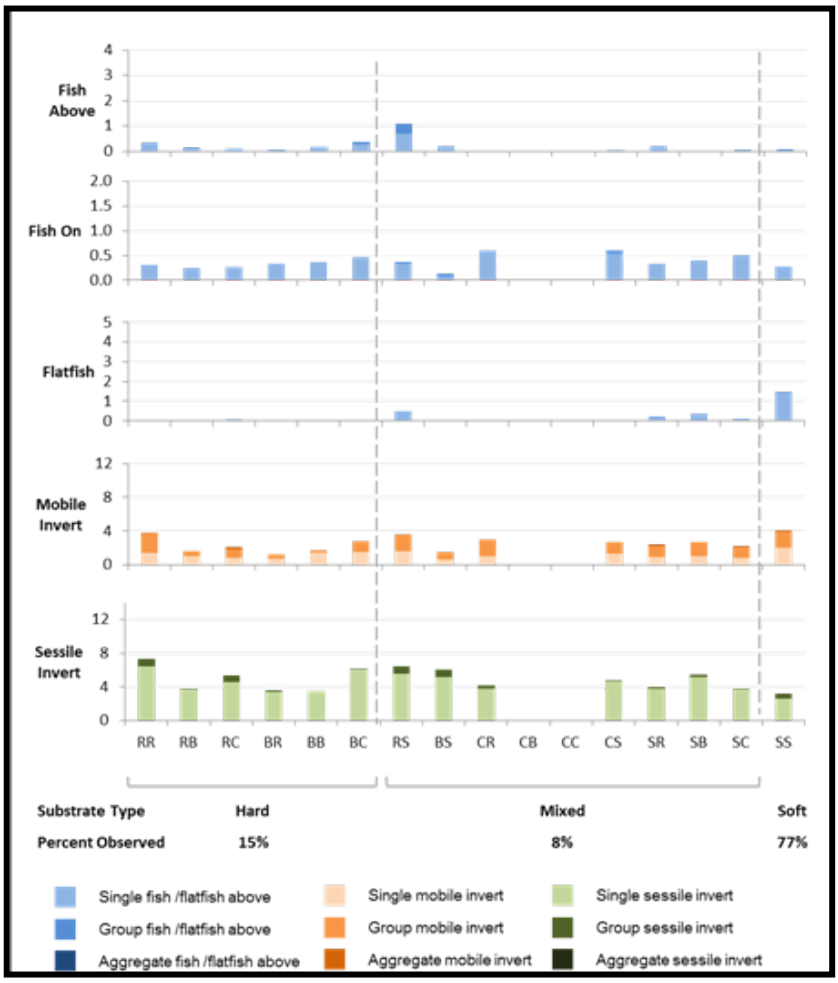


Figure 32. Fishes, mobile invertebrates, and sessile invertebrates at Point Reyes expressed as a percentage of all observations over Hard, Mixed, and Soft substrates.

Variability within the One-Year Baseline

This project, as described above, was conceived and implemented as a one-year baseline against which any future changes in these ecosystems could be evaluated. Our sampling with the ROV at Point Reyes (Figure 24, above) only occurred in 2011, therefore no inter-annual comparison is possible. Given that our sampling was conducted essentially at the moment of designation for the NCC MPAs, we were not focused on any "MPA effects" at this state, but rather the fullest characterization possible. Below we have included a brief summary of the variability in our observations of selected organisms and habitat attributes between years.

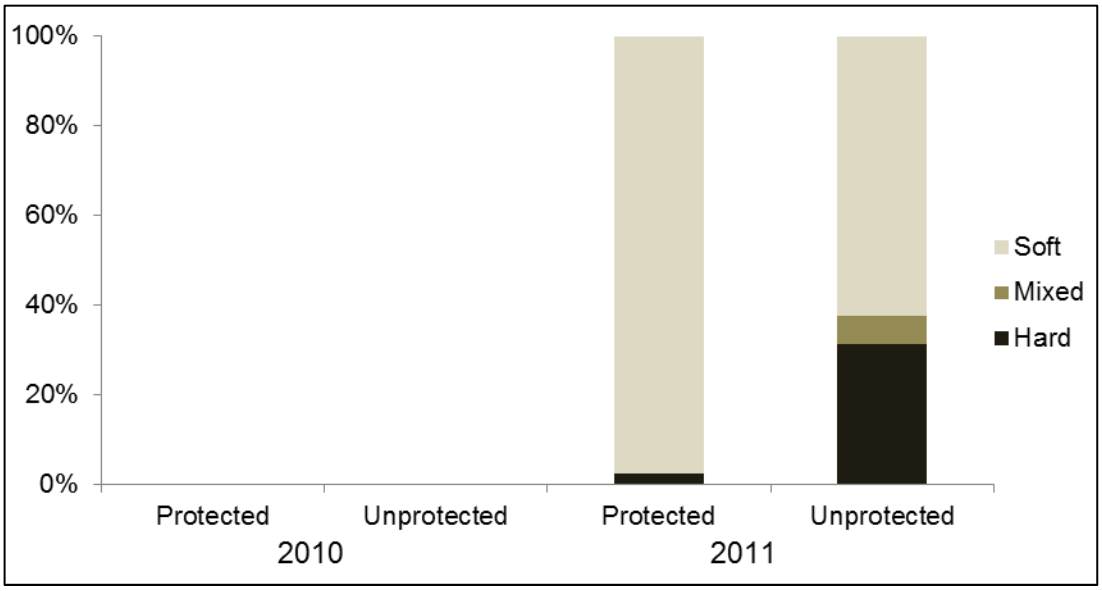


Figure 33. Variability in seafloor habitats sampled by the ROV between the 2010 and 2011 study years at Point Reyes. Note: no sampling was conducted in 2010.

Table 7. Variability between years and density in protected and unprotected areas for observed fishes at Point Reyes. Primary (******) and secondary (*****) species requested in NCC Monitoring Plan.

Point Reyes Fishes	Density 2010 ($x10^{-4}$ m^2)	Density 2011 ($x10^{-4}$ m^2)	Initial Variability 2010 to 2011	Density in Protected Areas 2010 & 2011 ($x10^{-4}$ m^2)	Density in Unprotected Areas 2010 & 2011 ($x10^{-4}$ m^2)
Species					
Black Rockfish *	-	0.068	NA	-	0.089
Blue Rockfish *	-	0.713	NA	-	0.930
Brown Rockfish *	-	0.215	NA	-	0.280
Canary Rockfish *	-	0.906	NA	0.097	1.151
China Rockfish *	-	0.079	NA	-	0.103
Copper Rockfish *	-	-	-	-	-
Gopher Rockfish *	-	0.079	NA	-	0.103
Halfbanded Rockfish *	-	-	-	-	-
Quillback Rockfish *	-	0.045	NA	-	0.059
Rosy Rockfish *	-	0.125	NA	-	0.162
Vermilion Rockfish **	-	0.113	NA	-	0.148
Yelloweye Rockfish **	-	0.011	NA	-	0.015
Cabezon	-	-	-	-	-
Eelpout	-	0.204	NA	0.146	0.221
Kelp Greenling	-	0.453	NA	-	0.590
Lingcod **	-	0.724	NA	0.292	0.856
Longspine Combfish	-	0.011	NA	-	0.015
North Pacific Argentine	-	-	-	-	-
Painted Greenling	-	-	-	-	-
Pink Seaperch	-	-	-	-	-
Poacher	-	0.011	NA	-	0.015
Ronquil	-	-	-	-	-
Sculpin	-	0.158	NA	0.292	0.118
Starry Skate	-	0.023	NA	-	0.030
English Sole *	-	-	-	-	-
Pacific Halibut *	-	-	-	-	-
Pacific Sanddab *	-	-	-	-	-
Petrale Sole *	-	-	-	-	-
Rex Sole *	-	-	-	-	-
Slender Sole *	-	-	-	-	-
Speckled Sanddab *	-	-	-	-	-
Starry Flounder **	-	-	-	-	-
Complex					
Olive/Yellowtail complex*	-	1.019	NA	-	1.328
Vermilion/Canary/ Yelloweye complex *	-	1.064	NA	0.097	1.358
Sebastomus **	-	0.170	NA	-	0.221
Other					
Pleuronectiformes *	-	10.561	NA	16.133	8.869
Sebastes spp. *	-	5.728	NA	0.389	7.349
Unidentified fishes	-	0.657	NA	0.680	0.649

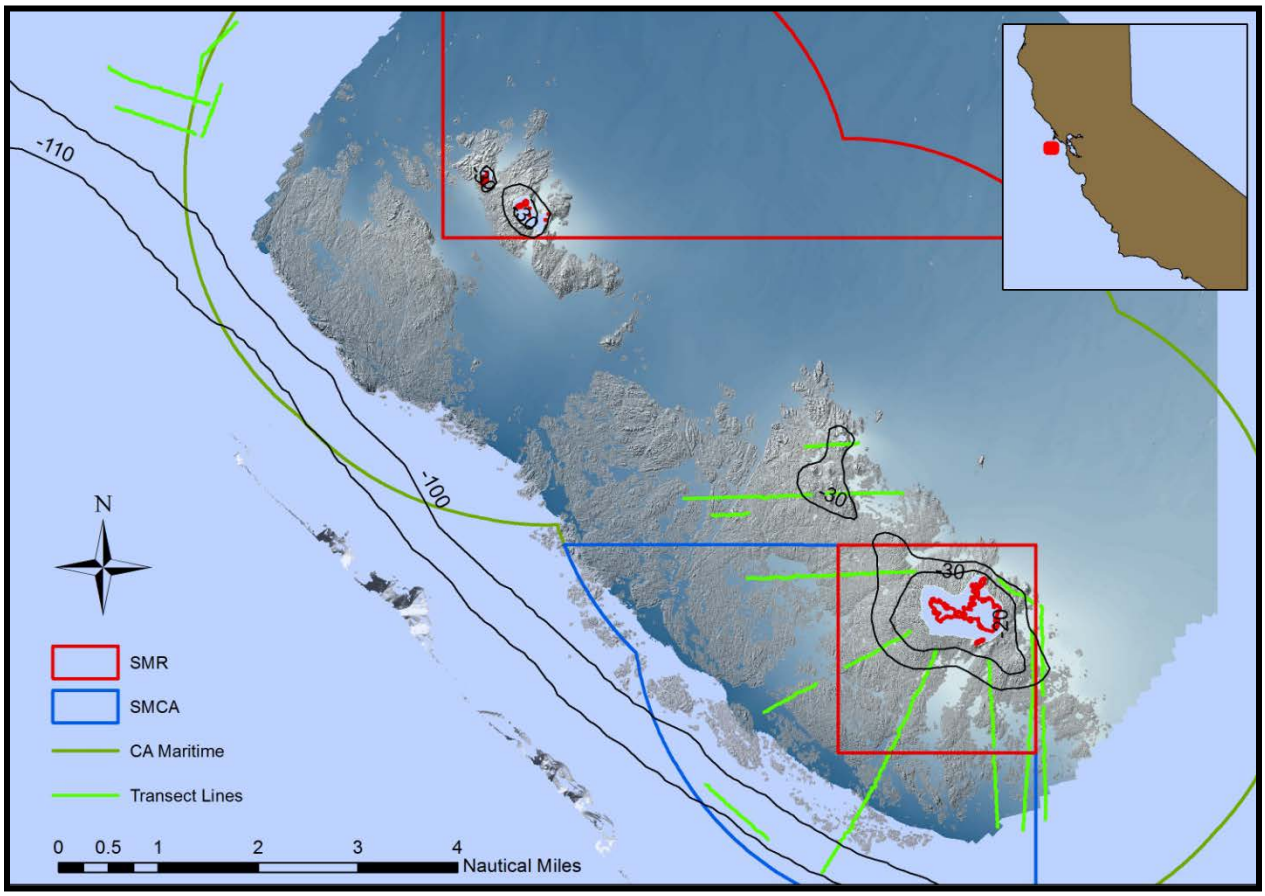


Figure 34. Map of ROV transects conducted at the Southeast Farallon Islands, including MPA boundaries, 20 and 30 meter isobaths, and sun-illuminated topographic map of the seafloor.

Classification of Seafloor Habitats - Habitat types were classified at each site using both sun-illuminated topographic maps created as part of the California State Mapping Project and additional data extracted from down-looking video imagery from the ROV. Habitat polygons were created in ArcGIS to capture habitats both within each MPA as well as areas adjacent to the MPAs. At the Southeast Farallon Islands they were classified as *Hard* (55% of the total area surveyed), which included moderate rocky outcrops, boulders and some cobbles; *Mixed* (19% of the total area surveyed),

including a combination of unconsolidated soft sediments with boulder, cobbles, or rock; and *Soft* sediment (26% of the total area surveyed; Fig. 35). Deep sandy substrate was characterized by mounds and depressions with many benthic fishes and invertebrates while shallow sandy substrate was characterized by large sand waves and fewer organisms.

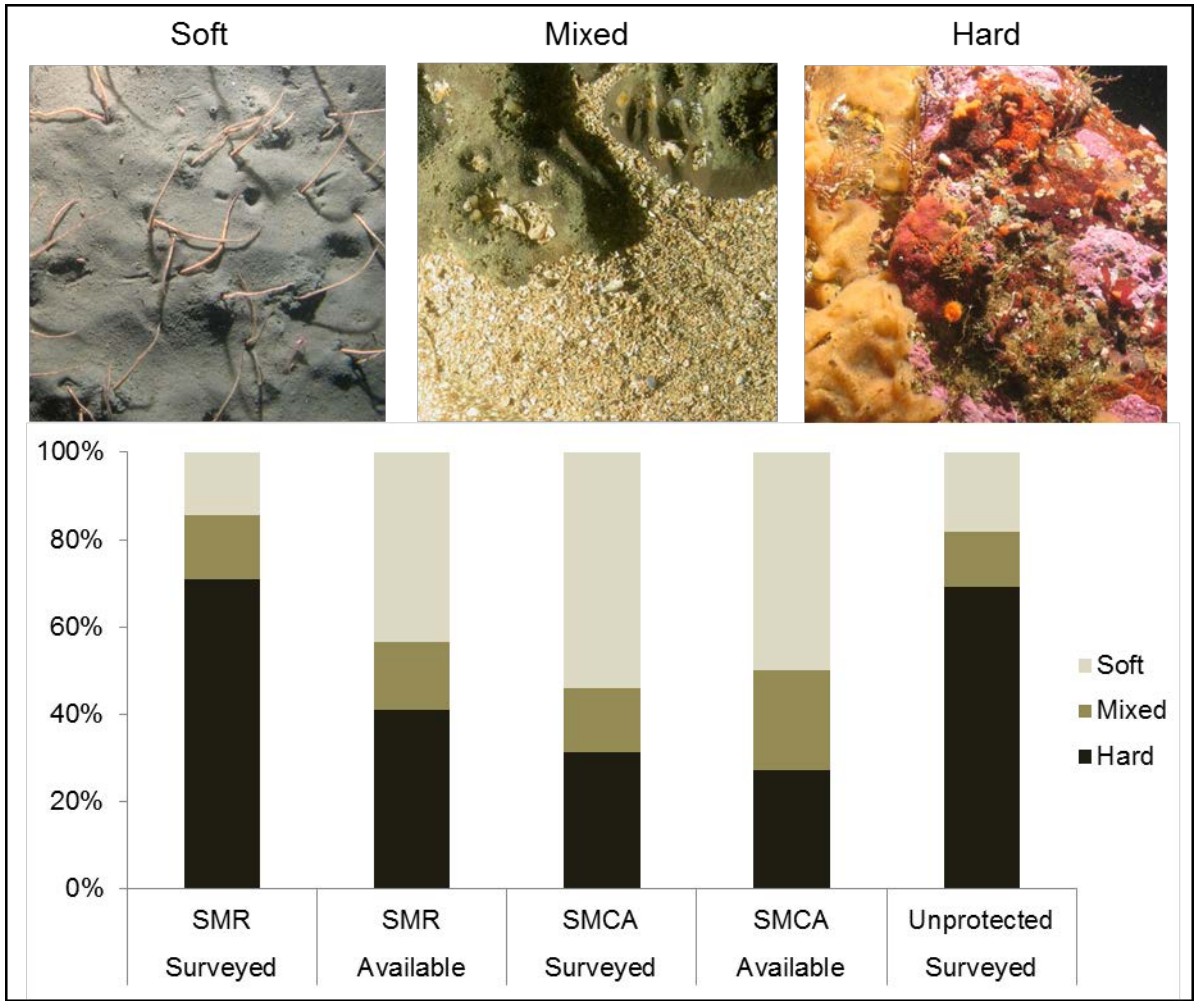


Figure 35. Substrate categories for the Southeast Farallon Islands, including the percentage of each broad substrate type surveyed by the ROV (Soft, Mixed, Hard) and the total amount of each available inside the SMR, the SMCA, and at the unprotected reference sites.

Fishes at the Southeast Farallon Islands

A total of 3,009 individual fishes were observed at the Southeast Farallon Islands, across 26 species, species groups, or morphological categories (Table 8). Counts of fishes identified to species ranged from a low of 1 fish (Black Rockfish) to a high of 278 fish (Rosy Rockfish). Flatfishes were abundant in the area but visibility limited our ability to identify most individuals.

Table 8. Count, relative abundance, density, and size frequency for observed fishes at the Southeast Farallon Islands. Primary (******) and secondary (*****) species requested in NCC Monitoring Plan.

Farallon Islands Fishes	Count	Relative Abundance	Density ($x10^{-4}$ m^2 ± 1SD)	Size frequency				
				10-20cm	20-30cm	30-40cm	40-50cm	+50 cm
Species								
Black Rockfish *	1	0.000	0.01 ± 0.04	-	1	-	-	-
Blue Rockfish *	349	0.101	2.59 ± 5.27	0.59	0.24	0.02	-	-
Brown Rockfish *	2	0.001	0.02 ± 0.07	0.50	-	0.50	-	-
Canary Rockfish *	98	0.028	0.07 ± 1.11	0.39	0.57	0.04	-	-
China Rockfish *	39	0.011	0.36 ± 0.59	0.05	0.79	0.13	0.03	-
Copper Rockfish *	19	0.006	0.17 ± 0.31	-	0.42	0.47	0.11	-
Gopher Rockfish *	11	0.003	0.06 ± 0.20	0.18	0.73	0.09	-	-
Halfbanded Rockfish *	3	0.001	0.02 ± 0.12	0.33	-	-	-	-
Quillback Rockfish *	73	0.021	0.67 ± 0.93	0.03	0.47	0.49	0.01	-
Rosy Rockfish *	287	0.083	2.42 ± 4.08	0.72	0.25	0.01	-	-
Vermilion Rockfish **	34	0.010	0.31 ± 0.41	0.03	0.38	0.56	0.03	-
Yelloweye Rockfish **	5	0.001	0.03 ± 0.12	0.20	-	0.20	-	-
Cabezon			-	-	-	-	-	-
Eelpout	8	0.002	0.03 ± 0.12	0.88	0.13	-	-	-
Kelp Greenling	182	0.053	1.76 ± 2.23	0.01	0.42	0.49	0.08	-
Lingcod **	178	0.052	1.48 ± 1.54	0.06	0.26	0.32	0.15	0.20
Longspine Combfish	3	0.001	0.04 ± 0.18	-	1	-	-	-
North Pacific Argentine	1	0.000	0.01 ± 0.06	1	-	-	-	-
Painted Greenling	12	0.003	0.09 ± 0.21	1	-	-	-	-
Pink Seaperch	24	0.007	0.19 ± 0.62	1	-	-	-	-
Poacher	13	0.004	0.16 ± 0.56	1	-	-	-	-
Ronquil	2	0.001	0.02 ± 0.07	0.05	-	-	-	-
Sculpin	11	0.003	0.07 ± 0.13	0.91	0.09	-	-	-
Starry Skate	1	0.000	0.02 ± 0.08	-	-	-	-	1
English Sole *	6	0.002	0.08 ± 0.27	0.33	0.67	-	-	-
Pacific Halibut *			-	-	-	-	-	-
Pacific Sanddab *	33	0.010	0.39 ± 1.67	0.52	0.42	0.06	-	-
Petrale Sole *	1	0.000	0.01 ± 0.07	1	-	-	-	-
Rex Sole *	7	0.002	0.09 ± 0.43	0.57	0.43	-	-	-
Slender Sole *	8	0.002	0.10 ± 0.49	0.75	0.25	-	-	-
Speckled Sanddab *	2	0.001	0.03 ± 0.09	1	-	-	-	-
Starry Flounder **	0	0.000	-	-	-	-	-	-
Species Complex								
Olive/Yellowtail complex*	212	0.062	1.69 ± 2.35	0.29	0.54	0.13	0.02	-
Vermilion/Canary/ Yelloweye complex *	11	0.003	0.08 ± 0.14	-	0.45	0.36	0.09	-
Sebastomus **	367	0.106	2.87 ± 4.49	0.79	0.17	0.01	-	-
Other								
Pleuronectiformes *	478	0.139	4.24 ± 11.52	0.83	0.15	0.02	0.00	-
Sebastes spp. *	513	0.149	3.75 ± 5.90	0.78	0.12	0.02	0.00	-
Unidentified fishes	453	0.131	4.03 ± 6.85	0.79	0.08	0.01	0.00	0.01

Fishes in Mid-Depth Rock and Soft Bottom Ecosystems

The majority of fishes found over hard substrates of the Southeast Farallon Islands were Rockfishes (*Sebastes* spp., Fig. 36). The Roundfishes and Other Fishes categories were broad categories used to bin organisms that were observed, but not identified, usually due to poor visibility. Roundfishes included all non-flat fishes that were not identifiable further, while Other Fishes was even more general and could include any species of fish found in the area. In the soft substrate, Flatfishes comprised approximately 50% of the fish observations.

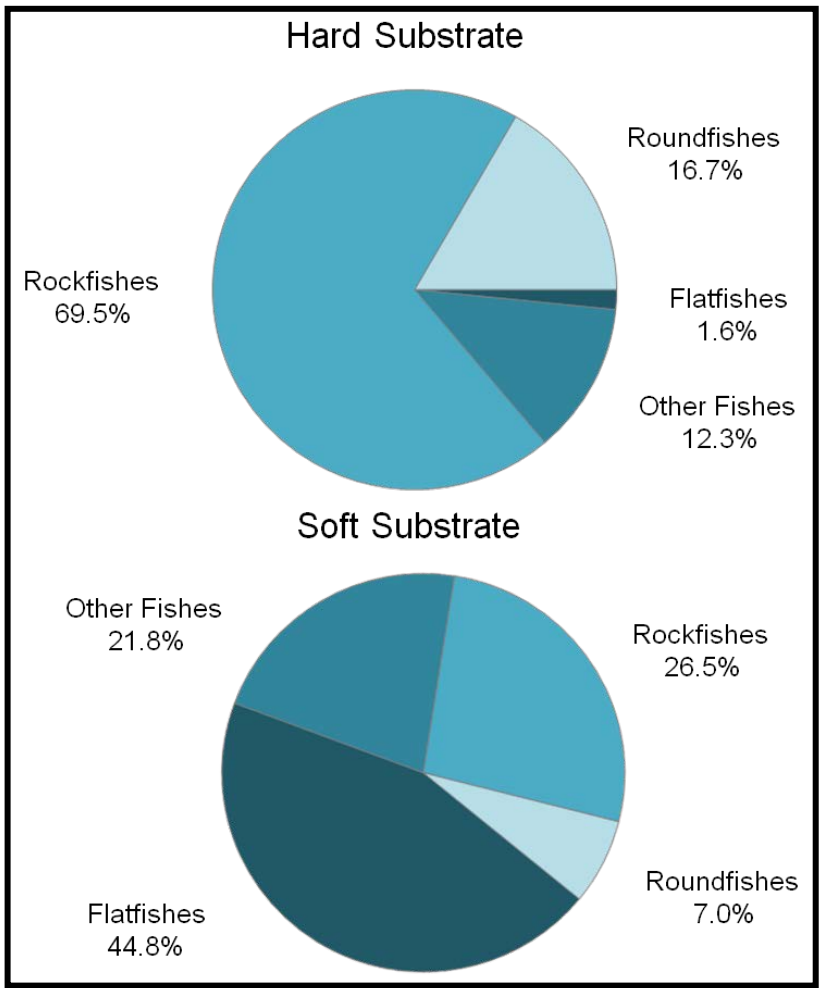


Figure 36. The fish observed at the Southeast Farallon Islands expressed as a percentage of the major categories of fishes found over Hard Substrate (top) and Soft Substrate (bottom).

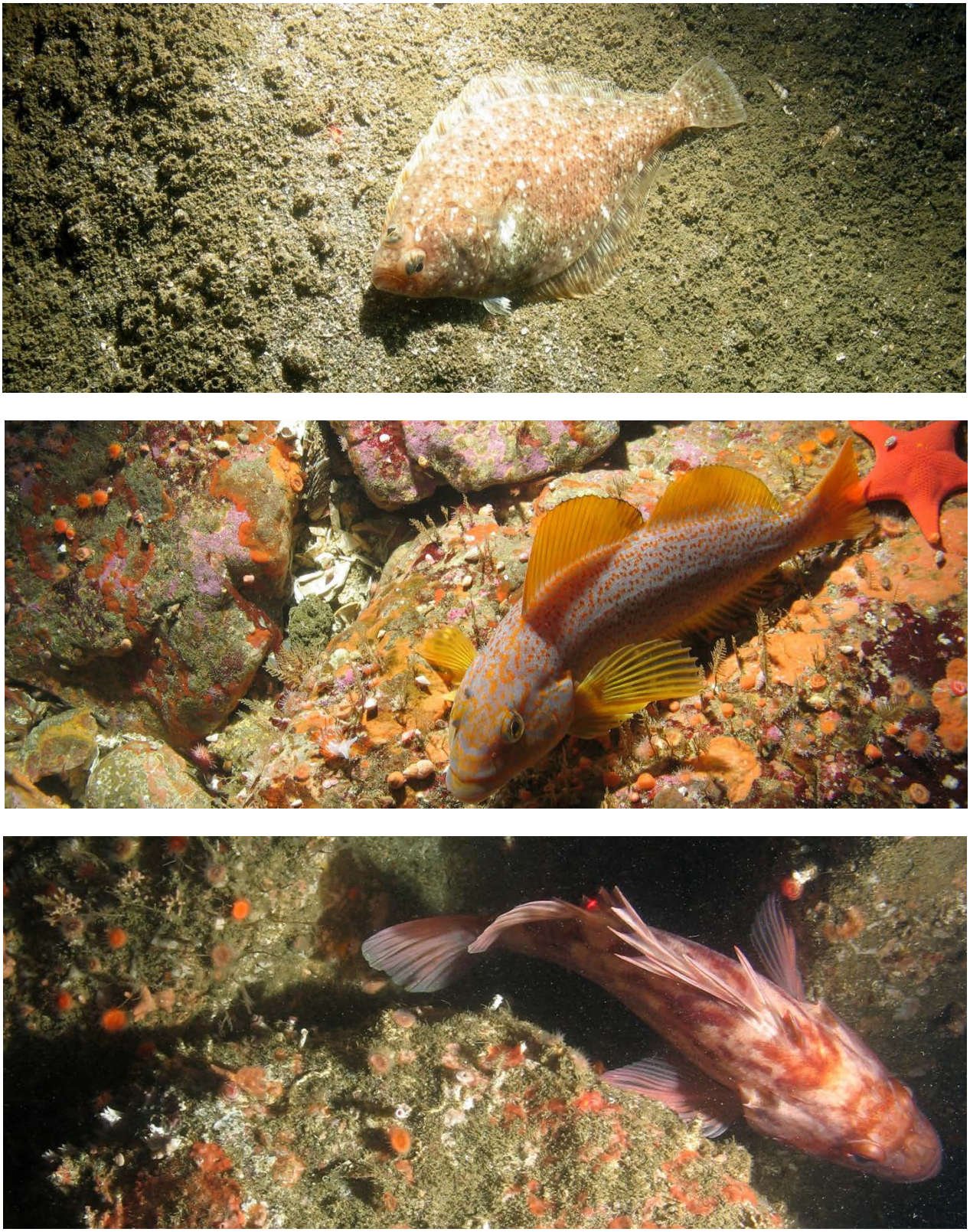


Figure 37. Fishes of the Southeast Farallon Islands occurring over soft substrate (top, Sanddab), mixed substrate (middle, female Kelp Greenling), and hard substrate (bottom, Brown Rockfish).

Mobile Invertebrates in Mid-Depth Rock and Soft Bottom Ecosystems

Sea Stars (~ 63%) and Sea Cucumbers (~34%) comprised the majority of mobile invertebrate observations over hard substrates, as well as most of the observations in soft substrates (over 72% and 25%, respectively). Zero crabs were observed over hard substrates in these areas. Within soft substrates, Dungeness Crab observations only totaled 0.5%, the lowest proportion of all five geographies.

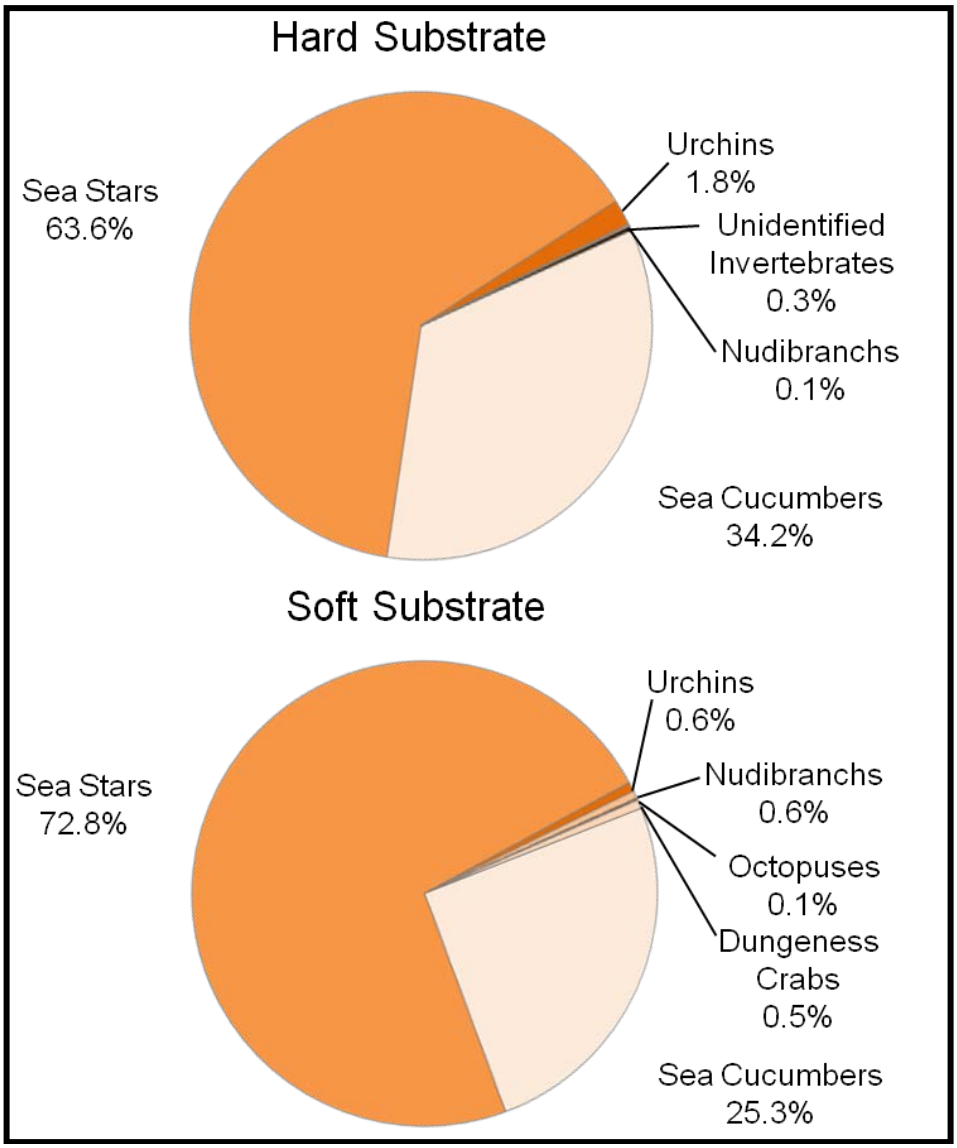


Figure 38. Mobile invertebrates observed at the Southeast Farallon Islands expressed as a percentage of the major categories of fishes found over Hard Substrate (top) and Soft Substrate (bottom).

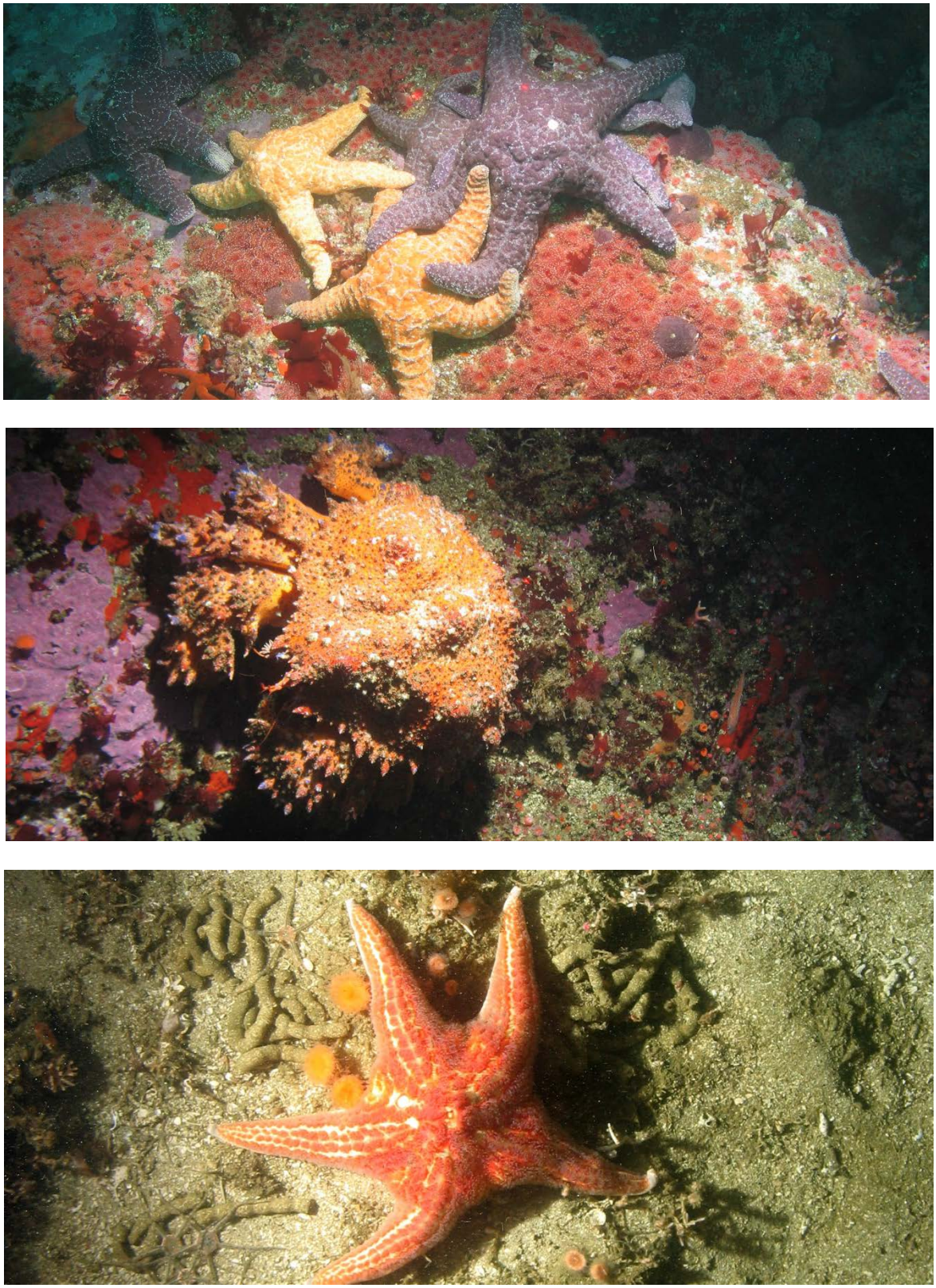


Figure 39. Mobile invertebrates of the Southeast Farallon Islands occurring over hard substrate (top, Ochre Sea Stars; middle, Puget Sound King Crab) and soft substrate (bottom, Leather Sea Star).

Structure-Forming Invertebrates in Mid-Depth Rock and Soft Bottom Ecosystems

Metridium (over 47%) and Anemones (over 29%) made up the majority of the sessile invertebrates observed over hard substrate in the Southeast Farallon Islands (Fig. 40). Sponges totaled more than 12% of the observations, which is the second highest proportion of all five geographies. Observations over soft substrate were almost entirely of Sea Whips/Pens (over 97%).

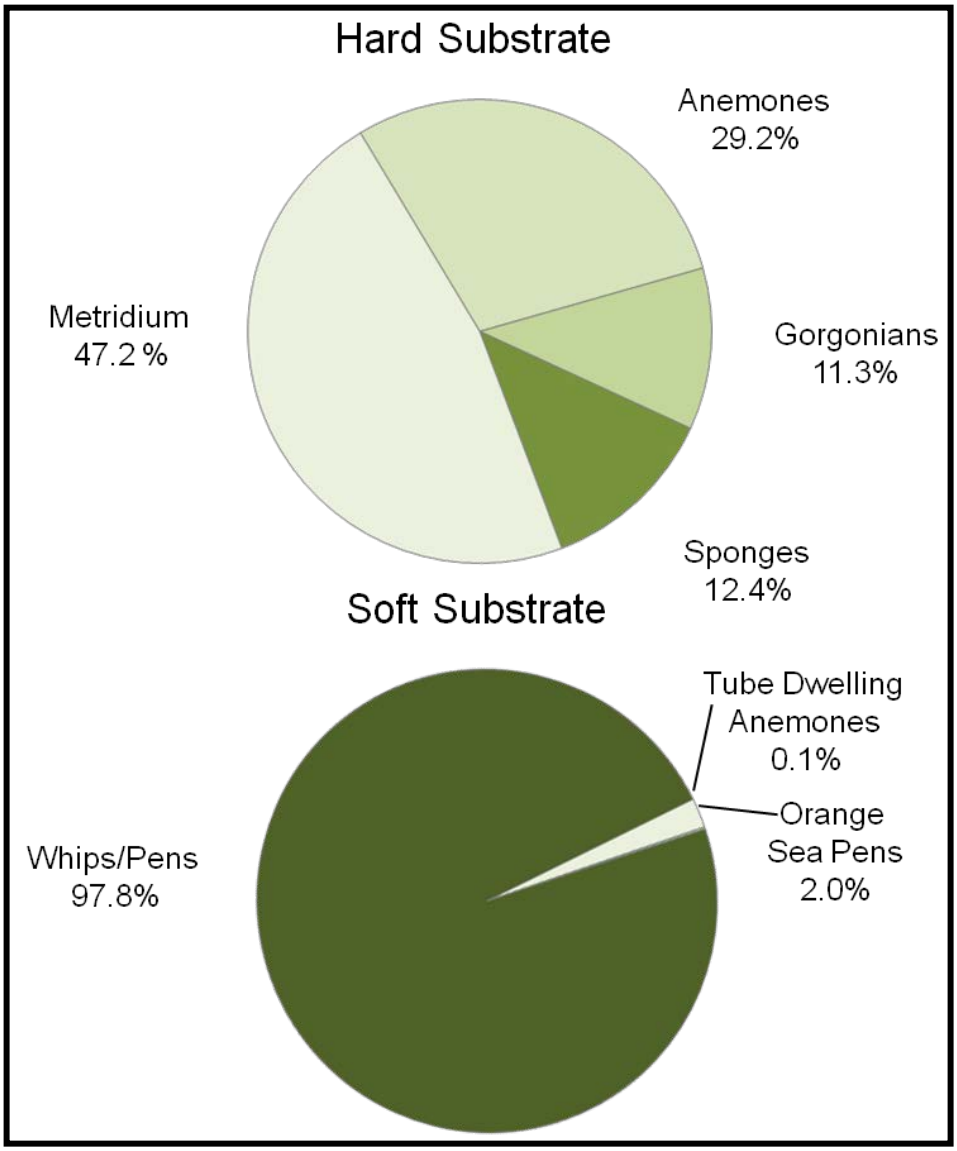


Figure 40. Structure-forming invertebrates observed at the Southeast Farallon Islands expressed as a percentage of the major categories of fishes found over Hard Substrate (top) and Soft Substrate (bottom).

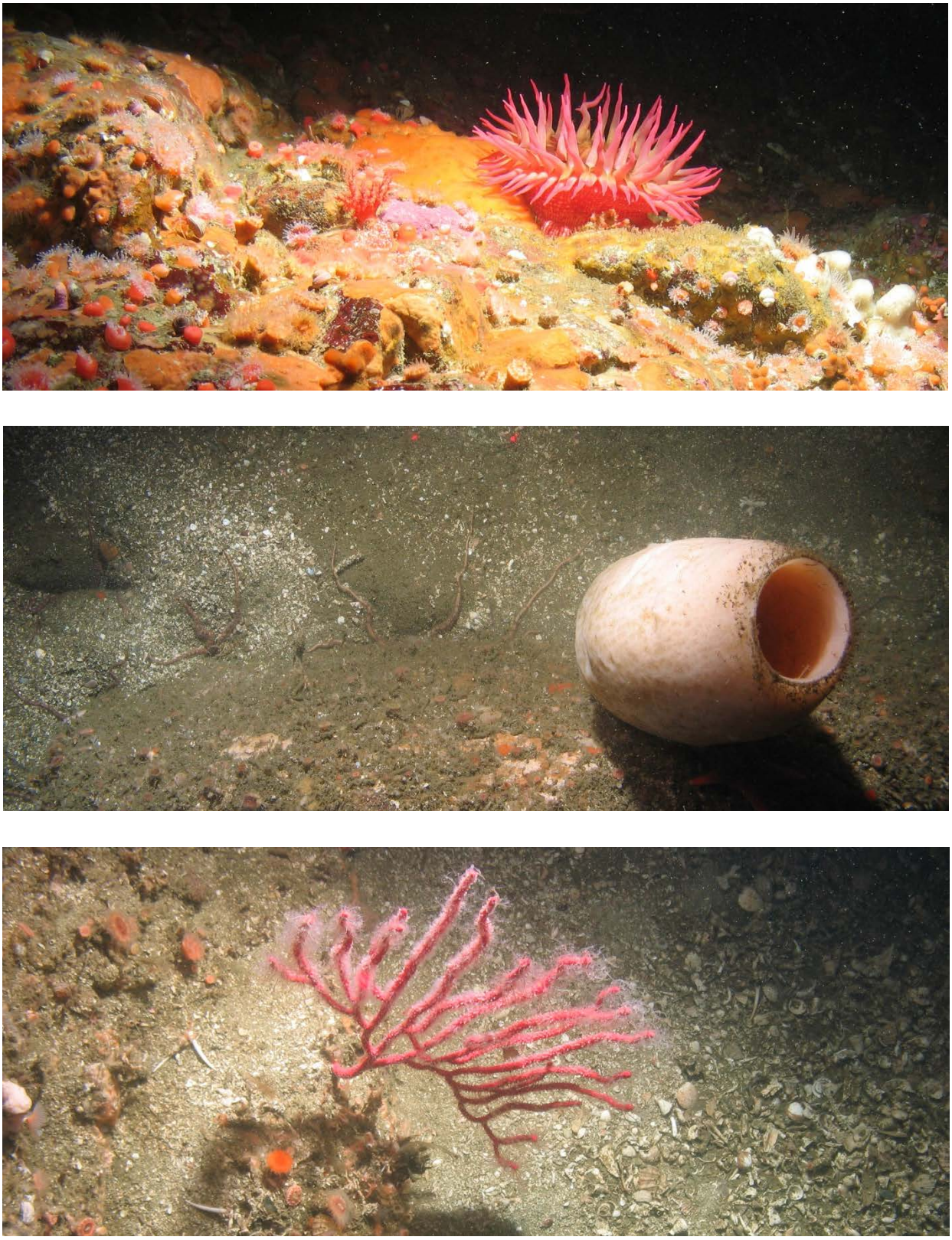


Figure 41. Sessile invertebrates of the Southeast Farallon Islands occurring over hard substrate (top, White-spotted Rose Anemone) and mixed substrate (middle, Sponge; bottom, Red Gorgonian).

Fish and Invertebrate Associations with the Seafloor

Summary data from 2011 indicate that overall, benthic fishes were observed more commonly than epibenthic fishes, though a large school of mixed Rockfish species (including Blue, Olive, and Yellowtail Rockfishes) was observed. Benthic fishes were observed on all substrate types primarily singularly and flatfishes were observed strictly on sand. Both mobile and sessile invertebrates occurred over all substrates.

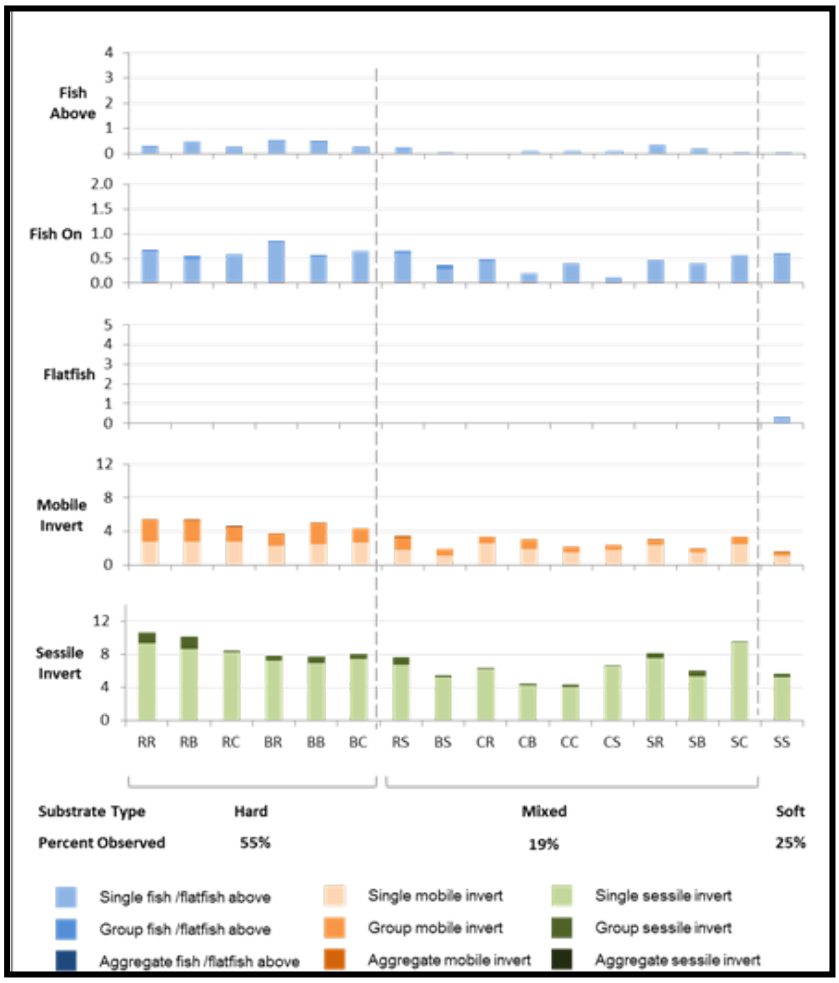


Figure 42. Fishes, mobile invertebrates, and sessile invertebrates at the Southeast Farallon Islands expressed as a percentage of all observations over Hard, Mixed, and Soft substrates.

Variability within the One-Year Baseline

This project, as described above, was conceived and implemented as a one-year baseline against which any future changes in these ecosystems could be evaluated. Our sampling with the ROV at Southeast Farallon Islands (Figure 34, above) in 2010 and 2011 was not intended to flesh out any differences between the two sampling periods, insofar as different areas were transected from one year to another. Further, given that our sampling was conducted essentially at the moment of designation for the NCC MPAs, we were not focused on any "MPA effects" at this state, but rather the fullest characterization possible. Below we have included a brief summary of the variability in our observations of selected organisms and habitat attributes between years.

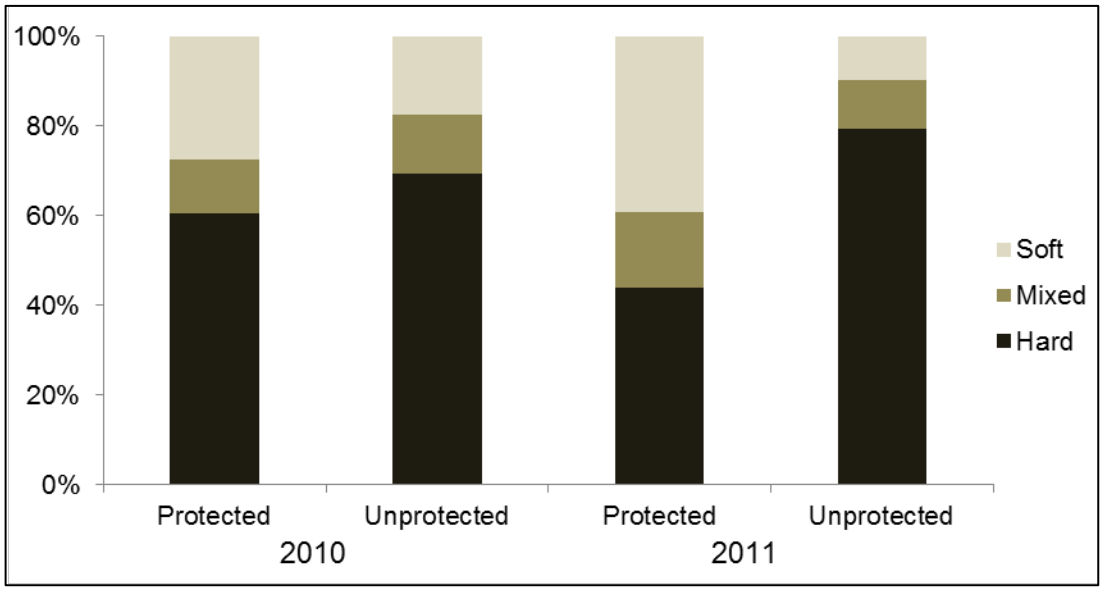


Figure 43. Variability in seafloor habitats sampled by the ROV between the 2010 and 2011 study years at the Southeast Farallon Islands.

Table 9. Variability between years and density in protected and unprotected areas for observed fishes at Southeast Farallon Islands. Primary (******) and secondary (*****) species requested in NCC Monitoring Plan.

Southeast Farallon Islands Fishes	Density 2010 ($x10^{-4}$ m^2)	Density 2011 ($x10^{-4}$ m^2)	Initial Variability 2010 to 2011	Density in Protected Areas 2010 & 2011 ($x10^{-4}$ m^2)	Density in Unprotected Areas 2010 & 2011 ($x10^{-4}$ m^2)
Species					
Black Rockfish *	-	0.009	NA	-	0.012
Blue Rockfish *	4.042	1.045	-74%	0.913	3.282
Brown Rockfish *	0.034	-	NA	0.012	0.012
Canary Rockfish *	0.791	0.477	-40%	0.403	0.772
China Rockfish *	0.310	0.193	-38%	0.095	0.374
Copper Rockfish *	0.120	0.110	-8%	0.166	0.060
Gopher Rockfish *	0.172	0.009	-95%	0.012	0.121
Halfbanded Rockfish *	-	0.028	NA	-	0.036
Quillback Rockfish *	0.705	0.293	-58%	0.439	0.434
Rosy Rockfish *	0.929	2.136	130%	1.233	2.208
Vermilion Rockfish **	0.378	0.110	-71%	0.190	0.217
Yelloweye Rockfish **	0.017	0.037	118%	0.012	0.048
Cabezon	-	-	-	-	-
Eelpout	-	0.073	NA	0.095	-
Kelp Greenling	1.634	0.798	-51%	1.127	1.050
Lingcod **	0.688	1.265	84%	1.091	1.038
Longspine Combfish	-	0.028	NA	0.036	-
North Pacific Argentine	-	0.009	NA	0.012	-
Painted Greenling	0.017	0.101	494%	0.024	0.121
Pink Seaperch	-	0.220	NA	0.273	0.012
Poacher	-	0.119	NA	0.154	-
Ronquil	-	0.018	NA	0.012	0.012
Sculpin	0.052	0.073	40%	0.083	0.048
Starry Skate	0.017	-	NA	0.012	-
English Sole *	0.034	0.037	9%	0.071	-
Pacific Halibut *	-	-	-	-	-
Pacific Sanddab *	-	0.303	NA	0.391	-
Petrale Sole *	0.017	-	NA	0.012	-
Rex Sole *	-	0.064	NA	0.083	-
Slender Sole *	-	0.073	NA	0.095	-
Speckled Sanddab *	-	0.018	NA	0.024	-
Starry Flounder **	-	-	-	-	-
Complex					
Olive/Yellowtail complex*	0.774	1.531	98%	0.901	1.64
Vermilion/Canary/ Yelloweye complex *	1.256	0.688	-45%	0.652	1.122
Sebastomus **	2.305	4.768	107%	3.320	4.435
Other					
Pleuronectiformes *	1.260	4.236	236%	5.799	0.555
Sebastes spp. *	12.074	12.121	0%	9.546	14.709
Unidentified fishes	0.654	3.805	482%	2.977	2.437

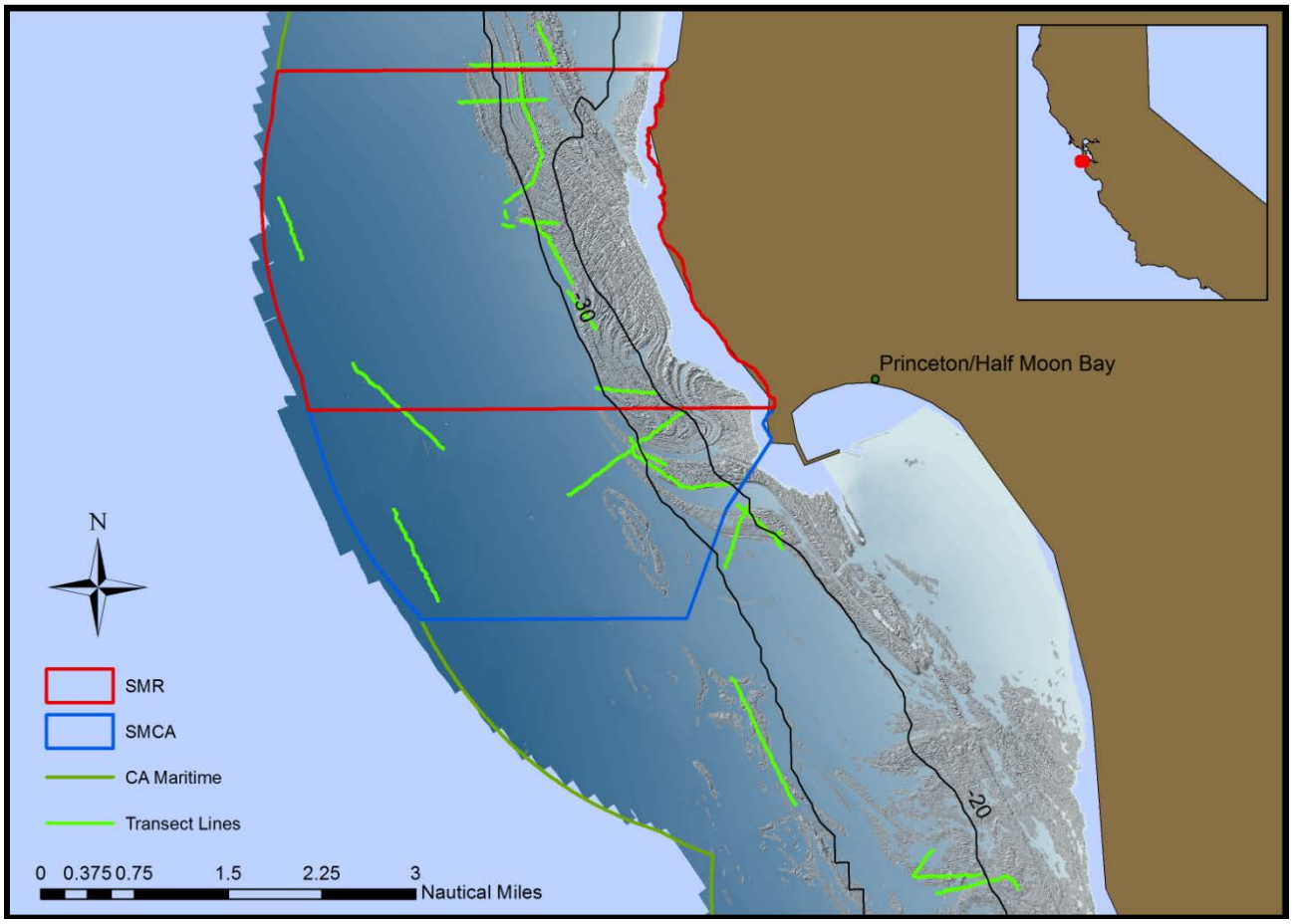


Figure 44. Map of ROV transects conducted at Pillar Point / Montara, including MPA boundaries, 20 and 30 meter isobaths, and sun-illuminated topographic map of the seafloor.

Classification of Seafloor Habitats - Habitat types were classified at each site using both sun-illuminated topographic maps created as part of the California State Mapping Project and additional data extracted from down-looking video imagery from the ROV. Habitat polygons were created in ArcGIS to capture habitats both within each MPA as well as areas adjacent to the MPAs. At Pillar Point / Montara they were classified as *Hard* (51% of the total area surveyed), which included large boulders, rocky outcrops, and some cobbles; *Mixed* (17% of the total area surveyed), including a combination of

unconsolidated soft sediments with boulder, cobbles, or rock; and *Soft* sediment (32% of the total area surveyed; Fig. 45).

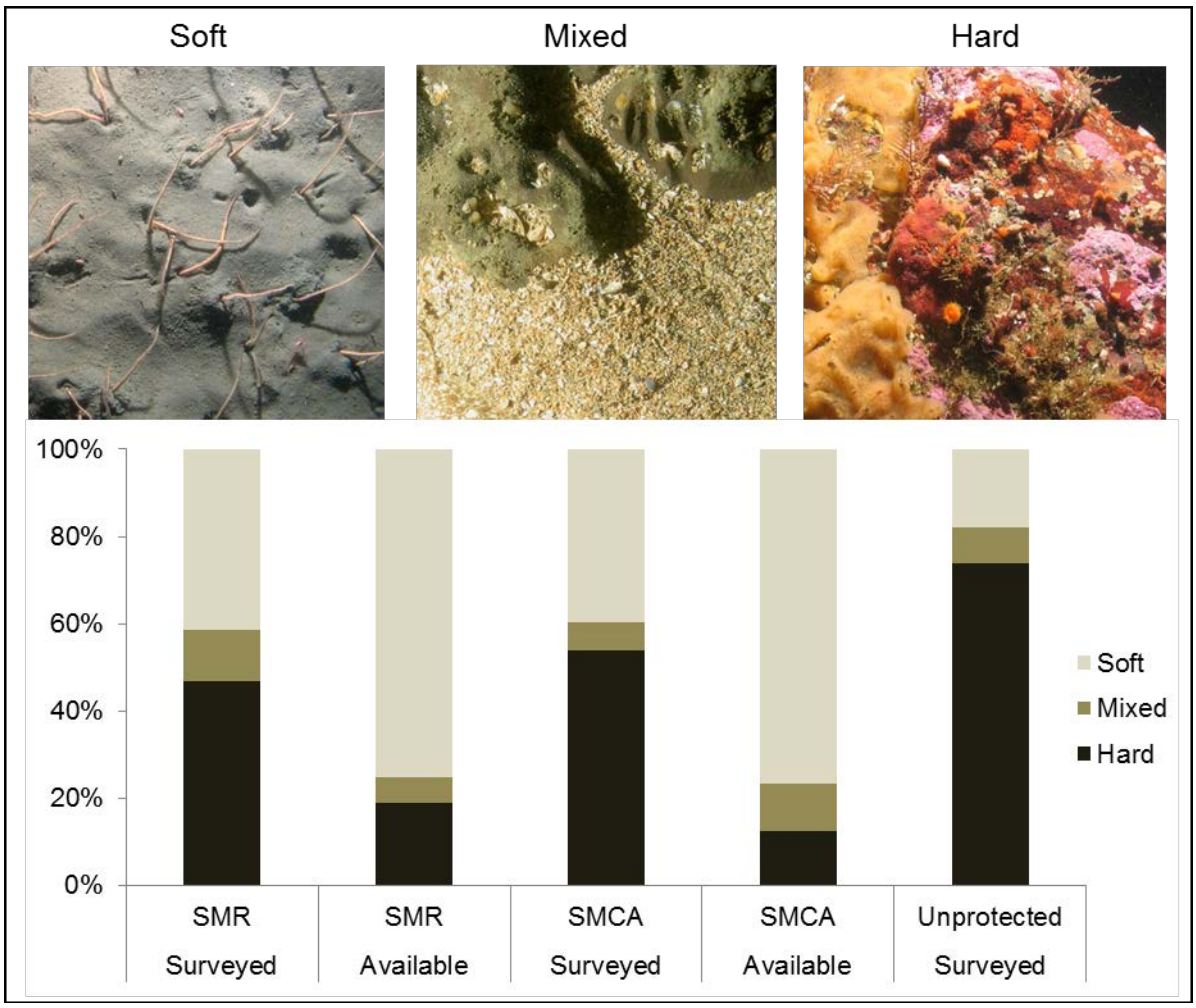


Figure 45. Substrate categories for Pillar Point / Montara, including the percentage of each broad substrate type surveyed by the ROV (Soft, Mixed, Hard) and the total amount of each available inside the SMR, the SMCA, and at the unprotected reference sites.

Fishes at Pillar Point / Montara

A total of 665 individual fishes were observed at Pillar Point / Montara across 26 species, species groups, or morphological categories (Table 10). Counts of fishes identified to species ranged from a low of 1 fish (Rosy Rockfish) to a high of 118 fish (Lingcod). Flatfishes were abundant in the area but visibility limited our ability to identify most individuals.

Table 10. Count, relative abundance, density, and size frequency for observed fishes at Pillar Point / Montara. Primary (**) and secondary (*) species requested in NCC Monitoring Plan.

Pillar Point / Montara Fishes	Count	Relative Abundance	Density ($x10^{-4}$ m^2 ± 1SD)	Size frequency				
				10-20cm	20-30cm	30-40cm	40-50cm	+50 cm
Species								
Black Rockfish *	3	0.005	0.02 ± 0.07	0.33	0.67	-	-	-
Blue Rockfish *	-	-	-	-	-	-	-	-
Brown Rockfish *	4	0.006	0.05 ± 0.16	0.25	0.75	-	-	-
Canary Rockfish *	22	0.034	0.21 ± 0.56	0.59	0.36	0.05	-	-
China Rockfish *	4	0.006	0.06 ± 0.16	0.5	0.5	-	-	-
Copper Rockfish *	-	-	-	-	-	-	-	-
Gopher Rockfish *	11	0.017	0.11 ± 0.29	0.181	0.545	-	-	-
Halfbanded Rockfish *	-	-	-	-	-	-	-	-
Quillback Rockfish *	-	-	-	-	-	-	-	-
Rosy Rockfish *	1	0.002	0.00 ± 0.00	-	1	-	-	-
Vermilion Rockfish **	5	0.008	0.02 ± 0.05	0.2	-	0.6	0.2	-
Yelloweye Rockfish **	-	-	-	-	-	-	-	-
Cabezon	-	-	-	-	-	-	-	-
Eelpout	1	0.002	0.01 ± 0.05	1	-	-	-	-
Kelp Greenling	108	0.169	1.17 ± 1.69	0.046	0.685	0.259	0.009	-
Lingcod **	119	0.186	1.55 ± 2.37	0.47	0.17	0.18	0.09	0.02
Longspine Combfish	2	0.003	0.03 ± 0.13	1	-	-	-	-
North Pacific Argentine	-	-	-		-	-	-	-
Painted Greenling	5	0.008	0.04 ± 0.15	1	-	-	-	-
Pink Seaperch	-	-	-		-	-	-	-
Poacher	1	0.002	0.01 ± 0.07	1	-	-	-	-
Ronquil	1	0.002	0.01 ± 0.04		-	-	-	-
Sculpin	1	0.002	0.01 ± 0.07	1	-	-	-	-
Starry Skate	-	-	-	-	-	-	-	-
English Sole *	1	0.002	0.01 ± 0.03	-	-	-	-	-
Pacific Halibut *	1	0.002	0.01 ± 0.05	-	-	-	-	-
Pacific Sanddab *	3	0.005	0.04 ± 0.20	-	-	-	-	-
Petrale Sole *	-	-	-	-	-	-	-	-
Rex Sole *	-	-	-	-	-	-	-	-
Slender Sole *	-	-	-	-	-	-	-	-
Speckled Sanddab *	-	-	-	-	-	-	-	-
Starry Flounder **	3	0.005	0.03 ± 0.20	0.67	0.33	-	-	-
Species Complex								
Olive/Yellowtail complex*	6	0.009	0.06 ± 0.16	0.33	0.50	0.17	-	-
Vermilion/Canary/ Yelloweye complex *	6	0.009	0.07 ± 0.16	0.33	0.17	0.33	-	-
Sebastomus **	1	0.002	0.00 ± 0.00	1.00	-	-	-	-
Other								
Pleuronectiformes *	99	0.155	1.17 ± 3.32	0.76	0.03	0.01	-	-
Sebastes spp. *	58	0.091	0.72 ± 1.95	0.60	0.24	0.02	-	-
Unidentified fishes	173	0.271	1.49 ± 1.52	0.62	0.13	0.02	-	0.01

Fishes in Mid-Depth Rock and Soft Bottom Ecosystems

Fishes found in the hard substrate habitat of Pillar Point / Montara comprised relatively even proportions of Rockfishes (*Sebastes* spp.), Roundfishes, and Other Fishes (Fig. 46). The Roundfishes and Other Fishes categories were broad categories used to bin organisms that were observed, but not identified, usually due to poor visibility. Roundfishes included all non-flat fishes that were not identifiable further, while Other Fishes was even more general and could include any species of fish found in the area. In the soft substrate, Flatfishes and Roundfishes comprised the majority of fish observations, with Roundfishes constituting the highest proportion of all five geographies.

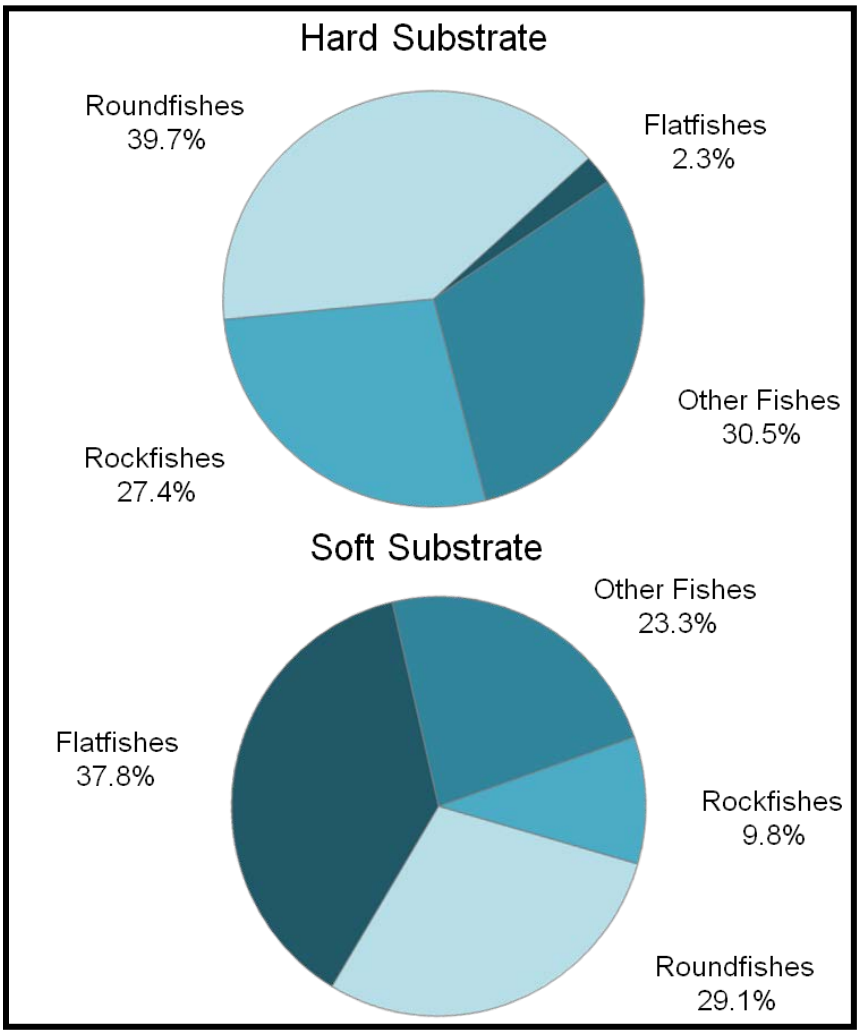


Figure 46. The fish observed at Pillar Point / Montara expressed as a percentage of the major categories of fishes found over Hard Substrate (top) and Soft Substrate (bottom).

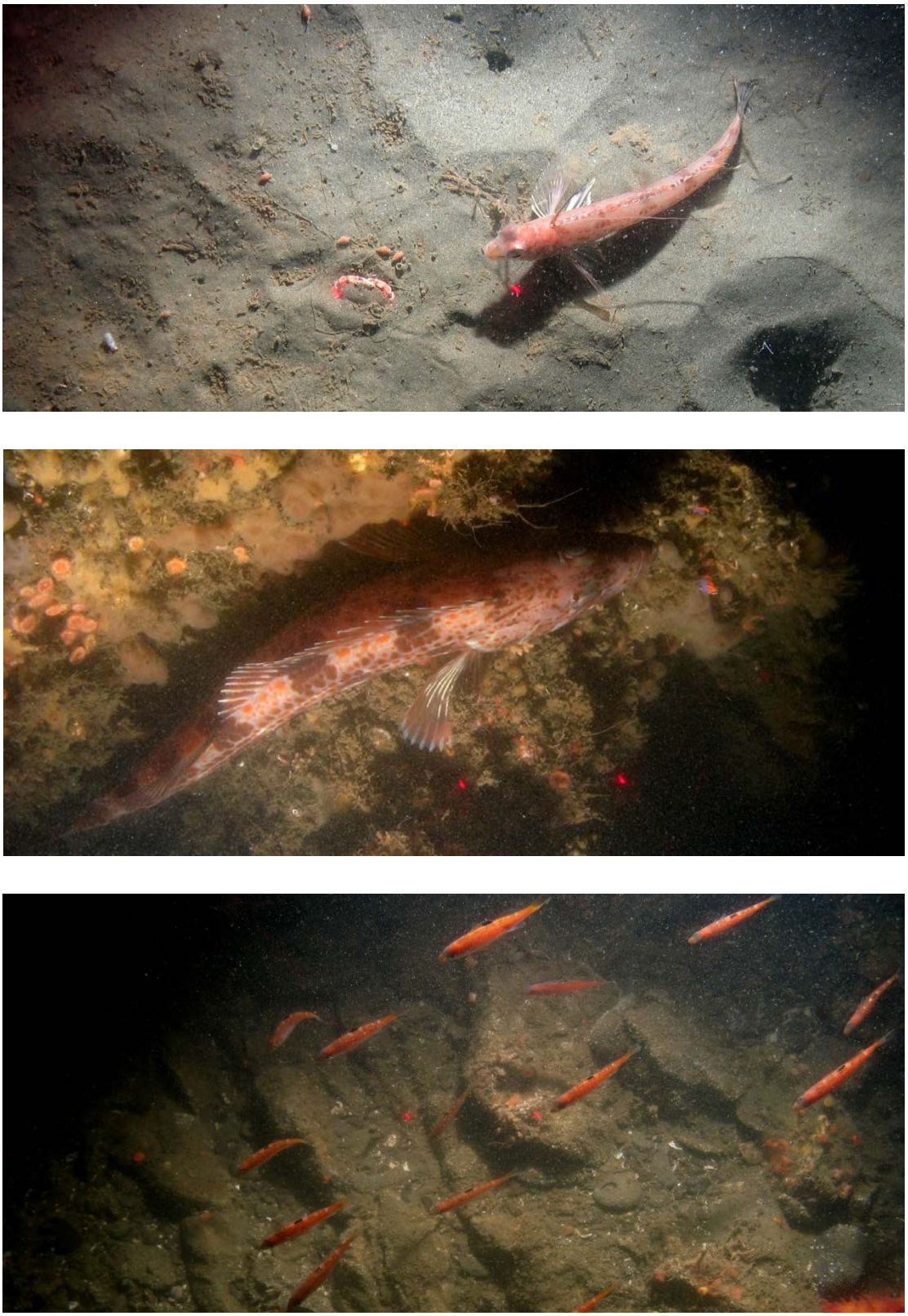


Figure 47. Fishes of Pillar Point / Montara occurring over soft substrate (top, Longspine Combfish) and hard substrate (middle, Lingcod; bottom, Young-of-the-Year Rockfish).

Mobile Invertebrates in Mid-Depth Rock and Soft Bottom Ecosystems

Sea Stars (over 85%) comprised the majority of mobile invertebrate observations over hard substrates, as well as the soft substrates (over 75%) of the Pillar Point / Montara study sites (Fig. 48). Within soft substrates, Dungeness Crab observations totaled approximately 20%, the second highest proportion of all five geographies.

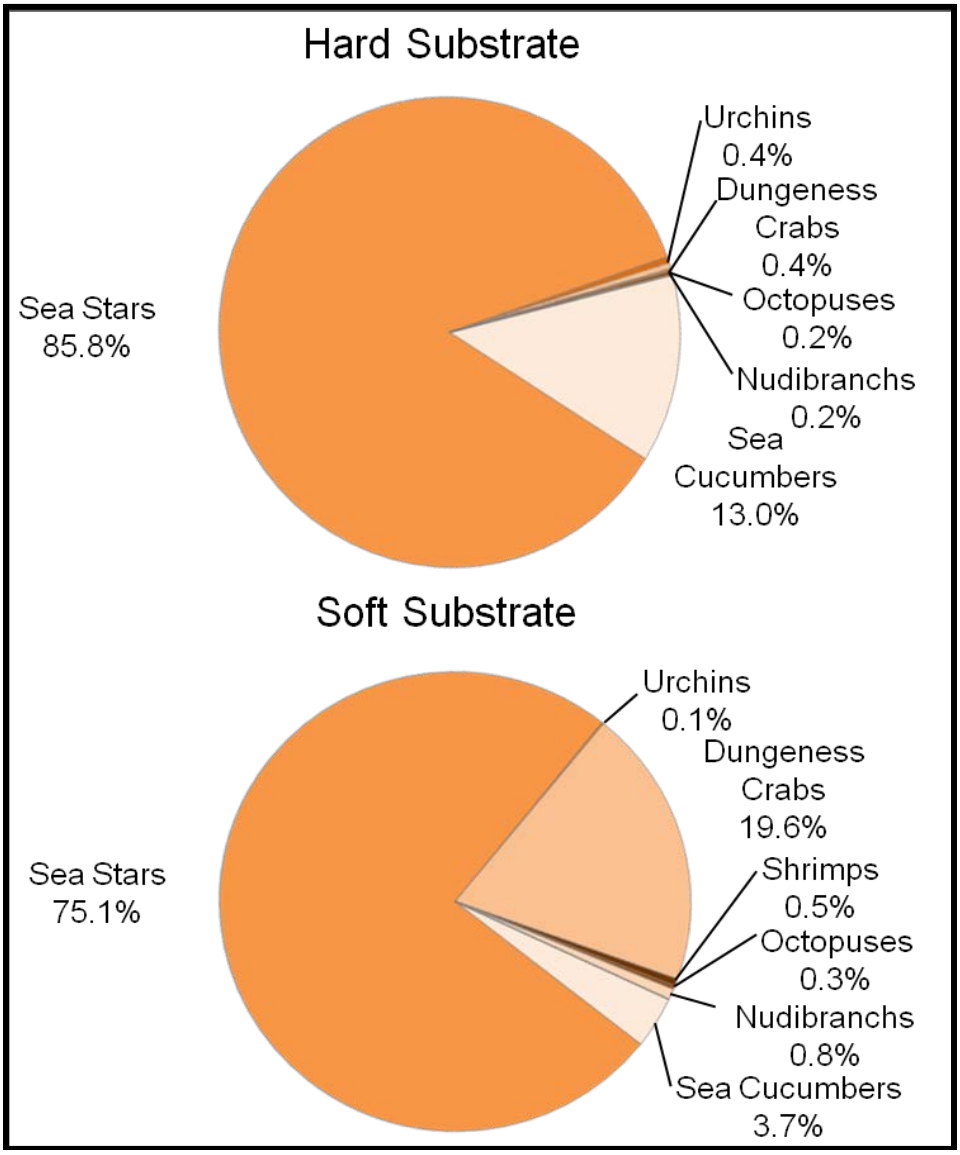


Figure 48. Mobile invertebrates observed at Pillar Point / Montara expressed as a percentage of the major categories of fishes found over Hard Substrate (top) and Soft Substrate (bottom).

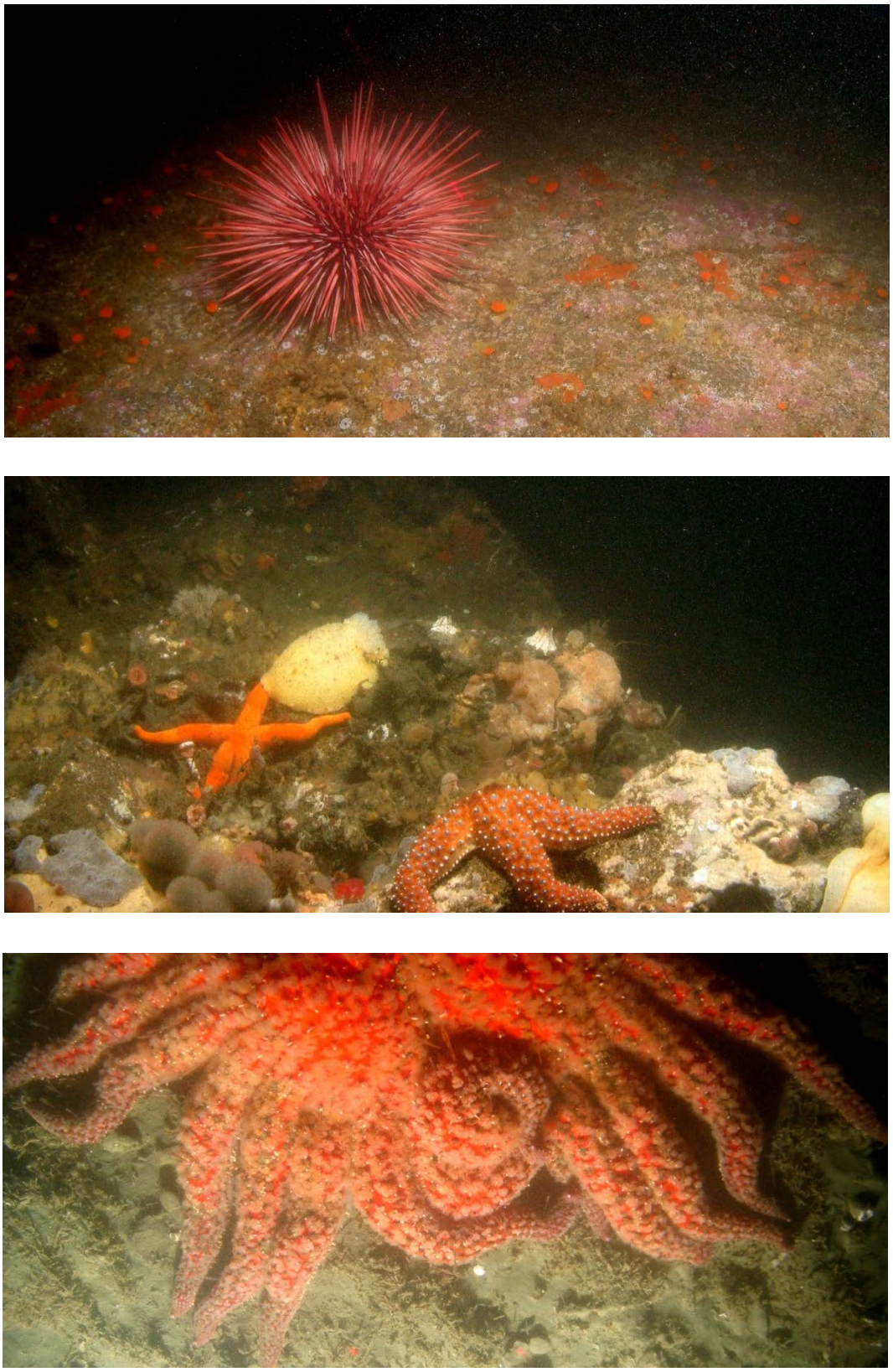


Figure 49. Mobile invertebrates of Pillar Point / Montara occurring over hard substrate (top, Red Urchin; middle, Sea Stars and Nudibranch) and soft substrate (bottom, Sun Star).

Structure-Forming Invertebrates in Mid-Depth Rock and Soft Bottom Ecosystems

Metridium (over 28%) and Anemones (over 38%) made up the majority of the structure-forming invertebrates observed over hard substrate at Pillar Point / Montara (Fig. 50). Sponges totaled more than 20% of the observations, which is the highest proportion of all five geographies. Over soft substrate, observations were almost entirely Sea Whips/Pens (over 99%).

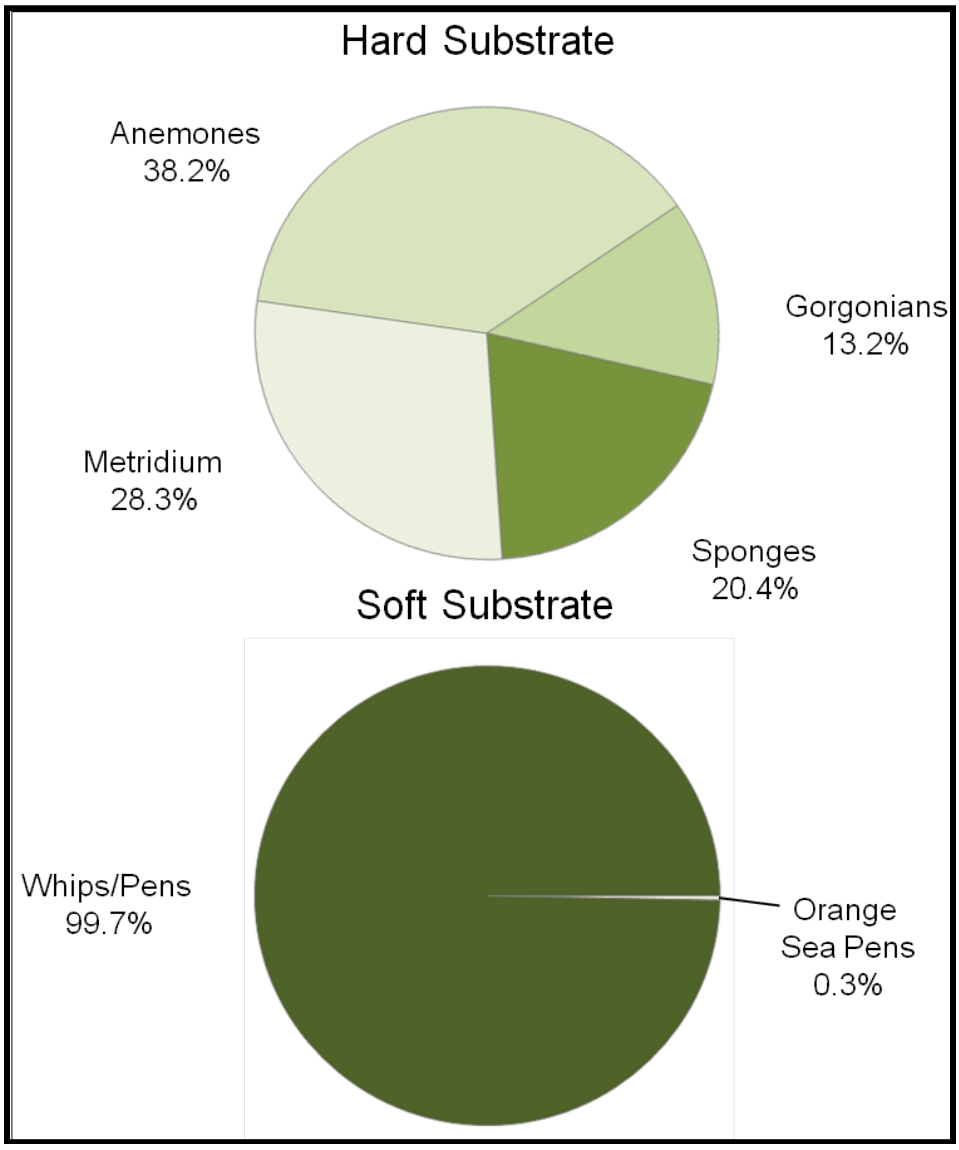


Figure 50. Structure-forming invertebrates observed at Pillar Point / Montara expressed as a percentage of the major categories of fishes found over Hard Substrate (top) and Soft Substrate (bottom).

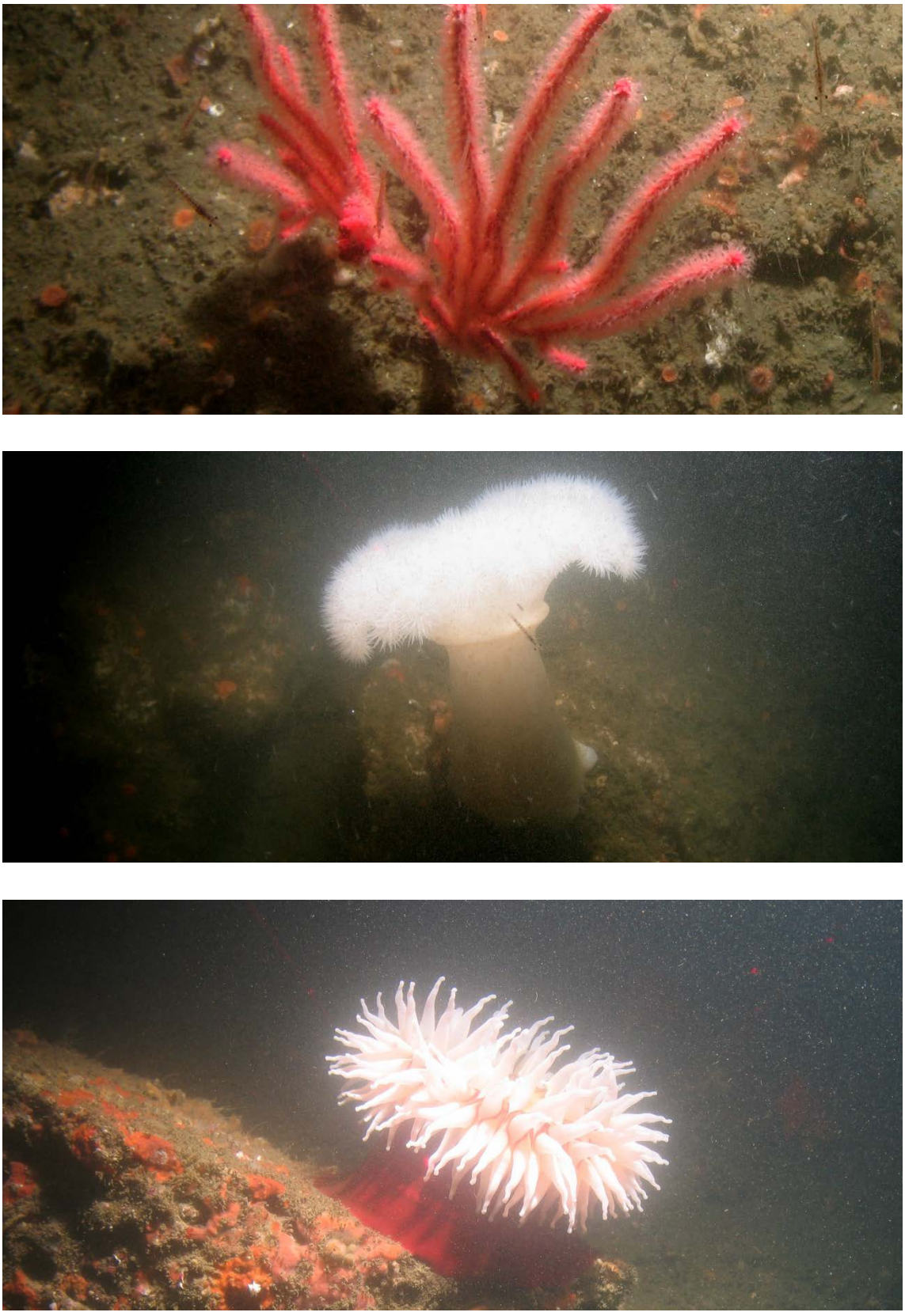


Figure 51. Sessile invertebrates occurring at Pillar Point / Montara over hard substrate (top, Red Gorgonian; middle, Metridium; bottom, Fish-eating Anemone).

Fish and Invertebrate Associations with the Seafloor

Summary data from 2011 indicate that overall, epibenthic fishes were rarely observed, except in an unprotected study site adjacent to the MPAs near large, rounded boulders. Fishes were most commonly observed in contact with the bottom over both hard and mixed substrates. Flatfishes were observed strictly on sand. Both mobile and sessile invertebrates occurred over all substrates, represented by different species in different habitats. Many newly recruited Dungeness Crabs and small Lingcod were observed in soft substrates.

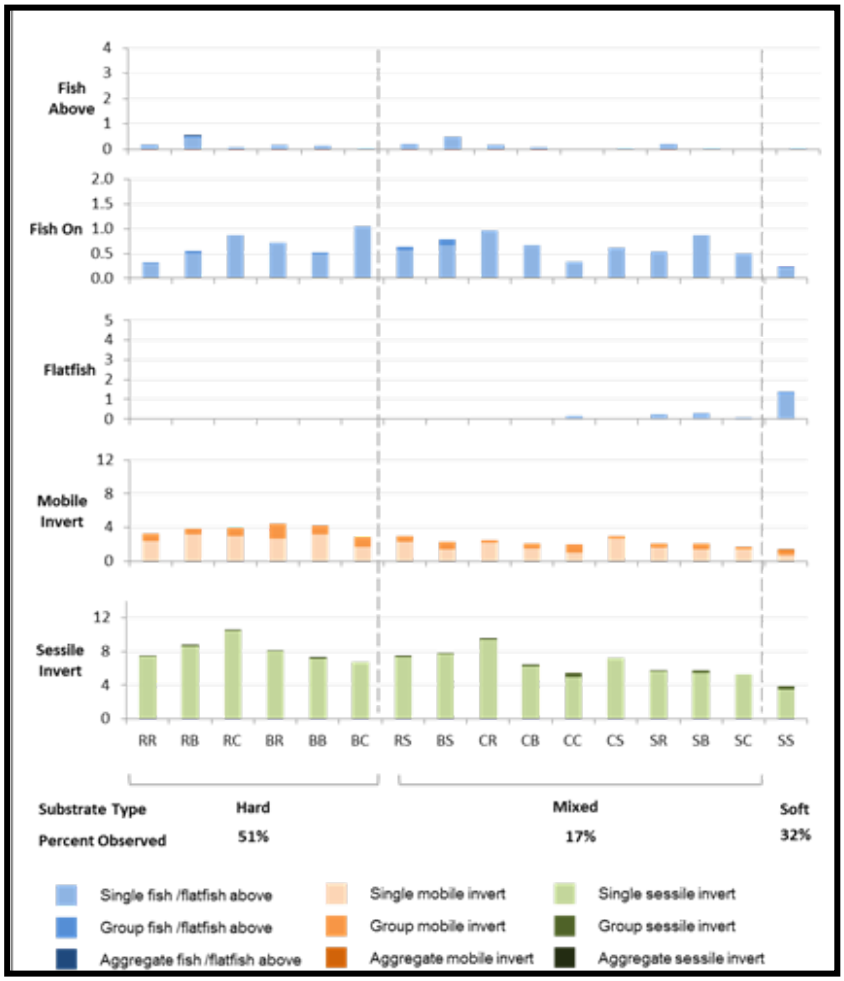


Figure 52. Fishes, mobile invertebrates, and sessile invertebrates at Pillar Point / Montara expressed as a percentage of all observations over Hard, Mixed, and Soft substrates.

Variability within the One-Year Baseline

This project, as described above, was conceived and implemented as a one-year baseline against which any future changes in these ecosystems could be evaluated. Our sampling with the ROV at Pillar Point / Montara (Figure 44, above) in 2010 and 2011 was not intended to flesh out any differences between the two sampling periods, insofar as different areas were transected from one year to another. Further, given that our sampling was conducted essentially at the moment of designation for the NCC MPAs, we were not focused on any "MPA effects" at this state, but rather the fullest characterization possible. Below we have included a brief summary of the variability in our observations of selected organisms and habitat attributes between years.

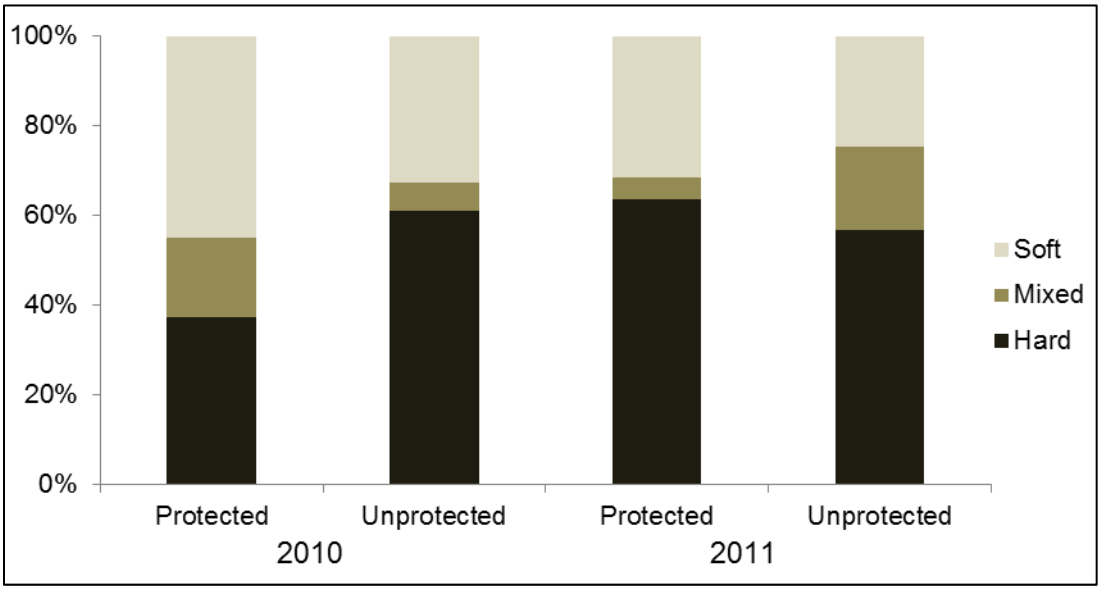


Figure 53. Variability in seafloor habitats sampled by the ROV between the 2010 and 2011 study years at Pillar Point / Montara.

Table 11. Variability between years and density in protected and unprotected areas for observed fishes at Pillar Point / Montara. Primary (******) and secondary (*****) species requested in NCC Monitoring Plan.

Pillar Point / Montara Fishes	Density 2010 ($x10^{-4}$ m^2)	Density 2011 ($x10^{-4}$ m^2)	Initial Variability 2010 to 2011	Density in Protected Areas 2010 & 2011 ($x10^{-4}$ m^2)	Density in Unprotected Areas 2010 & 2011 ($x10^{-4}$ m^2)
Species					
Black Rockfish *	-	0.025	NA	0.031	0.010
Blue Rockfish *	-	-	-	-	-
Brown Rockfish *	0.021	0.025	19%	0.047	0.010
Canary Rockfish *	0.233	0.091	-61%	0.202	0.086
China Rockfish *	-	0.033	NA	0.062	-
Copper Rockfish *	-	-		-	-
Gopher Rockfish *	0.106	0.049	-54%	0.078	0.058
Halfbanded Rockfish *	-	-	-	-	-
Quillback Rockfish *	-	-	-	-	-
Rosy Rockfish *	-	0.008	NA	-	0.010
Vermilion Rockfish **	0.021	0.033	57%	0.047	0.019
Yelloweye Rockfish **	-	-	-	-	-
Cabezon	-	-	-	-	-
Eelpout	0.021	-	NA	0.016	-
Kelp Greenling	1.289	0.387	-70%	0.992	0.422
Lingcod **	1.628	0.280	-83%	1.489	0.144
Longspine Combfish	-	0.016	NA	0.031	-
North Pacific Argentine	-	-	-	-	-
Painted Greenling	-	0.041	NA	0.016	0.038
Pink Seaperch	-	-	-	-	-
Poacher	-	0.008	NA	0.016	-
Ronquil	-	0.008	NA	0.016	-
Sculpin	-	0.008	NA	0.016	-
Starry Skate	-	-	-	-	-
English Sole *	-	0.008	NA	-	0.010
Pacific Halibut *	-	0.008	NA	0.016	-
Pacific Sanddab *	-	0.025	NA	0.047	-
Petrale Sole *	-	-	-	-	-
Rex Sole *	-	-	-	-	-
Slender Sole *	-	-	-	-	-
Speckled Sanddab *	-	-	-	-	-
Starry Flounder **	-	0.025	NA	0.016	0.019
Complex					
Olive/Yellowtail complex*	0.021	0.041	95%	0.047	0.029
Vermilion/Canary/ Yelloweye complex *	0.317	0.140	-56%	0.295	0.125
Sebastomus **	-	0.016	NA	-	0.019
Other					
Pleuronectiformes *	0.233	0.667	186%	1.303	0.077
Sebastes spp. *	0.909	0.634	-30%	1.085	0.480
Unidentified fishes	1.332	0.881	-34%	1.396	0.768

Analytical Products Derived from Baseline Data

One of our primary goals beyond the collection of the baseline data described throughout this report was to utilize those data for synthetic analyses that will allow us to extrapolate beyond the relatively limited scope of our actual sampling to areas and MPAs that were not sampled. Perhaps the most effective approach to achieving this goal has been to marry the precisely geo-referenced ROV-derived data with the topographic maps generated as part of the California State Mapping Project, provided at 2 meter resolution for nearly all of California state waters. Below are brief descriptions of two such projects, one dealing with gender-mediated distributions of Kelp Greenling and one that describes habitat associations for members of the Red Rockfish complex (Canary, Vermilion, and Yelloweye Rockfish), both of which are on-going as part of CSUMB Master's theses.

Further, the photographic and videographic imagery collected by this project is now part of a permanent archive of imagery housed at the Institute for Applied Marine Ecology at CSUMB and with MARE. In total, the archive now includes over 60,000 still photographs and more than 790 hours of video collected across the North Central Coast, Central Coast, and South Coast Study Regions of the Marine Life Protection Act. One of the more compelling applications of the combined archive is the opportunity to ask scientific or management questions that span regions and projects. Below is one such project, dealing with the age-based distribution of Lingcod across the North Central and Central Coast Study Regions, which is also part of a CSUMB Master's thesis.

Gender-mediated habitat utilization of Kelp Greenlings (Hexagrammos decagrammus) within the North Central Coast **- Jessica Flower Moye**

Figure 54. *Hexagrammos decagrammus*, Kelp Greenling (female)

Marine fish assemblages are broadly distributed based on large-scale oceanographic and physical conditions, such as water temperature and depth. Within this classification, various demersal fishes are known to associate with specific substrate types such as rocky reef or unconsolidated sediments. One such case of limited information is on fine-scale habitat associations of Kelp Greenlings (*Hexagrammos decagrammus*), an exploited species in California (right). In this study, video imagery and still photographs were collected by a remotely operated vehicle as part of the baseline characterization of the new California marine protected areas (MPAs) in the Marine Life Protection Act's North Central Coast study region. From this imagery, data on the micro-habitat associations of 316 female, 414 male, and 134 sexually indeterminate fish were quantified and the geo-referenced position was plotted over high-resolution (2 m) bathymetric multibeam maps of the seafloor within and adjacent to MPAs. These data suggest that kelp greenlings associate with rocky, low-relief habitat, despite gender. Ultimately, the information provided by this study will advance our understanding of this exploited species in support of current and future efforts for spatial management efforts such as designation and monitoring of MPAs and essential fish habitat.

Results to-date

Within the North Central Coast, Kelp Greenlings are associating with continuous, low-relief rocky substrate across all study sites, regardless of gender. Over 80% of the observed fish were 20 – 35 cm in length and occurred singularly.

Two example geographies, Point Arena and Bodega Head (below), represent the trends of the observed fish within the North Central Coast region. The majority of male, female, and undetermined gender Kelp Greenlings was observed over continuous rock substrate.

Predictive modeling using the Marine Geospatial Ecology Tool in ArcGIS will be used to create maps of other areas of suitable habitat and possible Kelp Greenling occurrence, which will support current and future efforts for spatial management and the effectiveness of the newly created MPAs.

Point Arena Distribution

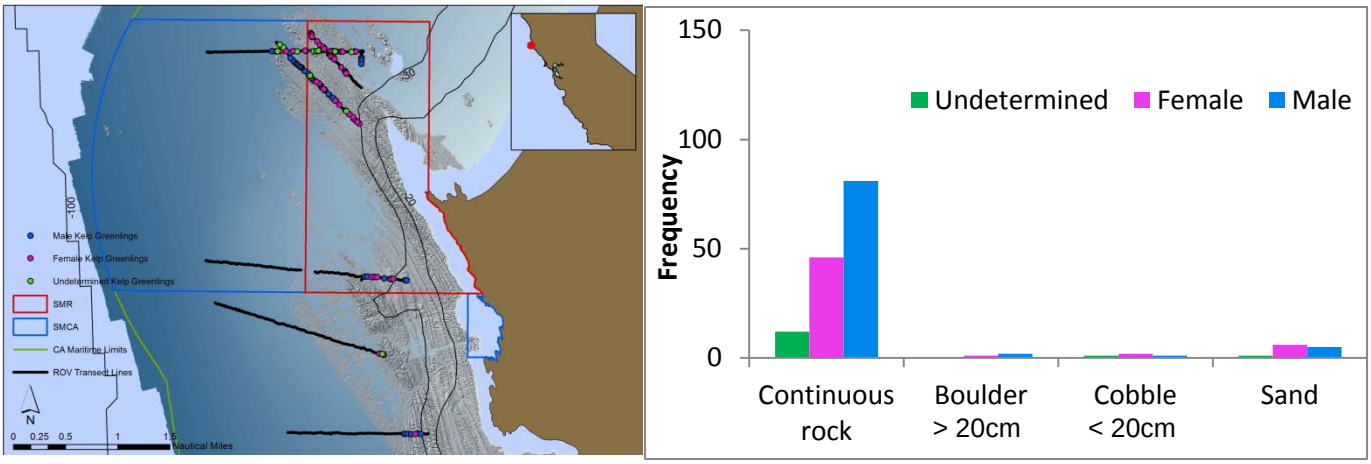


Figure 55. Kelp Greenling observations in the Point Arena study site of the NCC region. Most fish were observed over continous rock substrate.

Bodega Head Distribution

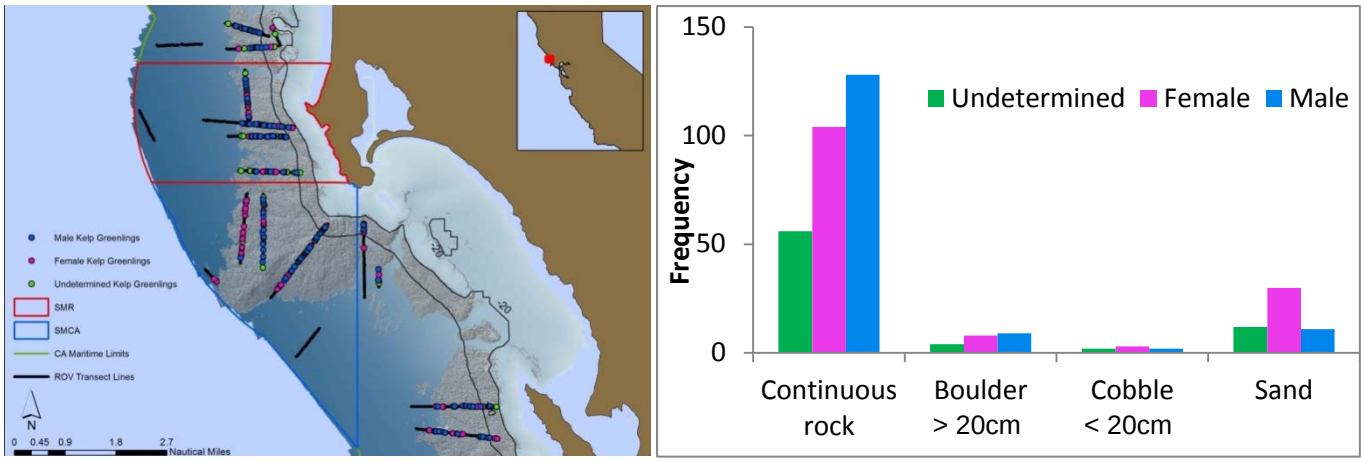


Figure 56. Kelp Greenling observations in the Point Arena study site of the NCC region. Most fish were observed over continous rock substrate.

Predicting distribution and habitat associations for the Red Rockfish Complex in the North Central Coast region of California using a remotely operated vehicle (ROV) **- Heather Kelley**

Figure 57. *Sebastes pinniger*, Canary Rockfish

While commercially important, the red rockfish complex (*Sebastes miniatus, Sebastes pinniger* (right), and *Sebastes ruberrimus*) is emblematic of our limited knowledge of baseline distribution and fish-habitat associations in the Marine Life Protection Act's (MLPA) north central coast region. The purpose of this research is to test whether the accuracy of predictive species-specific habitat suitability models increases with the spatial resolution of input data. The input data, rockfish relative abundance and habitat associations, will be extracted from ROV imagery at the fine scale (<1 m), intermediate scale (meters to kilometers) and broad scale (10-100 kilometers). Fish observations will be coupled with abiotic and biotic habitat attributes, i.e. substrate type, substrate relief and biogenic structure (>10 cm), at each of the three spatial scales. The results will also be considered in context of recently established MPAs to establish baseline conditions in the MLPA's north central coast region. A relative comparison of habitat suitability and predictive fish distribution models between five locations, will address the question of how transportable these models are within the study region. The inclusion of spatial scale and abiotic and biotic habitat attributes has the potential to increase the performance and resolution of habitat suitability and predictive maps in this and future studies. This research is part of a larger baseline characterization study and improvements to habitat suitability and predictive maps, as well as underwater imagery collection, have direct implications for marine spatial planning and long-term monitoring as required by the MLPA.

Results to-date

A total of 516 Canary rockfish were observed in the MLPA study region from Point Arena to Pillar Point, CA (below). All of the Canary rockfish observed were sub-adults according to Echeverria (1987). The observed size distribution is typical of Canary rockfishes in the 20-100 meter depth range.

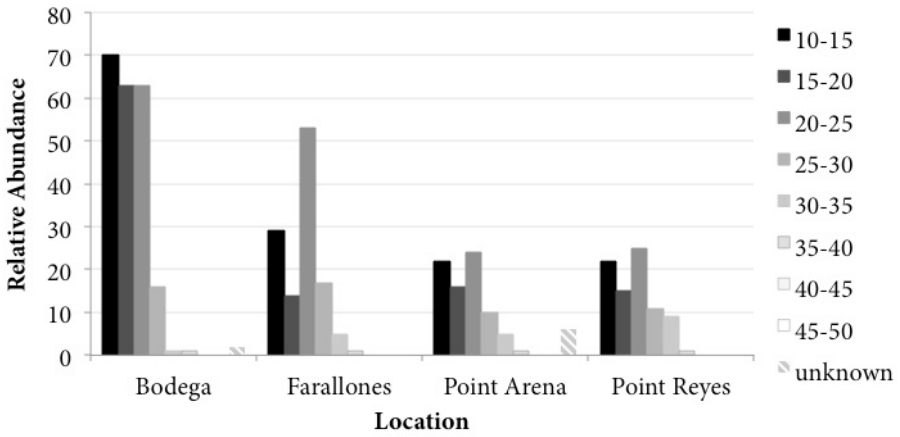


Figure 58. While Bodega Head had the greatest abundance of Canary rockfish, most of these were 10-25 centimeters in length.

Preliminary suitability modeling indicates modest differences between the fine and intermediate scales (Below). Based on their behavior as midwater aggregators and increased mobility up to 200-300 km (DeMott 1983; Lea et al. 1999), Canary rockfish may not associate strongly with fine scale habitat features.

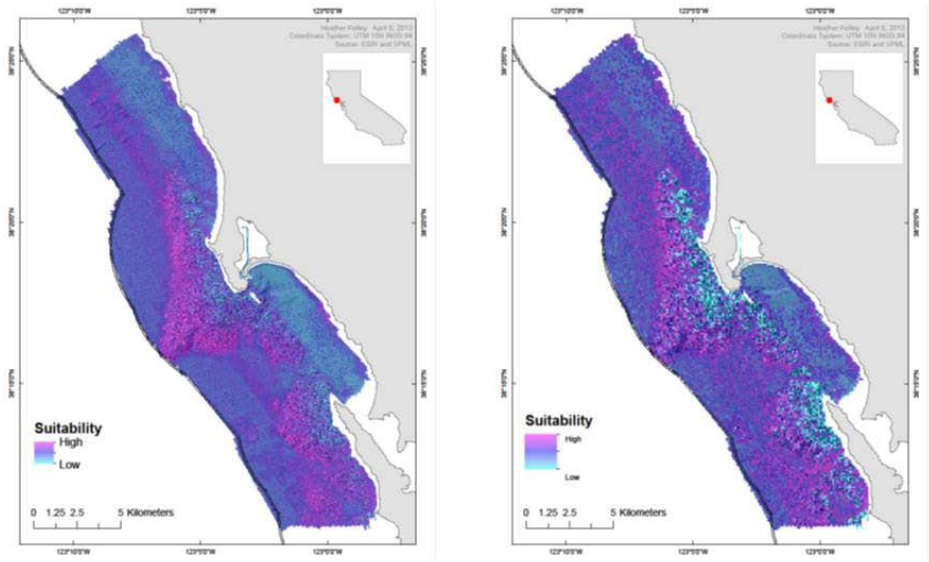


Figure 59. Suitability models for Canary rockfish in Bodega Bay, CA. Two meter resolution (left) and 100 meter resolution (right).

***Distribution and habitat utilization of lingcod (Ophiodon elongatus) off central California: Implications for Conservation and Management* - Megan Bassett**

Figure 60. *Ophiodon elongates,* Lingcod

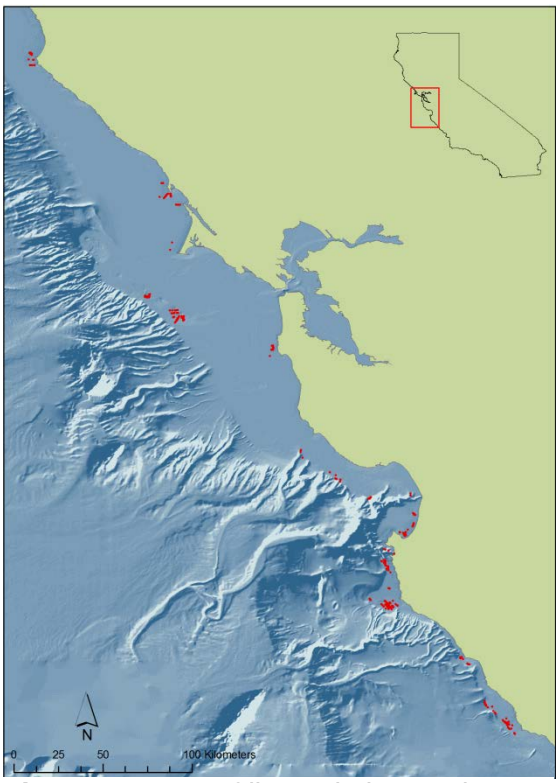


Figure 61. Map of lingcod observations (red points) from Point Arena in the north to Morro Bay in the south.

With a clear understanding of how organisms are dispersed across a landscape, resource managers are better able to successfully manage marine ecosystems. This is especially true for management strategies such as ecosystem based management and essential fish habitat (EFH). However, it has proven difficult to classify and define EFH for many species because knowledge on the spatial distribution of many marine organisms is lacking at finer scales (1 Km to 100s m). Studies on fine-scale habitat associations of lingcod (top right), an important and popular commercial and recreational fishery, are few and have relied mainly on acoustic telemetry. Furthermore, these studies are focused around the Pacific Northwest and British Columbia. An in-depth study on the habitat utilization of lingcod using visual observations has yet to be conducted in California. Underwater video imagery was collected from Point Arena to Morro Bay, California using a remotely operated vehicle (ROV) and towed camera sled (lower right). Observational data, collected from video, and derived habitat rasters, created from a high resolution (2 m) digital elevation model, will be used to create predictive habitat suitability maps with the Marine Geospatial Ecology Tool for ArcGIS. Rasters will include slope, topographic position index, substrate type (hard or soft), and rugosity. With in-depth information on the habitat utilization of lingcod, fishery managers will be able to make more informed decisions on areas essential for lingcod.

Results to-date

Preliminary results indicate that there is a difference in habitat utilization by lingcod of different size/age classes. Year 1 lingcod (≤ 25 cm) were observed more over soft substrate, while year 2 (30-45 cm) and year 3+ (≥ 50 cm) were observed more over hard substrate (below).

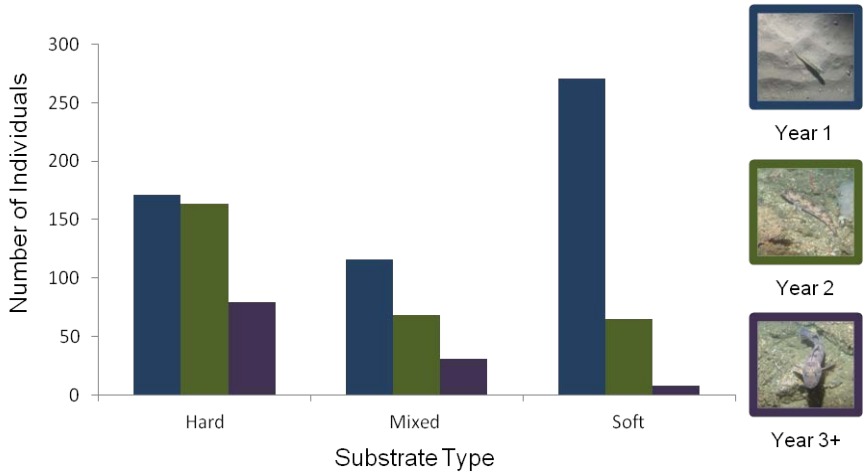


Figure 62. Lingcod observations over three substrate types. Note that the majority of year 1 lingcod were observed over soft substrate, while the majority of year 2 and year 3+ lingcod were observed over hard substrate.

It is interesting to note that overall, the majority of individuals observed were year 1 (556 individuals), which is almost double that of year 2 (296 individuals) and triple that of year 3+ (116 individuals). Similar trends can be seen in the utilization of different relief types (below). The majority of observations were made over low relief habitats, however the proportion of observations over higher relief areas is greater for year 2 and year 3+ individuals. Almost all year 1 lingcod (519 observations) were observed over low relief habitat (< 1m),

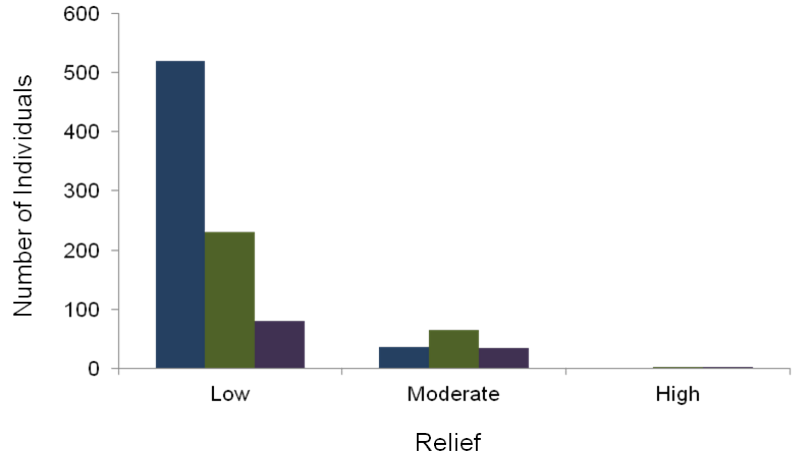


Figure 63. Lingcod observations over different relief types. Note that although the majority of observations were made over low relief habitats, the proportion of year 2 and 3+ lingcod is higher over moderate relief habitats.

while majority of observations over moderate relief (1-2m) habitat were of year 2 individuals. These trends in habitat utilization at different size/age classes support the theory of an ontogenetic shift in lingcod. However, further model analysis will provide a more in-depth look at habitat utilization of lingcod along the central coast of California.

Moving Forward with Long-term Monitoring

Now that the baseline characterization of the North Central Coast Study Region is complete, opportunities for long-term monitoring can be considered. It appears clear from the past three years that the increasing participation of citizen science groups in monitoring activities is going to provide at least some support for monitoring in the nearshore ecosystems, including the sandy and rocky intertidal (various programs), kelp forests (primarily Reef Check California), and sea birds (various programs). These programs have the advantage of covering fairly large areas at little to no cost to the state.

In the deeper ecosystems off-shore, those generally below the effective depth of SCUBA sampling (such as the areas sampled for this report) the likelihood of a strong citizen-based monitoring program coming to the fore is probably very low; working in the deep water is costly, including vessel support, vehicle support (ROV, submersible, camera sled), and the personnel necessary to operate both. And yet, despite the associated cost, the non-invasive sampling of marine ecosystems using imagery platforms has important advantages with so many marine populations at historically-low levels.

Clearly, in this era of limited budgets, an affordable approach to long-term monitoring must be found. But how? Which species should be sampled? Based on our experience thus far, we think that one approach forward may be to identify those species (fishes and invertebrates) that are a) observed in numbers that are appropriate for particular statistical analyses and b) are capable of being identified with a high level of confidence from imagery alone. This list will vary depending on the ecosystem, the imagery platform, and the visibility on any given day, and it may not necessarily include many of the species of interest for managers. However, it may provide an option for moving forward nonetheless.

Below we provide a first pass at a group of species and species complexes, including fishes as well as mobile and sessile invertebrates, that are capable of being monitored in this way and were observed during the baseline characterization effort in the North Central Coast. While we expect that many scientists could reach agreement on some of the organisms on this list, it is

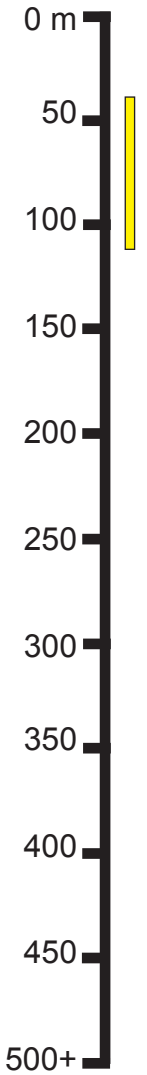
also likely that much discussion could be engendered to flesh this group out further. What we provide here is intended as a point of departure for discussion as each of the MLPA regions moves beyond baseline characterization.

Fishes – These seven species/species complexes were present in large numbers at one or more of the five study areas. Further, all are readily identifiable from video and/or still photographs, though differentiating between Vermilion and Canary Rockfish can be challenging to novice data collectors.

Mobile Invertebrates – Similar to fishes above, these two species of crab were both seen frequently across the study area.

Structure-forming Invertebrates – This category presents perhaps the greatest challenge. There are a great many species that could be included here, many of which have been observed serving as biogenic habitat for demersal fishes. Drawing upon a long list of paid student assistants (of varying degrees of expertise), we found these three organisms/groups to be tractable.

Sebastes miniatus (Vermilion Rockfish)



Farallon Islands, CA

Farallon Islands, CA

Phylum Chordata | Class Actinopterygii |
Order Scorpaeniformes | Family Scorpaenidae

Body color: Red-orange with dark mottling

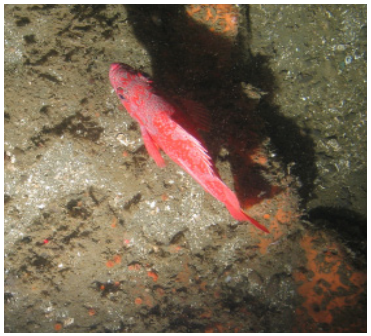
Size: 76 cm

Range: Zaikof Bay, Monatague Island, Alaska to Islas San Benito, central Baja California

Depth: 40 m to 105 m

Habitat: High relief, rocky habitat with crevices; Will aggregate both near the bottom and in the water column

Food Habits: Euphasiids, copepods, amphipods, shrimps, squid, octopus



Point Arena, CA

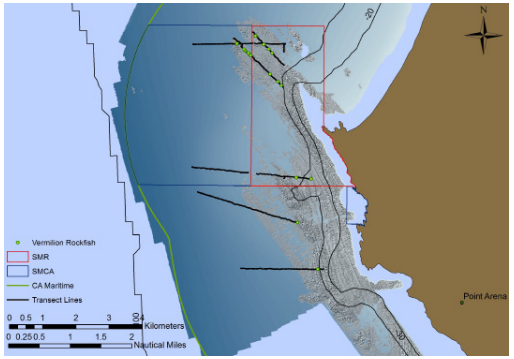
Point Reyes, CA

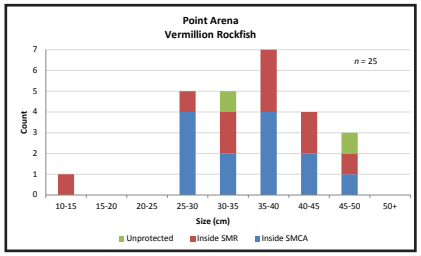
Spawning Timeline

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
X	X	X									X

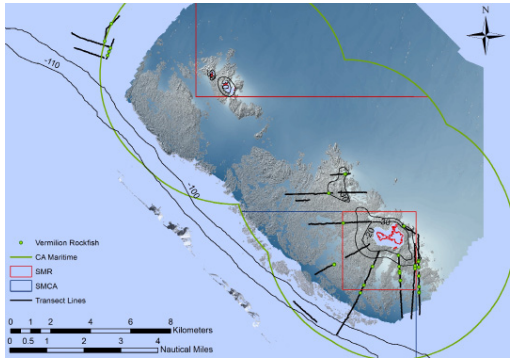
Sebastes miniatus (Vermilion Rockfish)

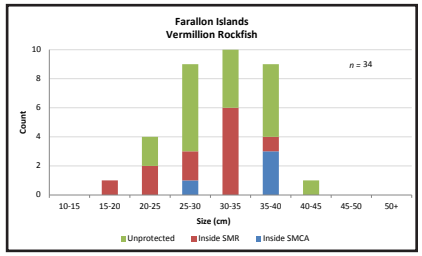
Point Arena



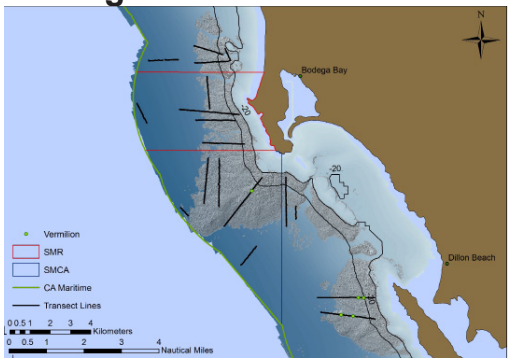


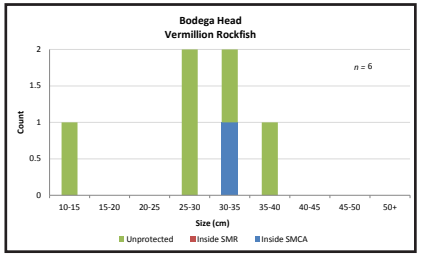
Farallon Islands



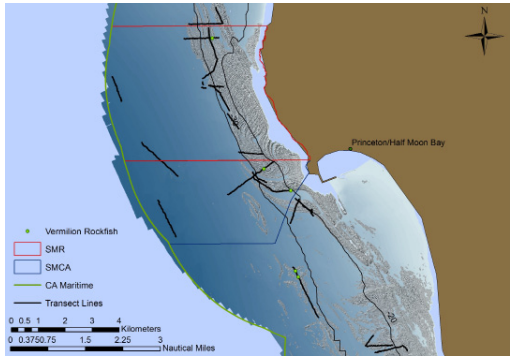


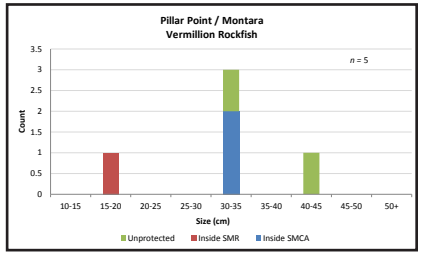
Bodega Head



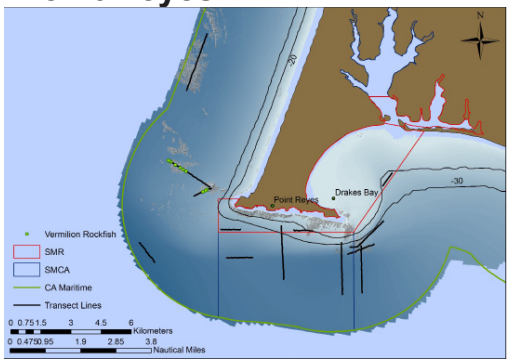


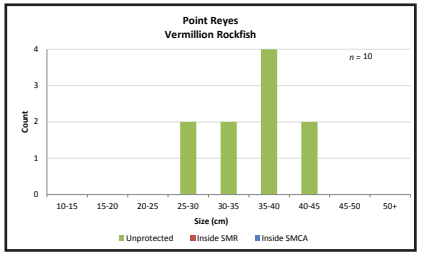
Pillar Point





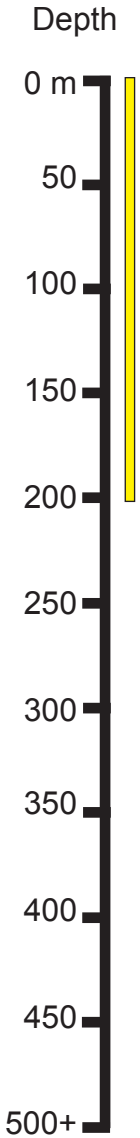
Point Reyes





Distribution of Vermilion Rockfish within each geography of the NCC region.

Ophiodon elongatus (Lingcod)



Farallon Islands, CA

Farallon Islands, CA

Phylum Chordata | Class Actinopterygii |
Order Scorpaeniformes | Family Hexagrammidae

Body color: Black-brown-green body color with dark mottling and a lateral line. Can sometimes have orange-yellow spots.

Size: 152 cm

Range: Shumagin Isalnds, Gluf of Alaska, Alaska to Punta San Carlos, central Baja California

Depth: 0 m to 200 m

Habitat: Most often found in high relief rocky habitat, but can be observed over soft substrate

Food Habits: Fish, shrimp, octopus, squid, hermit crab, fish eggs, hydroids

Farallon Islands, CA

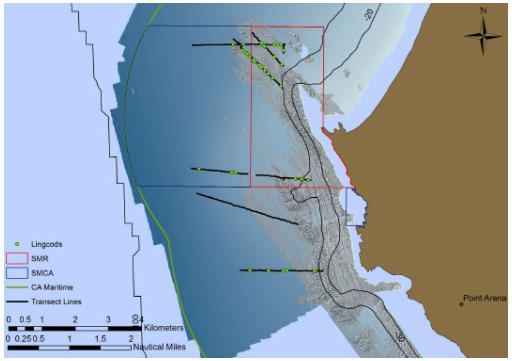
Farallon Islands, CA

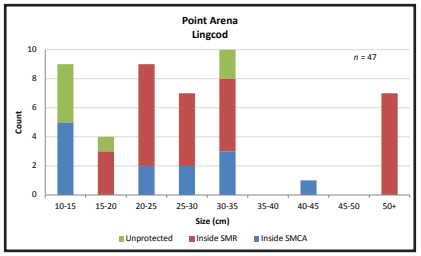
Spawning Timeline

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
X	X	X	X	X	X					X	X

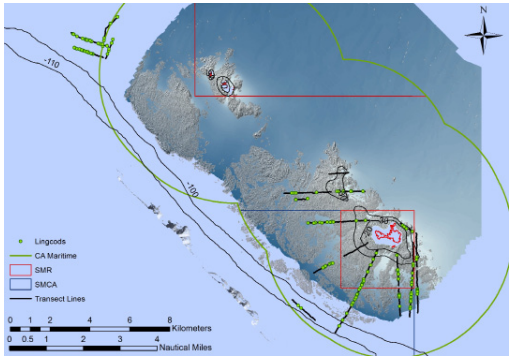
Ophiodon elongatus (Lingcod)

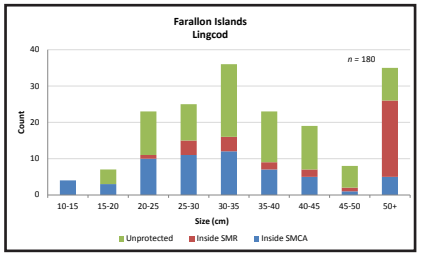
Point Arena



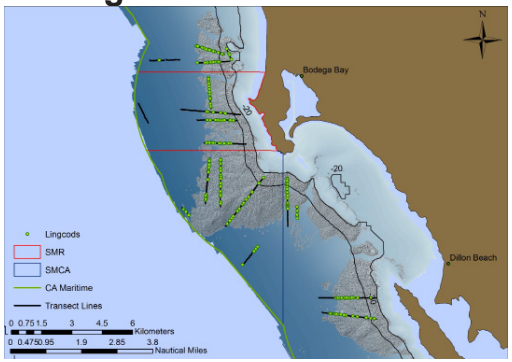


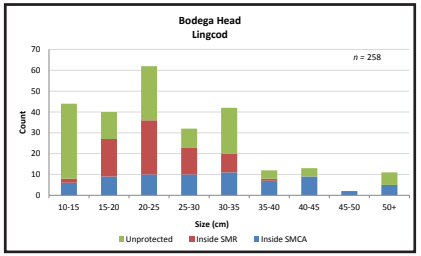
Farallon Islands



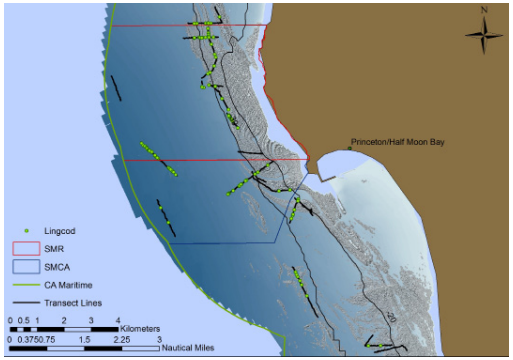


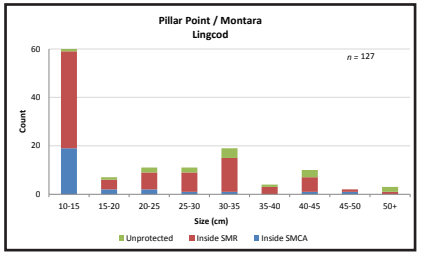
Bodega Head



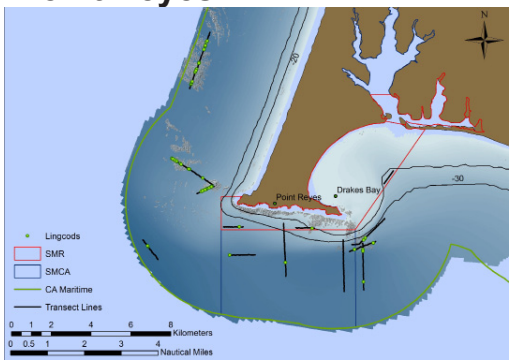


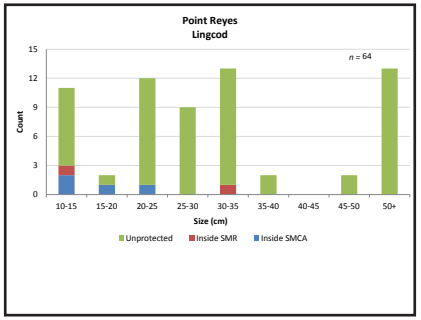
Pillar Point





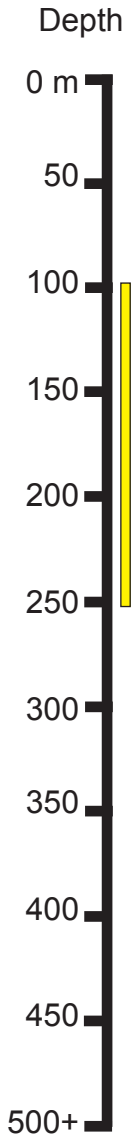
Point Reyes





Distribution of Lingcod within each geography of the NCC region.

Subgenus: *Sebastomus* (regarding Starry and Rosy Rockfish)



Farallon Islands, CA

Farallon Islands, CA

Phylum Chordata | Class Actinopterygii | Order Scorpaeniformes | Family Sebastidae | Genus Sebastes

Description: Smaller group of rockfish. Distinguishable by its bright pink/orange color and the 3-6 white spots below the dorsal fin.

Maximum length: Varies among species. Ranges between 23 cm and 56 cm with an average length of 41 cm.

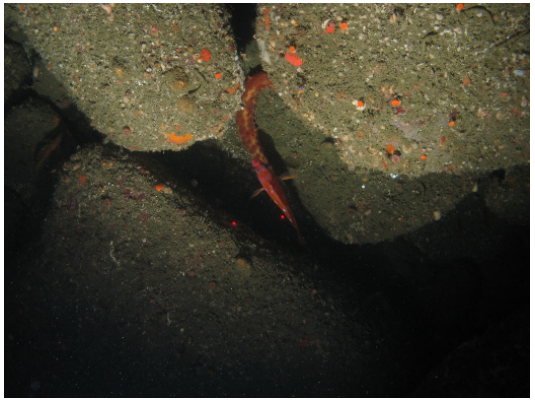
Depth Range: Varies among species. On average between 100 m and 250 m.

Habitat: Boulder fields or other high relief areas

Range: For the most part, the group resides off the coast of California and Baja California, but some species can be found as far north as Alaska.

Similar species: Other Sebastomus

Feeding Habits: Unknown



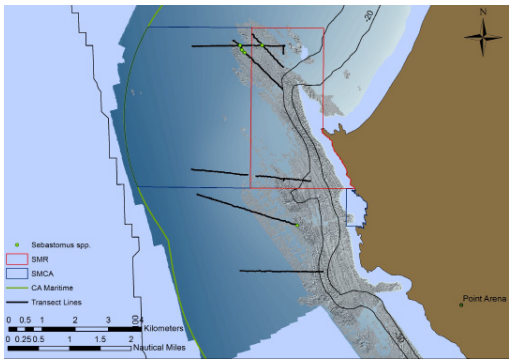
Farallon Islands, CA

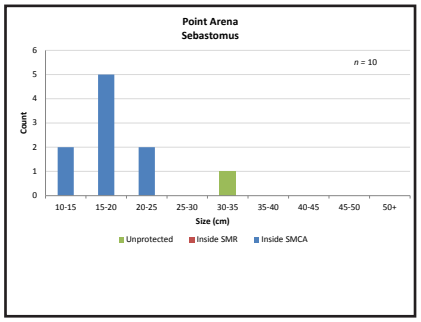
Spawning Timeline

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
X	X	X	X	X							

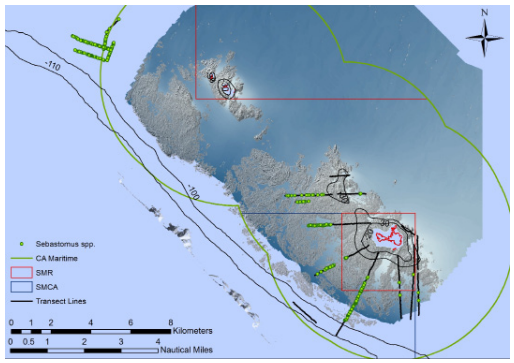
Subgenus: *Sebastomus* (regarding Starry and Rosy Rockfish)

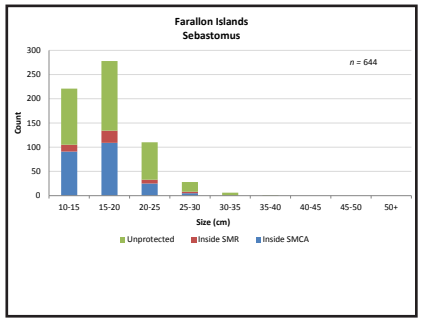
Point Arena



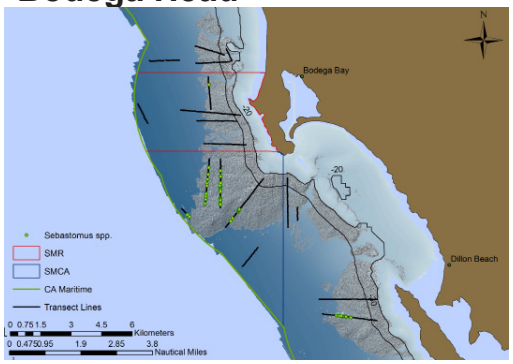


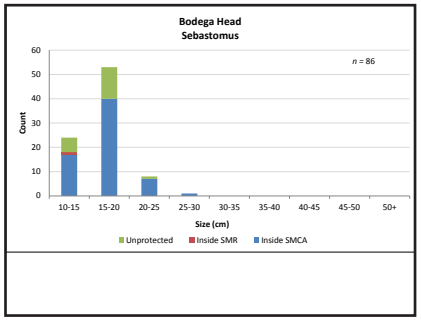
Farallon Islands



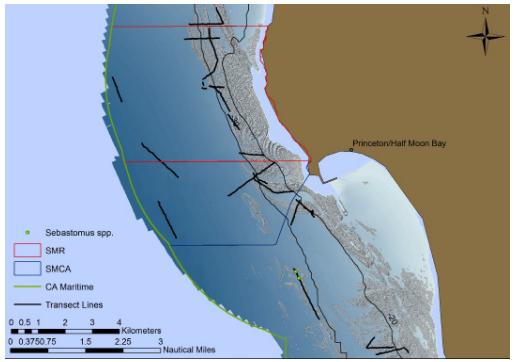


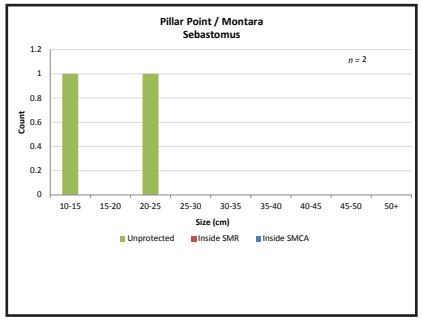
Bodega Head



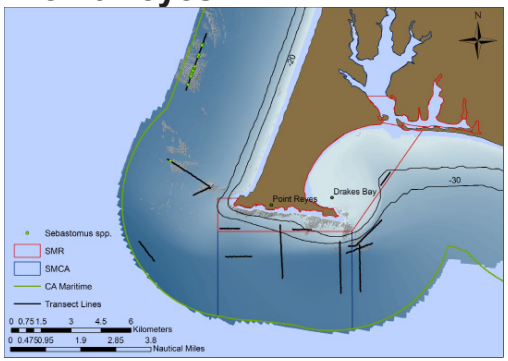


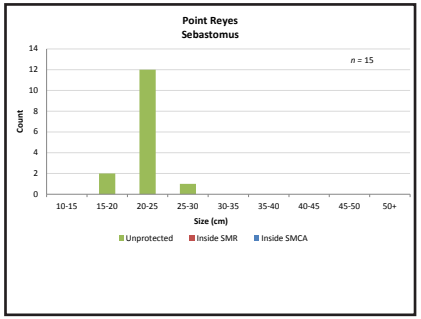
Pillar Point





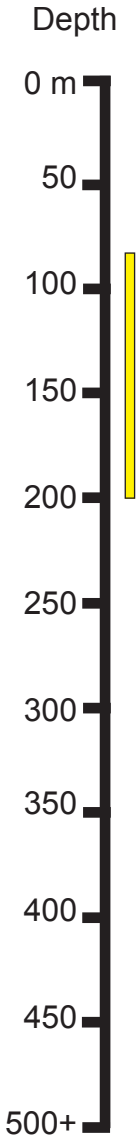
Point Reyes



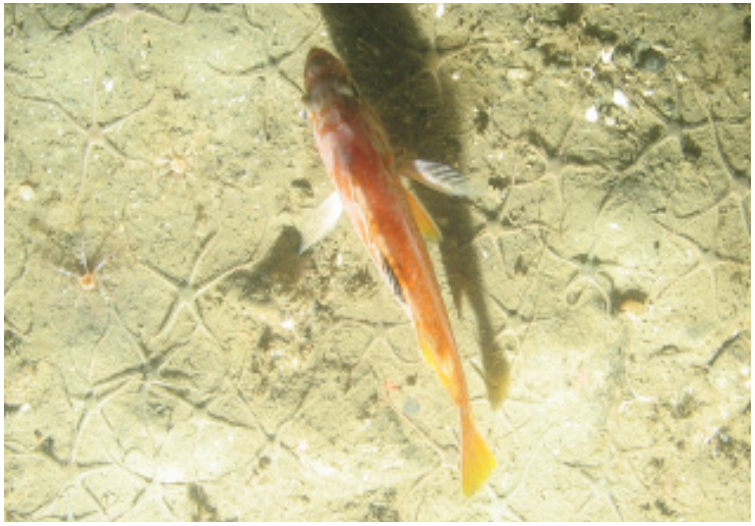


Distribution of *Sebastomus* spp. within each geography of the NCC region. Only Rosy and Starry Rockfish were positively identified, though Rosethorn and Greenspotted Rockfish were likely observed as well.

Sebastes pinniger (Canary Rockfish)




Bodega Head, CA


Bodega Head, CA

Phylum Chordata | Class Actinopterygii |
Order Scorpaeniformes | Family Scorpaenidae

Body color: Orange-yellow body with gray markings and orange fins. Anal fin points and slants anteriorly.

Size: 76 cm

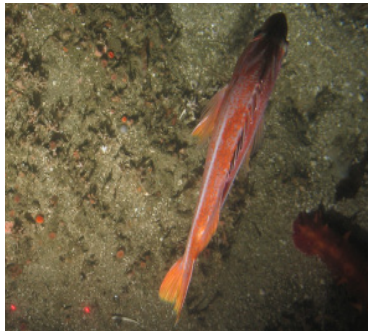
Range: Alaska to southern California

Depth: 80 m to 200 m

Habitat: High relief rocky habitat, sometimes found on cobble or muddy habitat. This species is found in aggregations in high relief rocky habitat, but will move to water column.

Food Habits: Euphausiids, caridean shrimps, red crabs, gelatinous zooplankton, and fish


Farallon Islands, CA

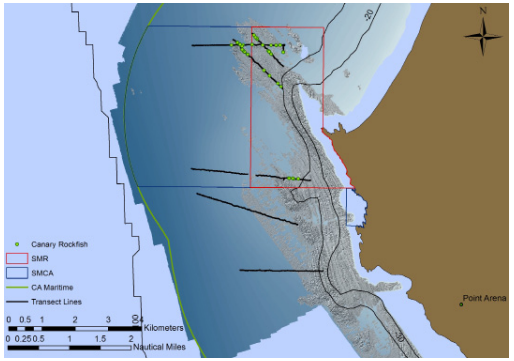

Farallon Islands, CA

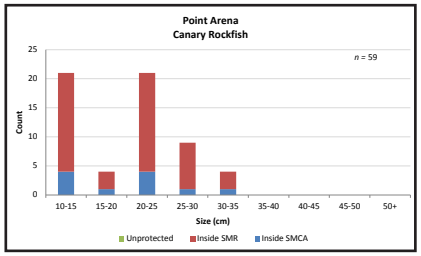
Spawning Timeline

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
X	X	X								X	X

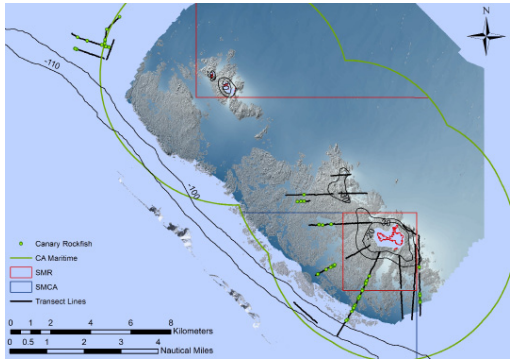
Sebastes pinniger (Canary Rockfish)

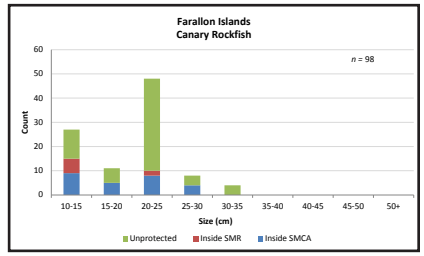
Point Arena



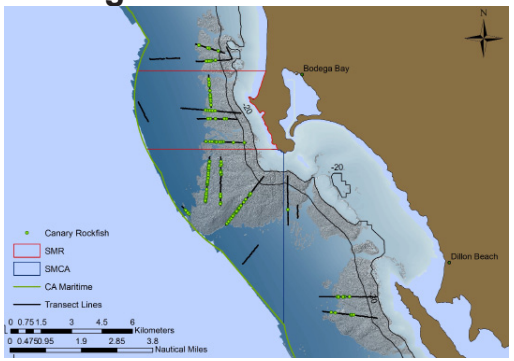


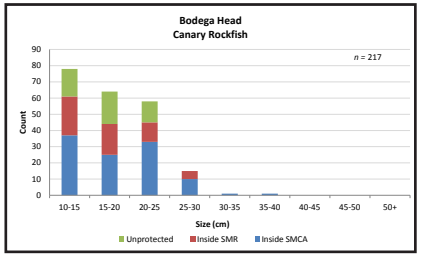
Farallon Islands



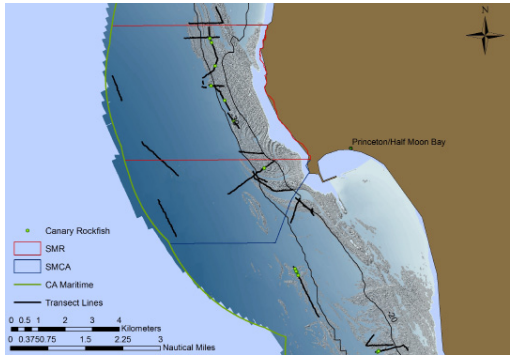


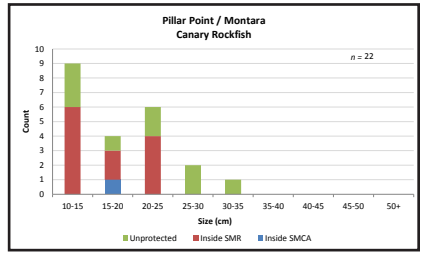
Bodega Head



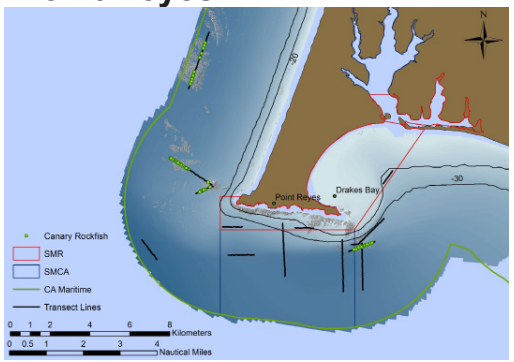


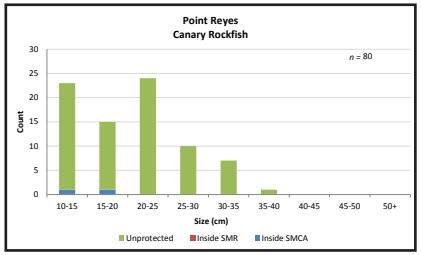
Pillar Point





Point Reyes

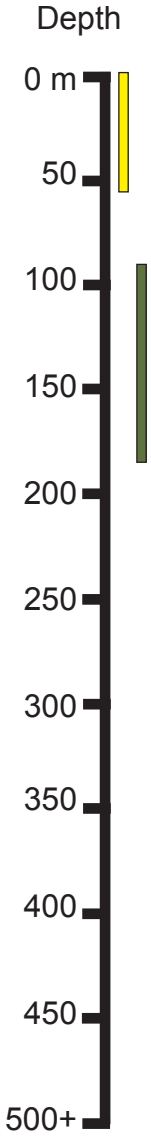




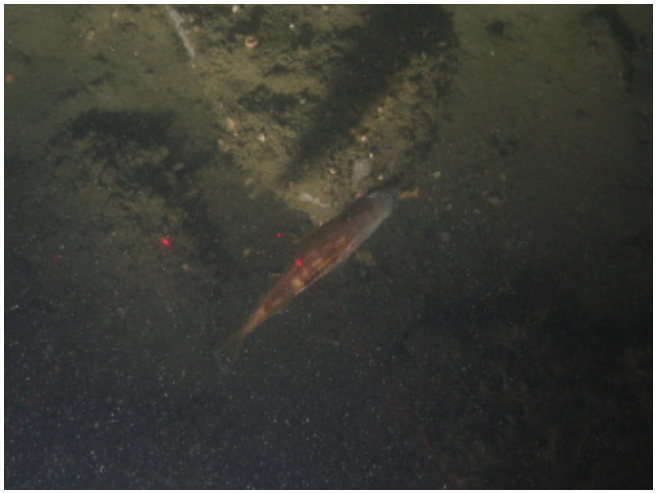
Distribution of Canary Rockfish within each geography of the NCC region.

Sebastes flavidus (Yellowtail Rockfish)
Sebastes serranoides (Olive Rockfish)

Phylum Chordata | Class Actniopterygii |
Order Scorpaeniformes | Family Sebastidae



Bodega Head, CA



Bodega Head, CA

Description: Dark green back with white spots under dorsal fins. Lighter green/ grey on sides with orange flecks. Fins are yellow/ orange.

Maximum length: Yellowtail: 66 cm
Olive: 61 cm

Depth Range: Yellowtail: 90-180 m
Olive: 0-55 m

Habitat: Yellowtail: Reside in schools near rocky, high relief bottoms
Olive: Found in small schools or alone. Reside in pelagic zone near structures, like oil platforms

Range: Yellowtail: Can be found from the Auletian Islands, Alaska to San Diego, CA. Commonly found from Southeast Alaska to San Miguel Island, CA.
Olive: Can be found from Southern Oregon to Islas San Benitos, Baja California. Commonly found from Cape Mendicino, CA to Santa Barbara, CA.

Similar species: Widow and Black Rockfish

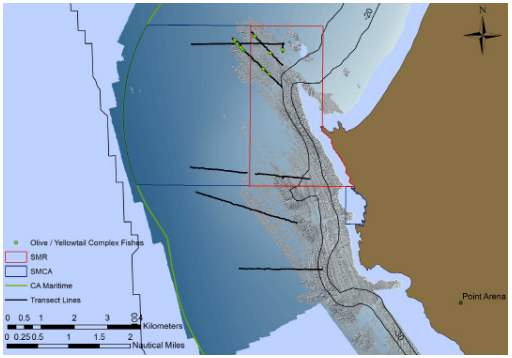
Feeding Habits: Yellowtail: Feeds both day and night on pelagic fish and crustceans such as krill.

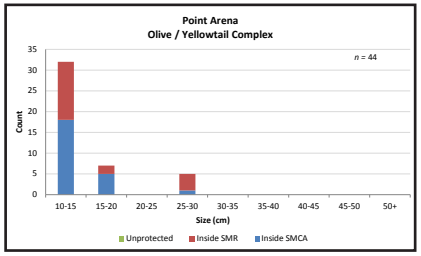
Spawning Timeline

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
X X	X X	X X	X	X	X	X					X

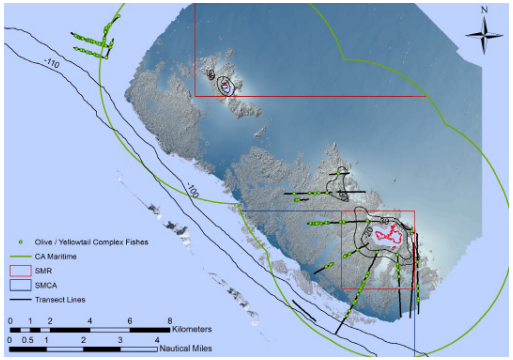
Sebastes flavidus (Yellowtail Rockfish)
Sebastes serranoides (Olive Rockfish)

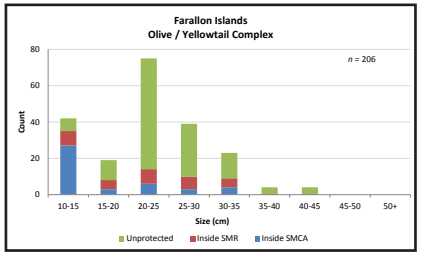
Point Arena



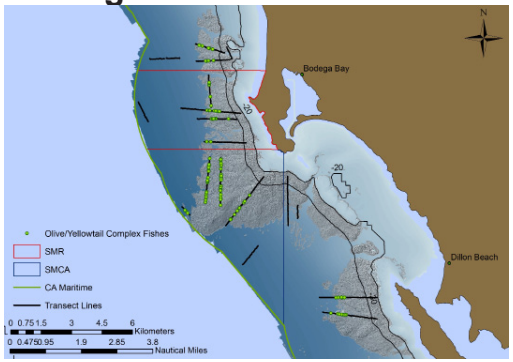


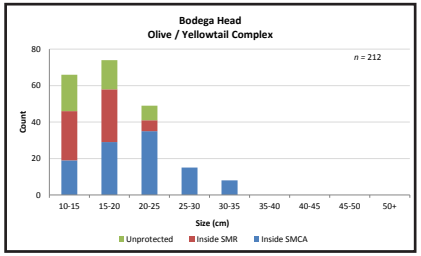
Farallon Islands



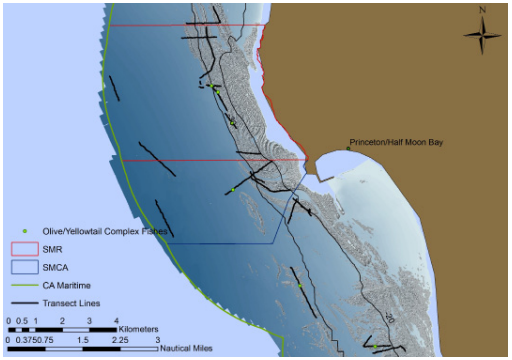


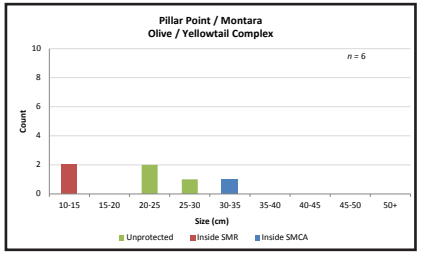
Bodega Head



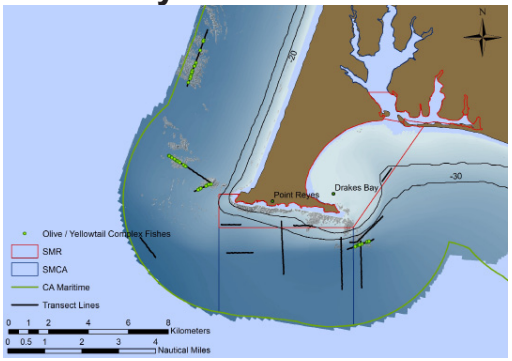


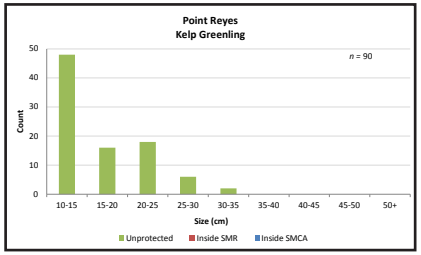
Pillar Point





Point Reyes

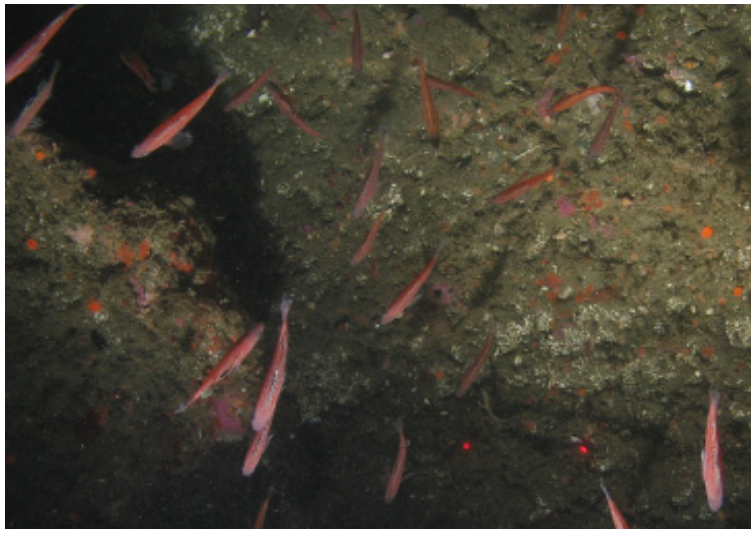




Distribution of Olive / Yellowtail Rockfishes within each geography of the NCC region

Sebastes mystinus (Blue Rockfish)

Farallon Islands, CA



Point Arena, CA

Phylum Chordata | Class Actinopterygii |
Order Scorpaeniformes | Family Scorpaenidae

Body color: Blue bodies with white-gray blotches. There are two dark stripes that protrude from the eye towards the belly. There are also dark stripes on the head.

Size: 53 cm

Range: Southeastern Alaska to northern Baja California

Depth: 0 m to 55 m

Habitat: Found in large aggregates in the water column above rocky habitat in or near kelp forests

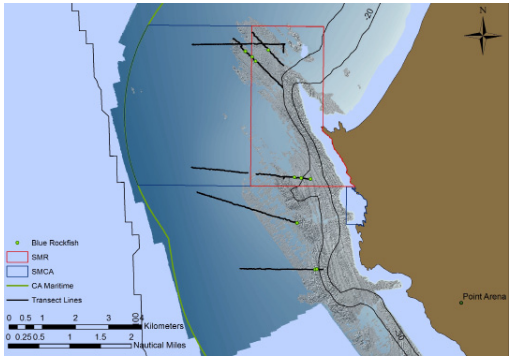
Food Habits: Copepods, amphipods, crustacean larvae, zooplankton, polychaetes.

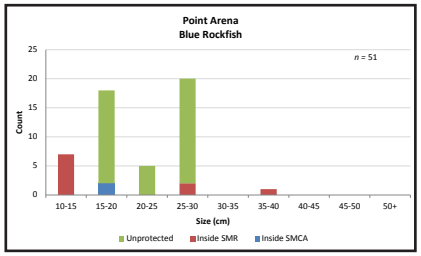
Spawning Timeline

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
X	X	X							X	X	X

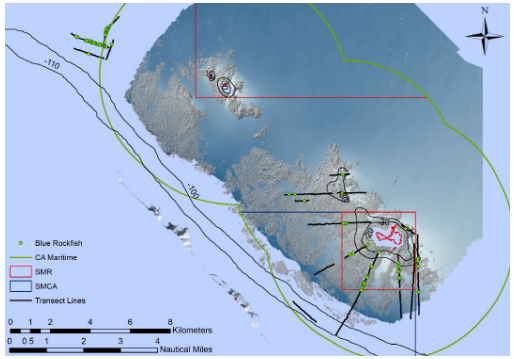
Sebastes mystinus (Blue Rockfish)

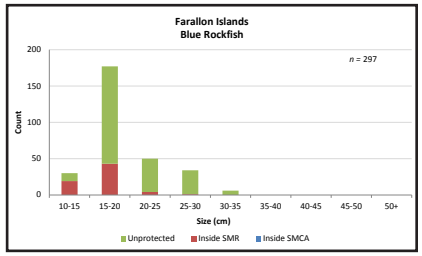
Point Arena



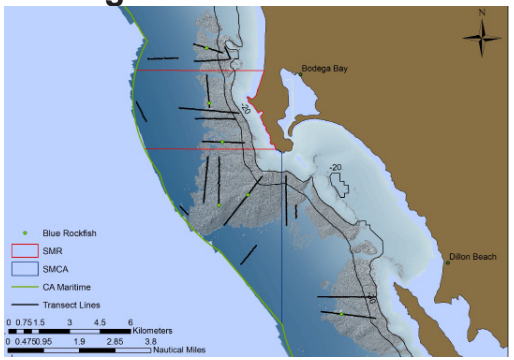


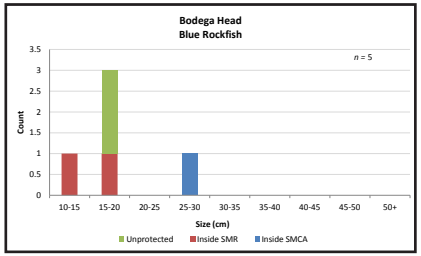
Farallon Islands



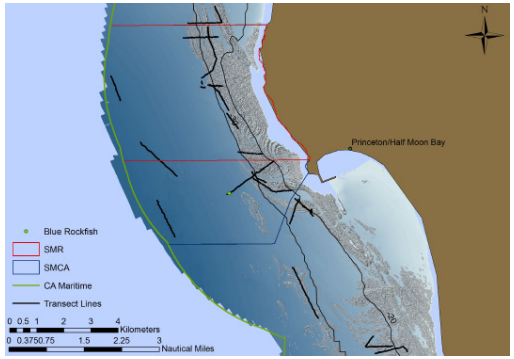


Bodega Head



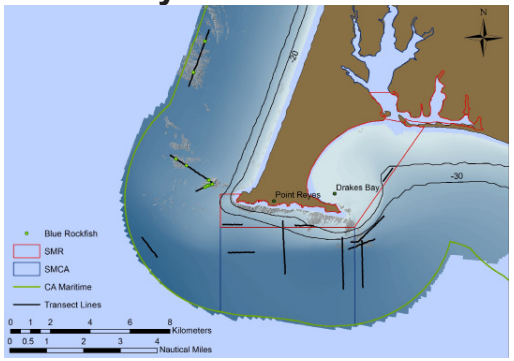


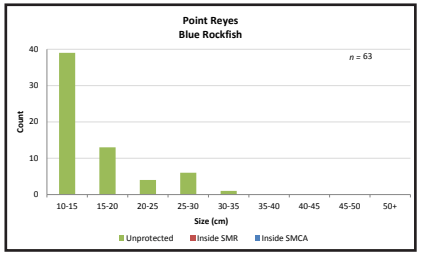
Pillar Point



n = 0

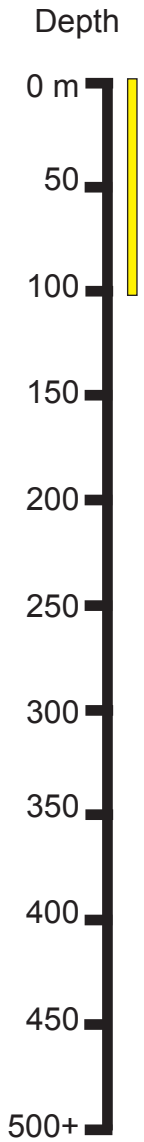
Point Reyes





Distribution of Blue Rockfish within each geography of the NCC region.

Hexagrammos decagrammus (Kelp Greenling)




Female; Farallon Islands, CA


Male; Bodega Head, CA

Phylum Chordata | Class Actinopterygii |
Order Scorpaeniformes | Family Hexagrammidae

Description: All individuals have yellow eyes. Females have gray-brown bodies and brown-yellow spots. Males have brown-orange bodies with white spots surrounded by blue a outline.

Size: 62.9 cm

Range: Attu Island, Aluetian Islands, Alaska to La Jolla, California

Depth Range: 0 m to 100 m

Habitat: Rocky habitat, always found on or near the seafloor

Food Habits: Copepods, amphipods, polychaetes, snails, chitons, hermit crabs, crabs, shrimps, brittle stars, fish, fish eggs, and algae


Female; Farallon Islands, CA

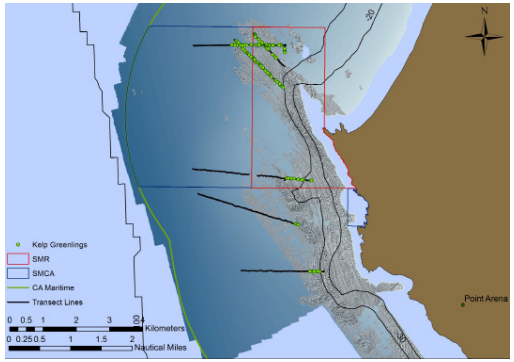

Male; Bodega Head, CA

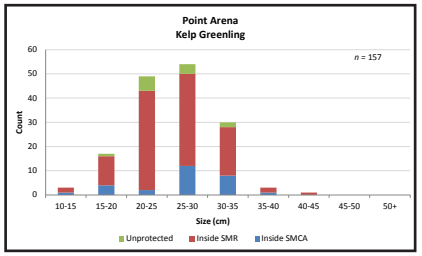
Spawning Timeline

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
X						X	X	X	X	X	X

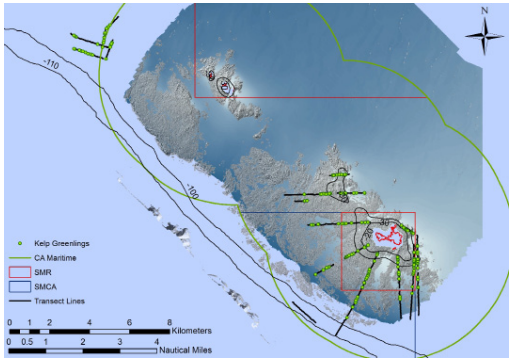
Hexagrammos decagrammus (Kelp Greenling)

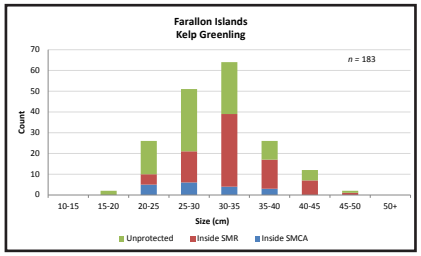
Point Arena



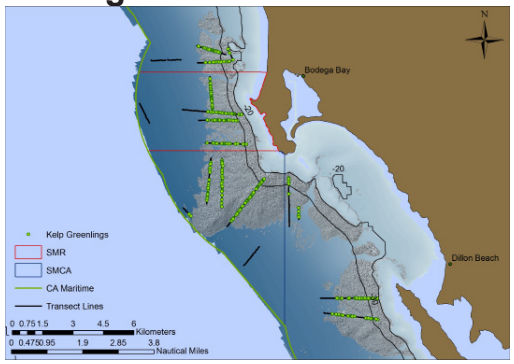


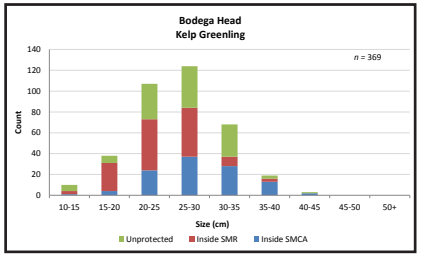
Farallon Islands



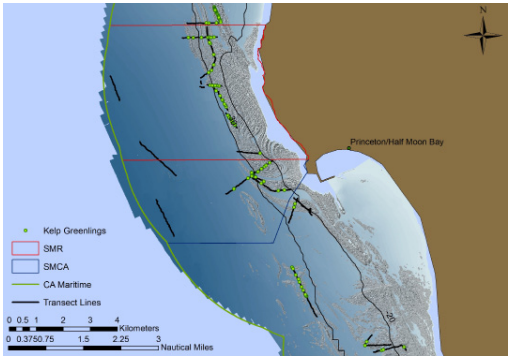


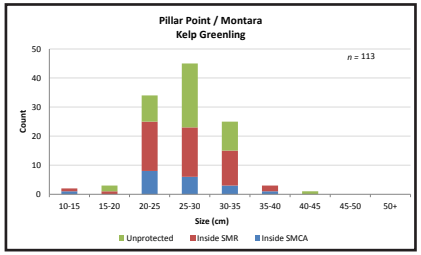
Bodega Head



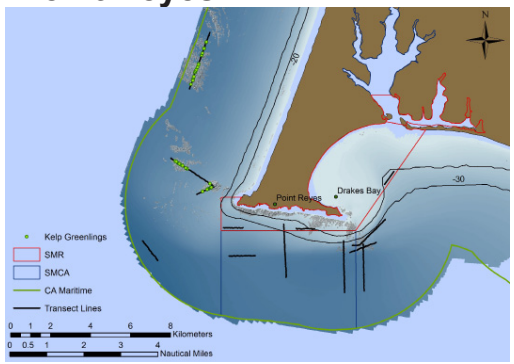


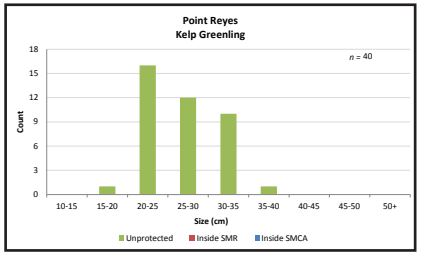
Pillar Point





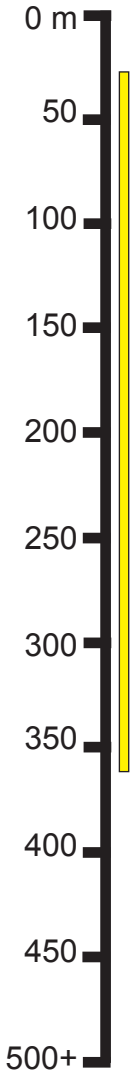
Point Reyes

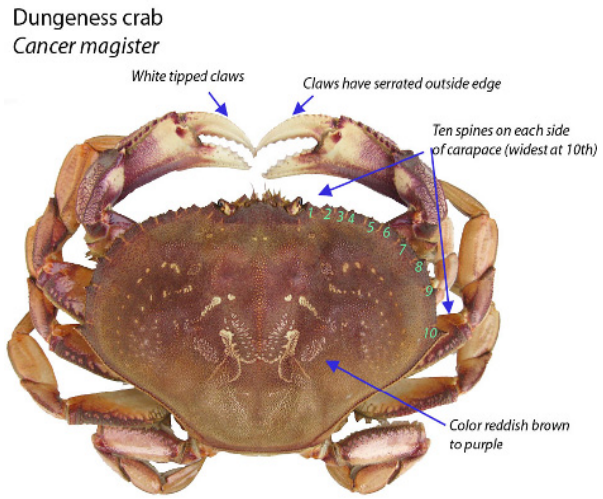




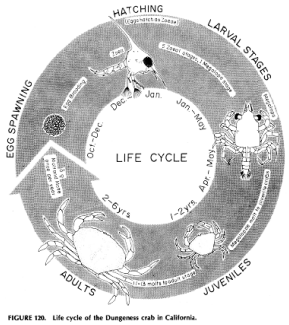
Distribution of Kelp Greenlings within each geography of the NCC region.

Metacarnicus magister (Dungeness Crab)

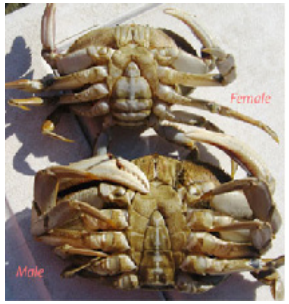




Bodega Head, CA



Life Cycle



Female vs. Male

Phylum Arthropoda | Class Malacostraca | Order Decapoda | Family Cancridae

Description: red, brown, purple, with white tipped claws

Size: carapice up to 20 cm

Depth Range: low intertidal to 360 m

Habitat: fine sand bottoms; most commonly found in sandy bottoms but can be found around low rock relief

Range: Aleutian Islands, Alaska to Point Conception, California

Similar species: Rock Crabs

Feeding Habits: molluscs, crustaceans, fishes, cnidaria, plankton, bivalves, shrimp, medusa

Bodega Bay, CA

Juvenile

Bodega Head, CA

Young Adult

Bodega Head, CA

Adult

Bodega Head, CA

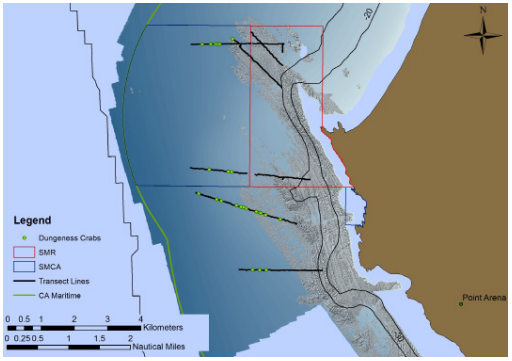
Bodega Head, CA

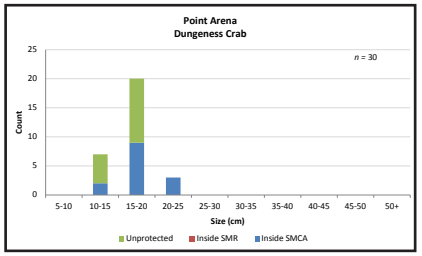
Spawning Time-

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
		X	X	X	X	X	X				

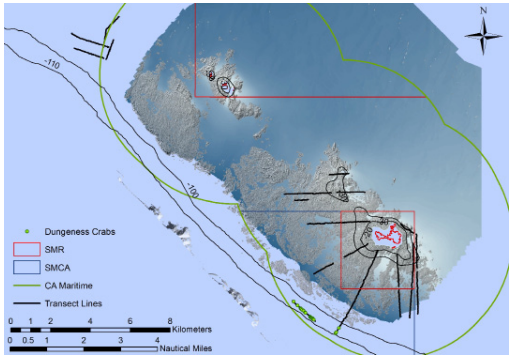
Metacarnicus magister (Dungeness Crab)

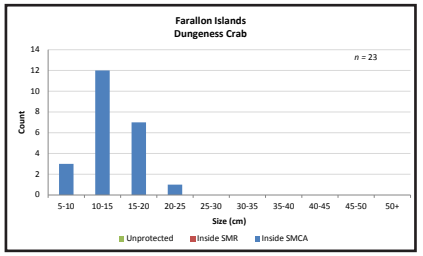
Point Arena



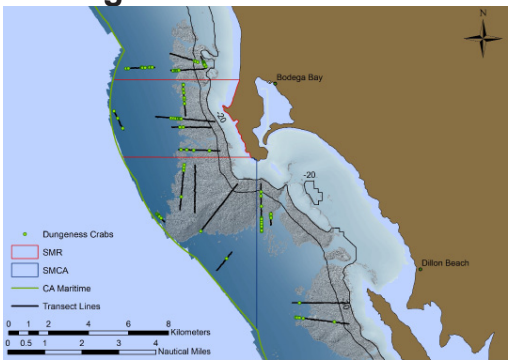


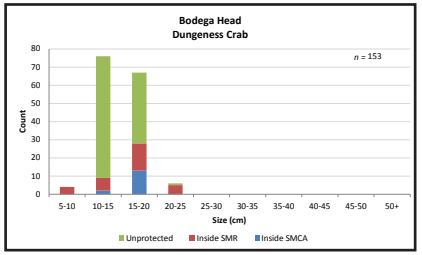
Farallon Islands



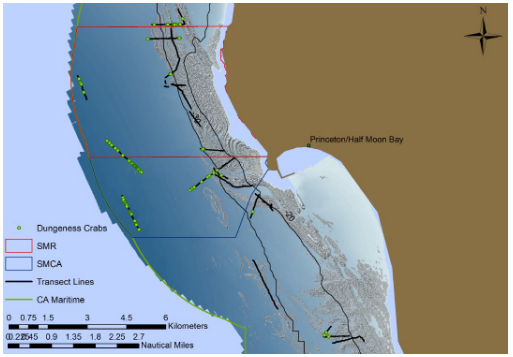


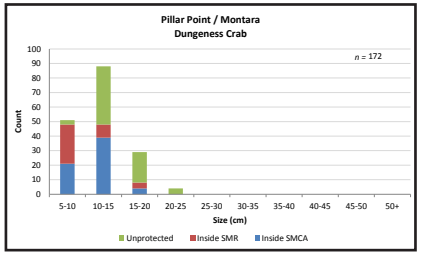
Bodega Head



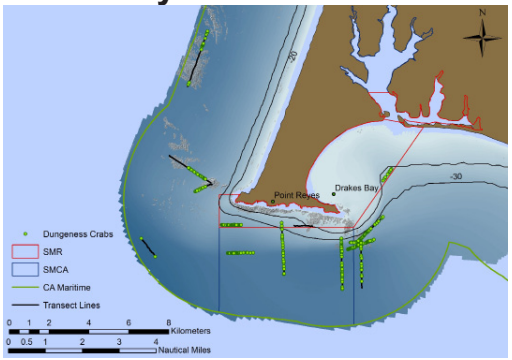


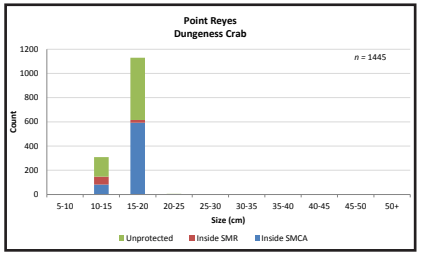
Pillar Point





Point Reyes

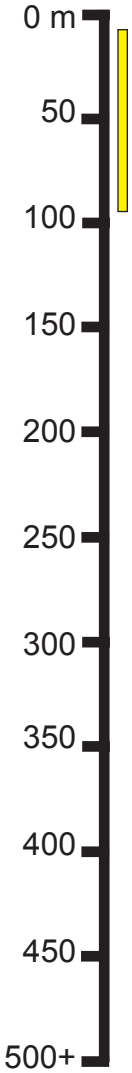




This page includes the distribution of all Dungeness Crab within each geography of the NCC region

Cancer productus (Red Rock Crab)

Depth



Farallon Islands, CA

Phylum Arthropoda | Class Malacostraca | Order Decapoda | Family Cancridae

Description: bright red carapace and claws as an adult, juveniles can vary in color

Size: carapace width approximately 17 cm

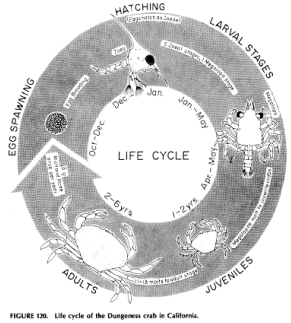
Depth Range: low intertidal to approximately 91 m

Habitat: found on rocky or soft bottoms

Range: Alaska to San Diego, California

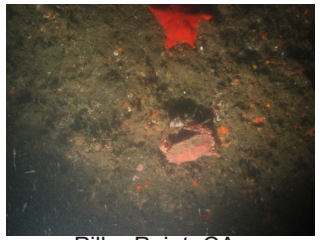
Similar species: Dungeness Crab

Feeding Habits: bivalves

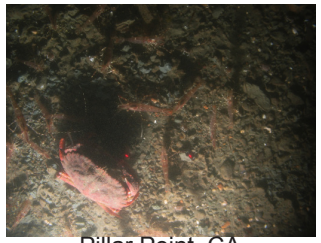


Life Cycle

Bodega Head, CA



Pillar Point, CA



Pillar Point, CA

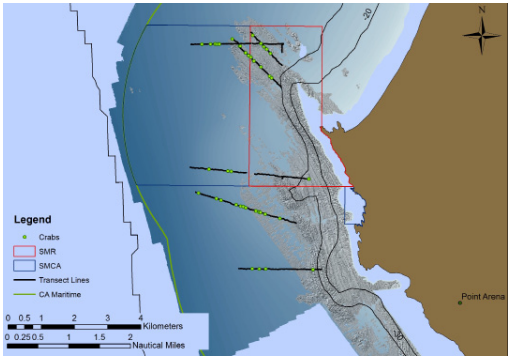
Pillar Point, CA

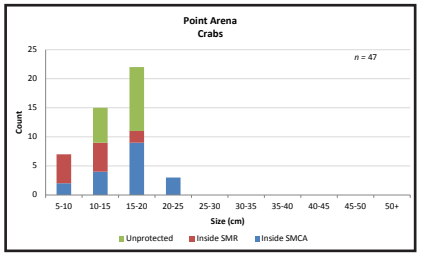
Spawning Time-

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
		X	X	X	X	X	X				

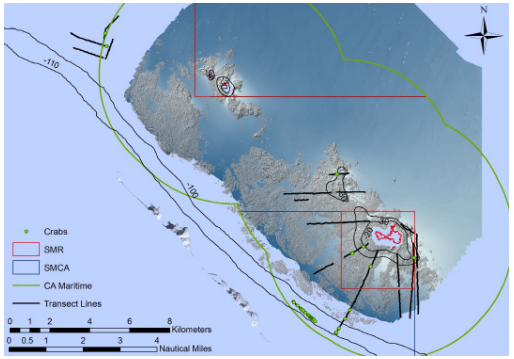
Cancer productus (Red Rock Crab)

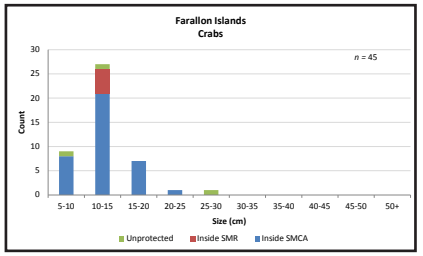
Point Arena



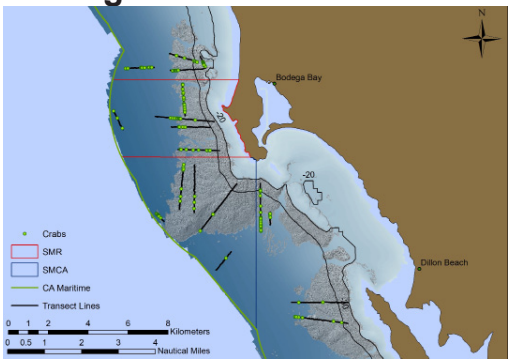


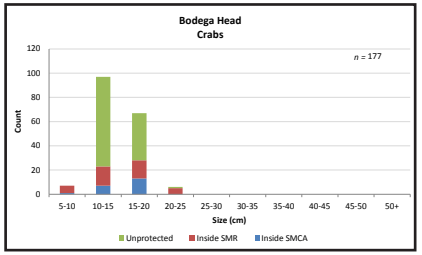
Farallon Islands



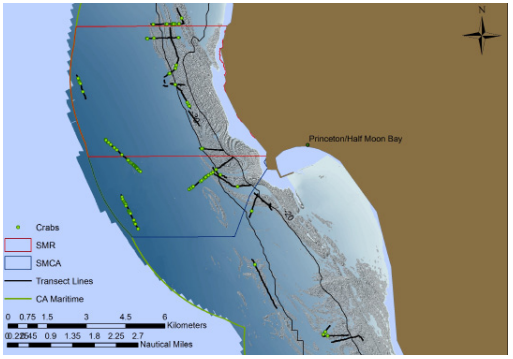


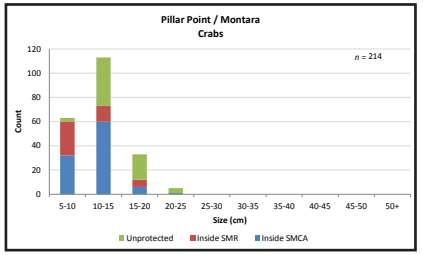
Bodega Head



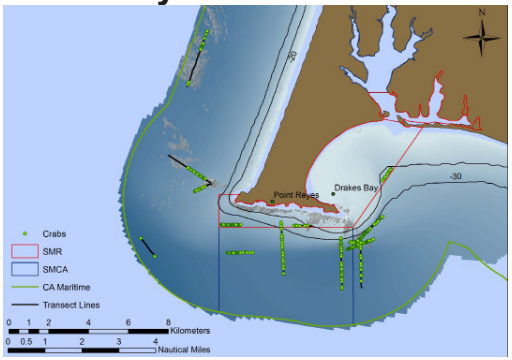


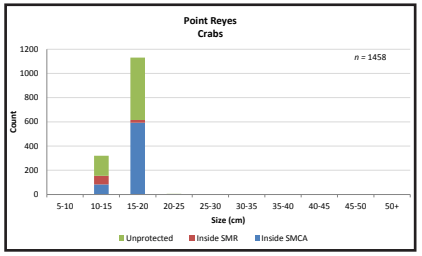
Pillar Point





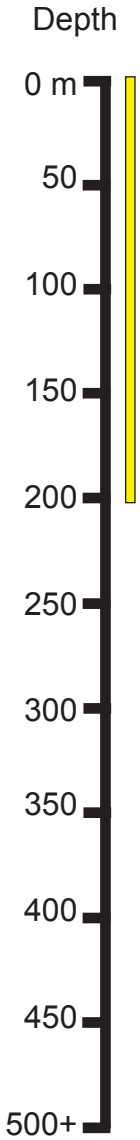
Point Reyes

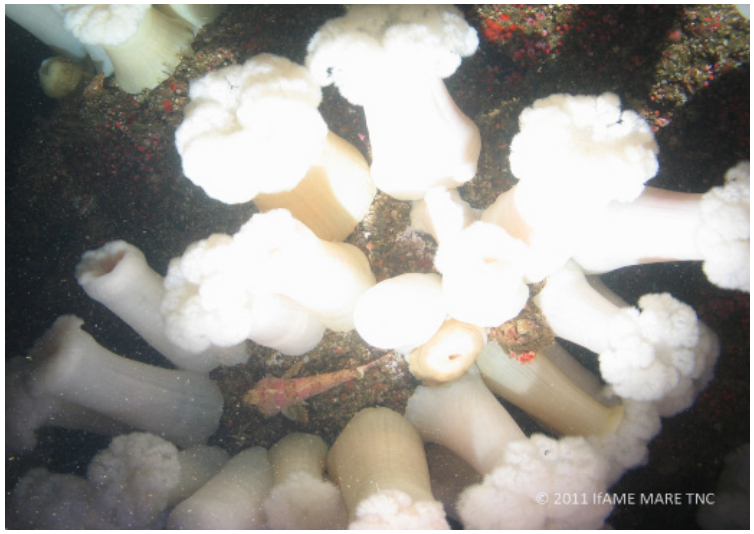




This page includes the distribution of all Red Rock Crabs within each geography of the NCC region

Metridium farcimen (Metridium)





Farallon Islands, CA


Farallon Islands, CA

Phylum Cnidaria | Class Anthozoa | Order Actiniaria | Family Metridiidae

Description: white stalk with white blooms

Size: 100 cm high and 10 cm wide

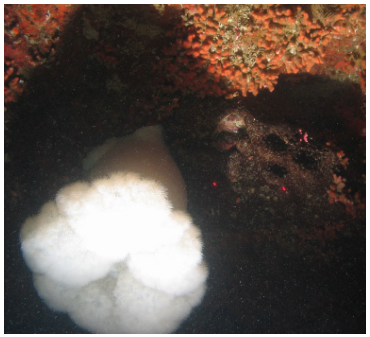
Range: Alaska to southern California

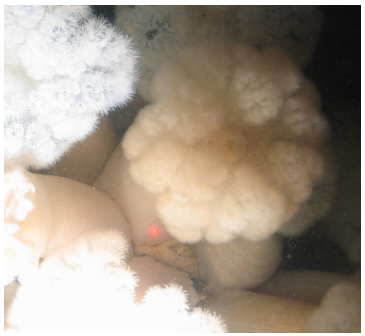
Depth Range: subtidal to 200 m

Habitat: reefs, wrecks and other structures

Food Habits: uses stinging tentacles to stun and catch prey

Natural History: gametes are spawned through the gastrovascular cavity and into the ocean


Farallon Islands, CA

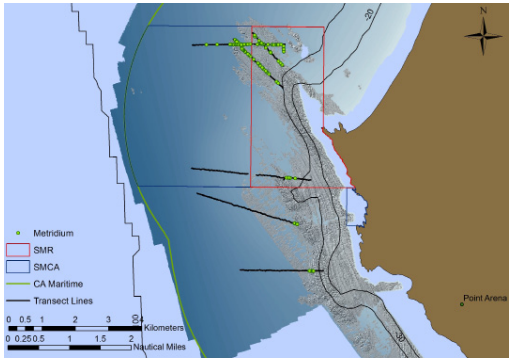

Farallon Islands, CA

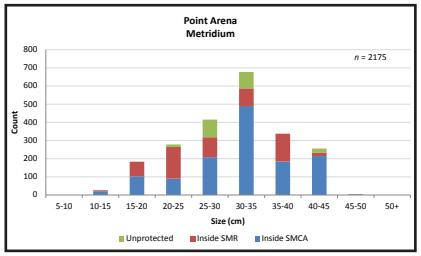
Spawning Timeline

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
							x	x			

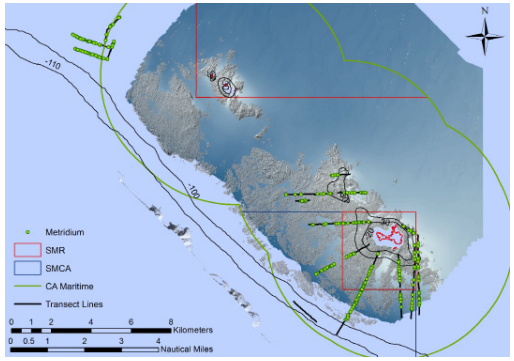
Metridium farcimen (Metridium)

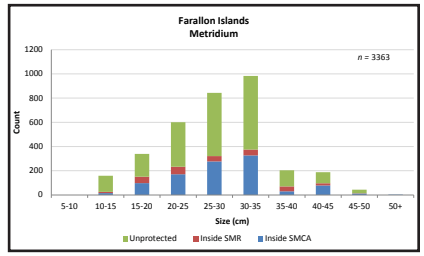
Point Arena



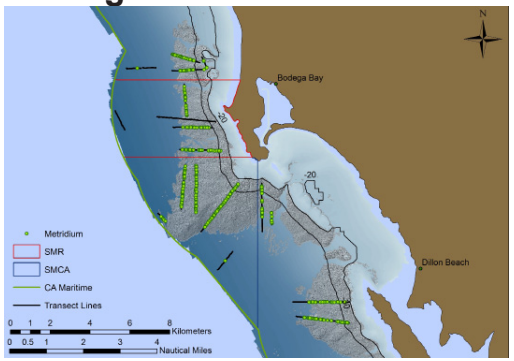


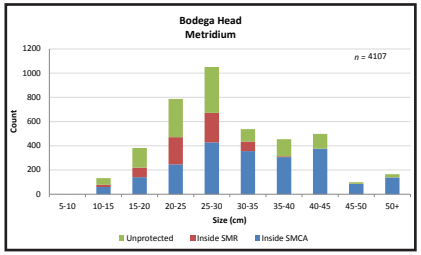
Farallon Islands



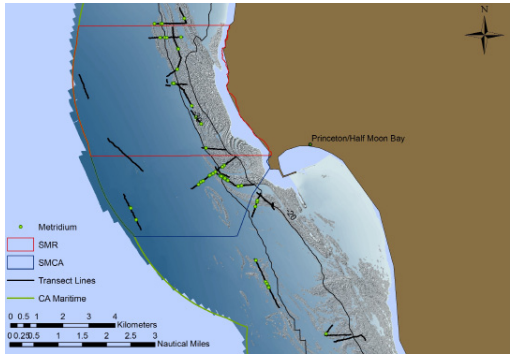


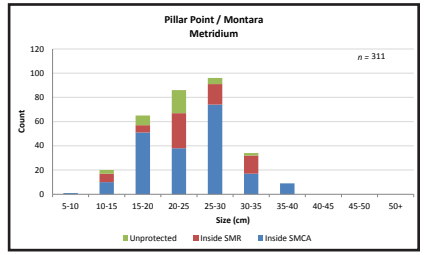
Bodega Head



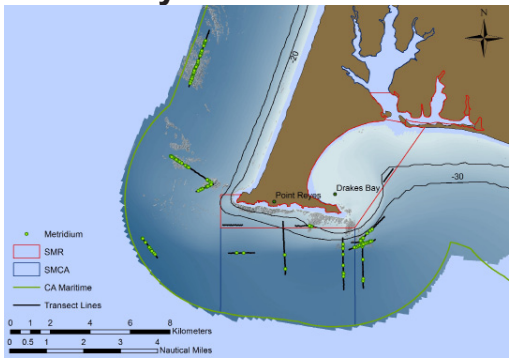


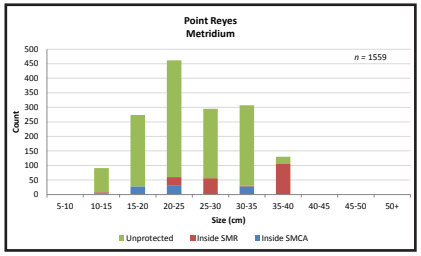
Pillar Point





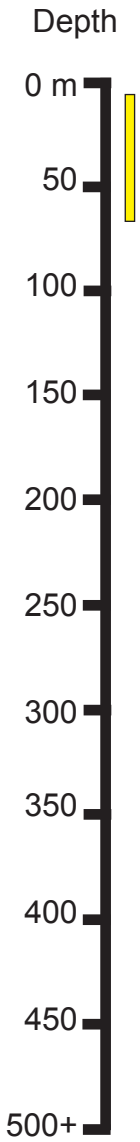
Point Reyes





This page contains the distributon of Metridium within each geography of the NCC region

Red Gorgonian



Bodega Head, CA

Monterey Bay, CA

Phylum Cnidaria | Class Anthozoa |
Order Alcyonacea | Family Gorgoniidae

Body color: red branches with white polyps

Size: 90 cm

Range: central California to Baja California

Depth: 15 m to 60 m

Habitat: rocks and reefs

Food Habits: filter feeders

Natural History: ovulid snail lives and feeds off this branches of the red gorgonian

Point Arena, CA

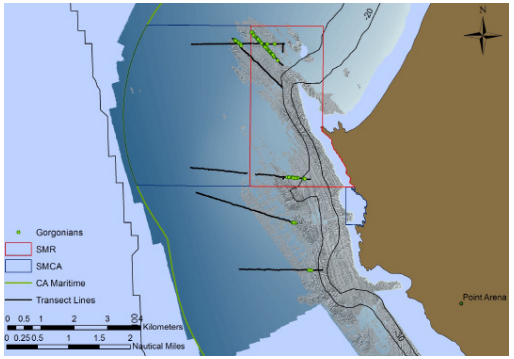
Farallon Islands, CA

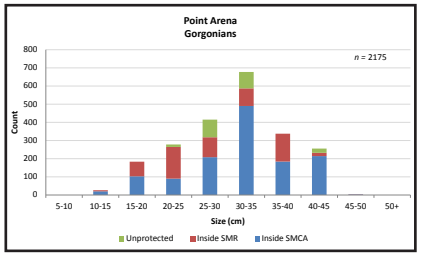
Spawning Timeline

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
							x	x			

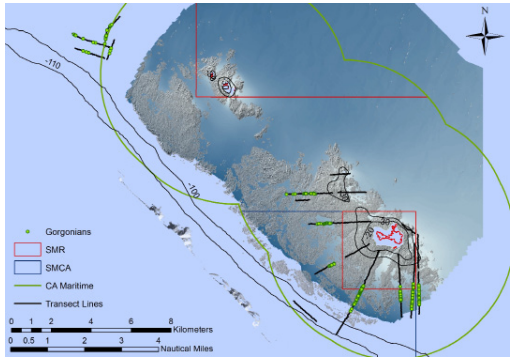
Red Gorgonian

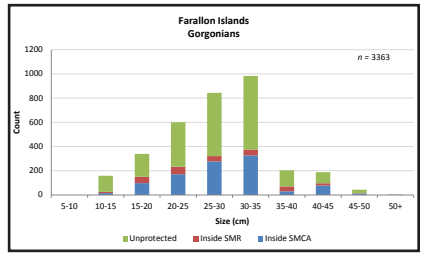
Point Arena



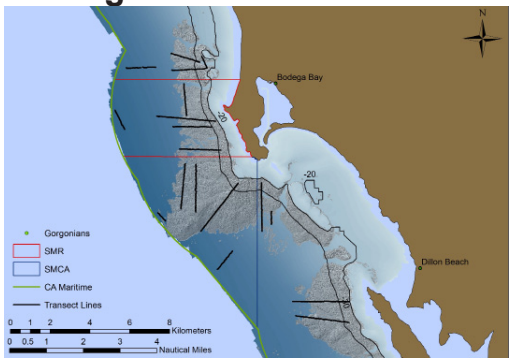


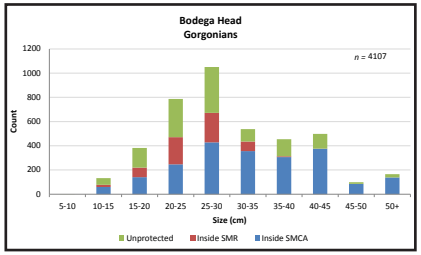
Farallon Islands



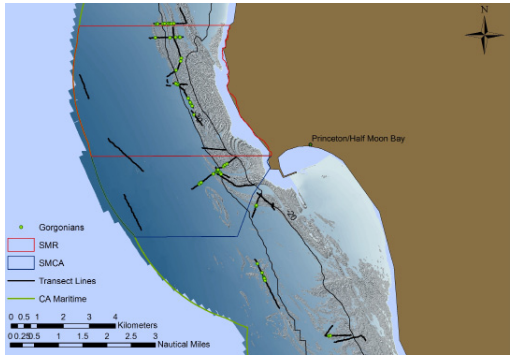


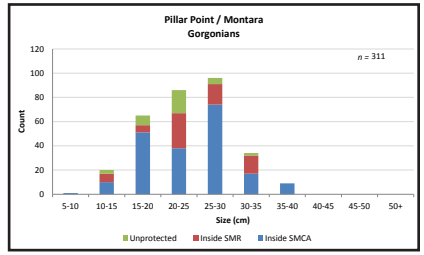
Bodega Head



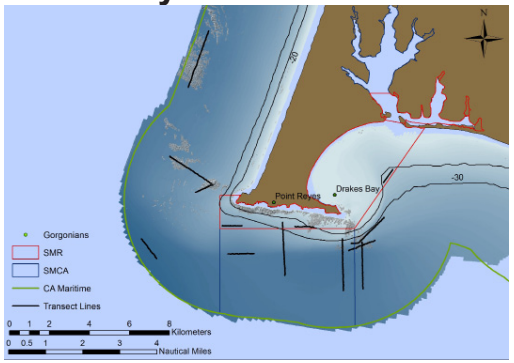


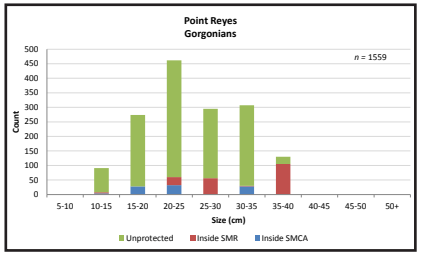
Pillar Point





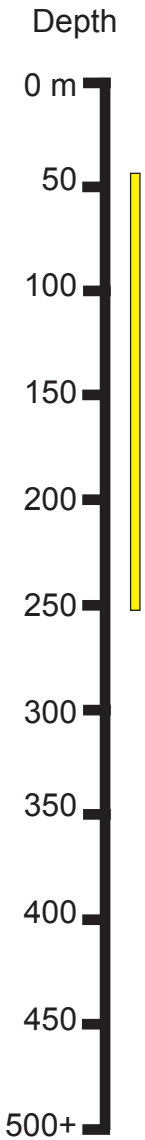
Point Reyes

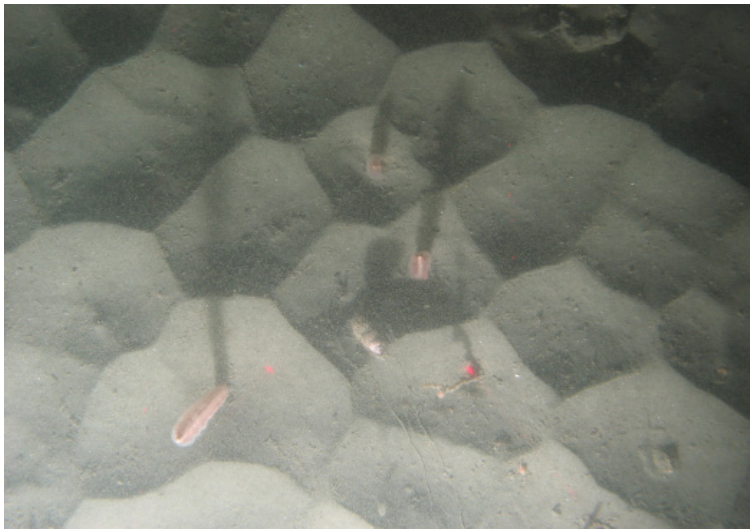




This page contains the distributon of Red Gorgonians within each geographyof the NCC region

Octocorallians (Sea Whips and Pens)




Pillar Point, CA


Farallon Islands, CA

Phylum Cnidaria | Class Anthozoa |
Subclass Octocorallia

Body color: whitish-gray axis and gray to greenish lateral branches

Size: 48 cm to 250 cm

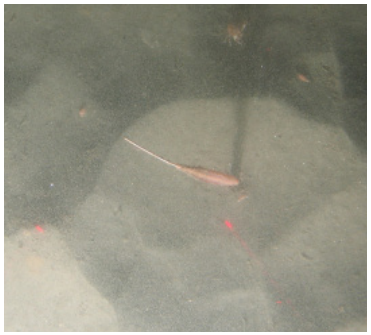
Range: northern Alaska to northern Mexico

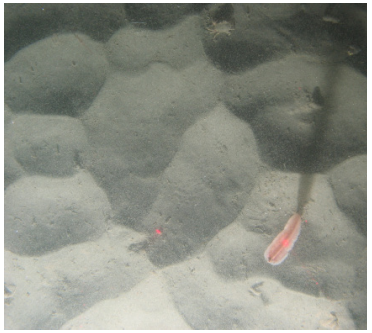
Depth: subtidal to 135 m

Habitat: sandy bottoms

Food Habits: filter feeders

Natural History: stays in the polyp phase during life cycle; various spawning times


Pillar Point, CA

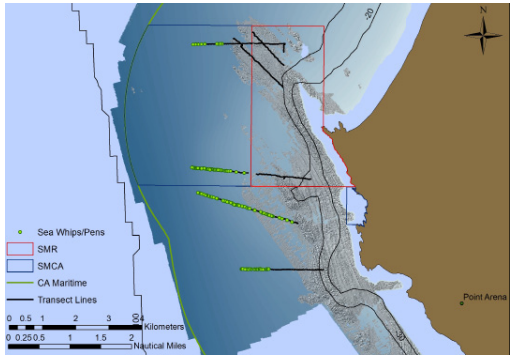

Pillar Point, CA

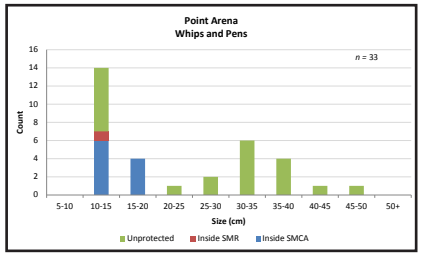
Spawning Timeline

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec

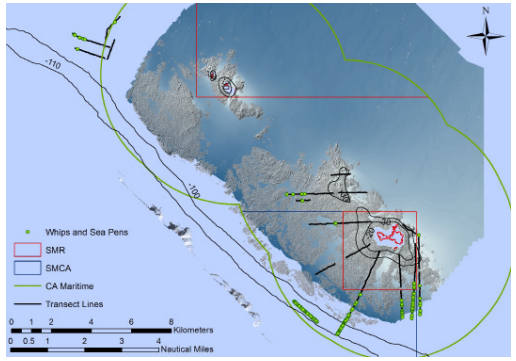
Octocorallians (Sea Whips and Pens)

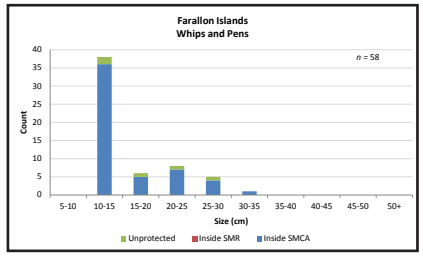
Point Arena



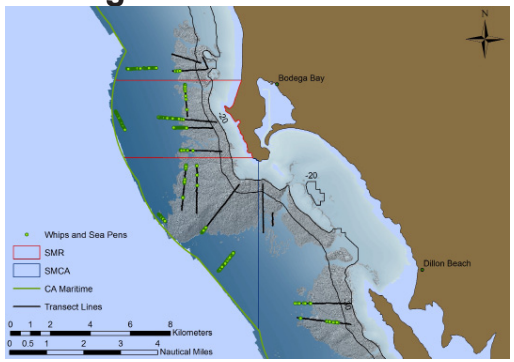


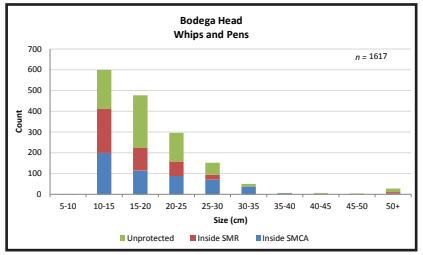
Farallon Islands



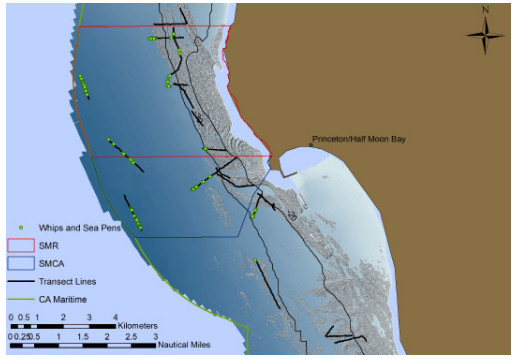


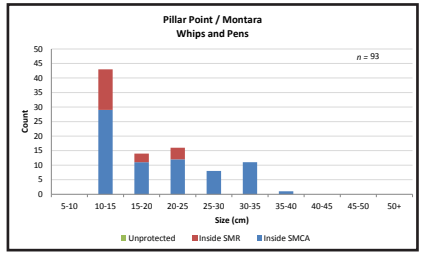
Bodega Head



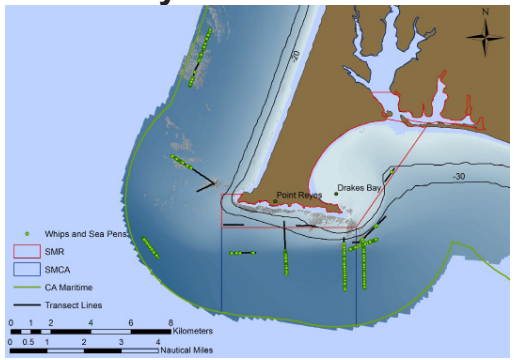


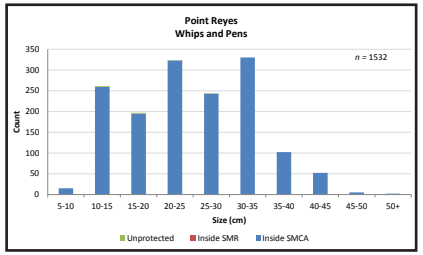
Pillar Point





Point Reyes





This page contains the distributon of all Sea Whips / Pens, including Orange Sea Pens, within each geography of the NCC region

Financial Reports

Institute for Applied Marine Ecology at CSU Monterey Bay

Budget Category	Budgeted amount	Actual expenditures	Balance	Variance
Salary & Wages	*$ 216,869.00*	$ 213,638.00	$ 3,231.00	1.5%
Fringe Benefits	*$ 38,437.00*	$ 40,760.00	$ (2,323.00)	-6.0%
Supplies	*$ 27,500.00*	$ 26,356.00	$ 1,144.00	4.2%
Domestic Travel	*$ 6,000.00*	$ 5,301.00	$ 699.00	11.7%
Direct Cost Total	**$ 288,806.00**	**$ 286,055.00**	**$ 2,751.00**	
Indirect Costs	$ 72,202.00	$ 72,202.00	$ -	
Total	$ 361,008.00	$ 358,257.00	$ 2,751.00	

Salary and benefits - Spending on salary closely matched the budgeted amount over the course of the grant period. However, benefits were paid at a higher rate than anticipated due to the annual fluctuation of fringe rates administered by the University Corporation. Despite the transfer of $19,410 from salary to fringe to cover this for staff salaries, the 6% over-budget in fringe occurred. In general, salaries were paid to the PI for project supervision and oversight, to research staff for data management, analysis, and reporting, and to graduate student assistants for data collection and entry and QA/QC checking of baseline survey data.

Supplies - Funding was spent on computers, hard drives and tapes for data (imagery) storage, video recording equipment, and other items required for collecting data in the field and processing imagery in the lab. Additional funds transferred from travel allowed the purchase of additional computers for data processing, storage, and analysis.

Travel – Funding supported staff and student assistant travel to/from study sites for data collection and to conferences and PI meetings for sharing of results and collaborative discussions. Extra travel funds were transferred to supplies to allow for the purchase of additional computers for data processing.

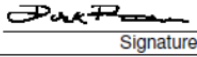
Funds and descriptions refer to expenditures as of 5/15/2013.Subsequent expenditures will utilize the remaining funds via the no-cost extension (granted on 12/31/2012).

MPA REQUEST FOR REIMBURSEMENT

Grant Number: 09-015	**Project Number: R/MPA-8**						
Name of Grantee: **Marine Applied Research & Exploration**	**Purchase Order Number:** 10306234					**All Invoices - Original**	
	CA Sea Grant accounting #: SEA4984						
Address (include zip code): 1230 Brickyard Cove #101 Richmond, CA 94801	**Project Leader: Dirk Rosen**						
	Billing Period Covered: From:					To:	28-Feb-13
Category Reimbursement *(insert rows as needed for additional budget categories)*	**Original Budget**	**Feb 2011 Rebudget**	**Rebudget**	**Sept 2011 Rebudget**	**Revised Budget**	**Total Cost to Date**	**Remaining Balance**
Salaries	$ 107,383.00	$ 7,000.00		$ 26,809.59	$ 141,192.59	$ 139,874.06	$ 1,318.53
Benefits	$ 15,504.00	$ 3,000.00		$ 6,928.90	$ 25,432.90	$ 25,437.10	$ (4.20)
Supplies	$ 8,000.00	$ 5,000.00	$ (5,589.17)	$ -	$ 7,410.83	$ 7,633.96	$ (223.13)
Equipment	$ -	$ -	$ 5,589.17	$ -	$ 5,589.17	$ 5,589.17	$ -
Travel	$ 43,460.00	$(15,000.00)		$ 3,596.67	$ 32,056.67	$ 32,412.59	$ (355.92)
Other Costs	$ 183,666.00	$ -		$ (986.00)	$ 182,680.00	$ 182,680.00	$ -
Indirect Costs (AKA - Project Management)	$ 86,009.00	$ -		$ (36,349.16)	$ 49,659.85	$ 49,461.38	$ 198.46
							$ -
							$ -
							$ -
							$ -
TOTAL	$ 444,022.00	$ -	$ -	$ 0.00	$ 444,022.01	$ 443,088.26	$ 933.74
TOTAL AMOUNT REQUESTED						**NOTE:** All receipts for expenditures over $1,000 and all travel/mileage expenses required.	

CERTIFICATION OF GRANTEE/CONTRACTOR

I hereby certify that the above costs were incurred in the performance of work required under the agreement and are consistent with the amounts evidenced by supporting documents and expenditures.



Signature

Dirk Rosen - Executive Director
Printed Name and Title

Email or fax the invoice to Sea Grant and keep the original for your records.

ATTN: Alice Jimenez
Email: a7jimenez@ucsd.edu
Fax: (858) 534-0577

Descriptions of ReBudgets:

Feb 2011 Rebudget- to take overage in travel and apply to salary, benefits and supplies

Rebudget- SeaGrant wanted to see purchased equipment (portion of thruster) broken out seperately from Supplies

Sept 2011 Rebudget- was due to reapportioning of Indirect Costs, due to guideline changes.

References

de Marignac J, Hyland J, Lindholm J, DeVogelaere A, Balthis WL, Kline D. 2008. A comparison of seafloor habitats and associated benthic fauna in areas open and closed to bottom trawling along the central California continental shelf. Marine Sanctuaries Conservation Series NMSP-09. U.S. Department of Commerce, National Oceanic and Atmospheric Administration, National Marine Sanctuary Program, Silver Spring, MD. 42 pp.

DeMott GE. 1983. Movement of tagged lingcod and rockfishes off Depoe Bay, Oregon. Master's Thesis, Oregon State University, Oregon.

Greene HG, Yoklavich MM, Starr RM, O'Connell VM, Wakefield WW, Sullivan DE, McRea Jr. JE, and Cailliet GM. 1999. A classification scheme for deep seafloor habitats. Oeanologica Acta 22(6): 663-678.

Hallenbeck T, Kvitek R, Lindholm J. 2012. Rippled scour depressions add ecologically significant heterogeneity to soft bottom habitats on the continental shelf. Marine Ecology Progress Series 468: 119-133.

Lea RN, McAllister RD, VenTresca DA. 1999. Biological aspects of nearshore rockfishes of the genus *Sebastes* from central California: with notes on ecologically related sport fishes. Fish Bulletin 177: 1-109.

Lindholm J, Auster P, Valentine P. 2004. Role of a large marine protected area for conserving landscape attributes of sand habitats on Georges Bank (NW Atlantic). Marine Ecology Progress Series 269: 61-68.

Tamsett A, Heinonen K, Auster PJ, Lindholm J. 2010. Dynamics of hard substratum communities inside and outside of a fisheries closed area in Stellwagen Bank National Marine Sanctuary (Gulf of Maine, NW Atlantic). Marine Sanctuaries Conservation Series ONMS-10-05. 53pp.

Tissot BM, Yoklavich MM, Love MS, York K, Amend M. 2006. Benthic invertebrates that form habitat on deep banks off southern California, with special reference to deep sea coral. Fish Bulletin 104:167-181.

Appendix - ROV Operations

Imagery Collection Cruise aboard F/V Donna Kathleen: 02 - 23 July 2010

This log describes the first of two cruises conducted for the larger study. It represents the first baseline survey through which we refined the sampling regime and subsequent data collection and analyses from the imagery gathered. A day-by-day breakdown of operations completed is provided in Table 7 below.

Table 7. Summary of daily operations for July 2010.

Date	Operations	Location	Notes
2 July	MOB ROV	Pillar Point Harbor	
3 July	ROV operations	Montara SMR inside	ROV thruster problems, multiple GFI (ground fault interruption) trips, resolved and completed 1 hour on bottom.
4 July	ROV operations	Montara SMR In/Out	Visibility very poor, ½ day of imagery collection.
5 July	ROV operations	Pillar Point Ref Site/SMCA In/Out	Full day of imagery collection.
6 July	ROV operations	Montara SMR In/Out, Pillar Point SMCA In/Out	Full day of imagery collection.
7 July	Transit/ROV operations	Transit to Farallon Is., S. Farallon SMR/SMCA In	½ day transit, full day imagery collection.
8 July	ROV operations	Ref site, Farallones SMR/SMCA Out	ROV camera problems, full day of imagery collection.
9 July	ROV operations/ transit	Farallones SMR/SMCA In/Out, transit to Pillar Point Harbor	Full day of imagery collection. Spare camera delivered.
10 July	Transit to Bodega Harbor		Boat and personnel relocate to Bodega Bay.
11 July	ROV operations	Bodega Head SMR In	ROV still camera problems. ½ day imagery collection.
12 July	ROV operations	Bodega Head SMCA In	ROV camera problems delayed launch. ½ day imagery collection.
13 July	ROV operations	Bodega Head SMR/SMCA Out	Full day of imagery collection.
14 July	ROV operations	Bodega Head Ref site, SMR/SMCA In	Full day of imagery collection.
15 July	Transit/ROV operations	Transit to Pt Arena, Point Arena SMCA/SMR In/Out	Relocated to Pt Arena early, full day of imagery collection.
16 July	ROV operations	Pt Arena SMCA ref site, SMCA/SMR In	Full day of imagery collection. Strobe malfunction aborted final dive.
17 July	Transit/ROV operations	Bodega Head SMR In	Transit to Bodega Bay, ½ day imagery collection.
18-21 July	No operations		Weather prohibited operations.
22 July	Transit/ROV operations	Transit to Pt Reyes SMR	Aborted. ROV thruster problems not resolvable.
23 July	DEMOB ROV	Pillar Point Harbor	

Imagery Collection aboard F/V Donna Kathleen: 06 July - 10 Aug 2011

The Year 2 cruise was the second planned for the study. It represents the final survey for the baseline project. The Year 2 cruise was conducted aboard the fishing vessel *F/V Donna Kathleen*. A day-by-day breakdown of operations completed is provided in Table 8 below.

Table 8. Summary of daily operations for July 2011.

Date	Operations	Location	Notes
6 July	MOB ROV	Pillar Point Harbor	
7 July	ROV operations	Montara SMR inside	Test dives, no data
8 July	ROV operations	Pillar Point Harbor	ROV maintenance and repair.
9 July	ROV operations	Montara SMR Inside	Full day of imagery collection.
10 July	ROV operations	Montara SMR In, Pillar Point SMCA In/Out	Full day of imagery collection.
11 July	ROV operations	Pillar Point SMCA Out, Ref site	KQED team onboard, full day imagery collection.
12 July	Transit/ROV operations	Transit to Farallones SMR/SMCA	Full day of imagery collection – CDFG protocol.
13 July	ROV operations/ transit	Farallones SMR/SMCA In/Out, transit to Pillar Point Harbor	Full day of imagery collection – CDFG protocol. Weather worsening, return to Pillar Point.
14 July	ROV operations	Pillar Point SMCA Out	½ day imagery collection.
15 July	Transit/ROV operations	Transit to Farallones SMR/SMCA	½ day imagery collection/ ½ day ROV repair.
16 July	ROV operations	Farallones Ref site	Full day of imagery collection.
17 July	ROV operations	Farallones SMR/SMCA In	Full day of imagery collection.
18 July	ROV operations/ Transit	Farallones SMR/SMCA In/CDFG site, Pt Reyes SMCA	½ day of imagery collection in Farallones, transit to Pt Reyes, ½ day imagery collection Point Reyes.
19 July	ROV operations/ transit	Pt Reyes SMCA/SMR In/Out, transit to Bodega Bay	Full day of imagery collection, transit to Bodega Bay.
20-22 July	No operations	Bodega Bay	Crew time off.
23 July	ROV operations	Bodega Head SMR In	Full day of imagery collection.
24 July	No operations	Bodega Head SMCA In/SMCA In	Full day of imagery collection.
25 July	Transit/ROV operations	Bodega Head SMR	½ day of imagery collection. Weather deteriorated.
26 July	No operations	Bodega Bay Harbor	Weather prevented operations.
27 July	ROV operations	Bodega Head Ref site	Full day of imagery collection.
28 July	Transit/ROV operations	Transit to Pt Reyes, Pt Reyes Ref site/SMCA Out	Full day of imagery collection.
29 July	ROV operations/Transit	Pt Reyes SMR/SMCA In/Out, transit to Bodega Bay	Full day of imagery collection.
30 July	ROV operations	Bodega Head SMR/SMCA – CDFG protocol	Full day of imagery collection.
31 July	ROV operations	Bodega Head Ref site – CDFG/IfAME protocols	Full day of imagery collection.
1-6 Aug	No operations	Transit to Pt Arena/ crew relocation	Crew time off, weather too poor to operate
7 Aug	ROV operations	Pt Arena SMR/SMCA In, CDFG and IfAME protocols	Full day of imagery collection.
8 Aug	ROV operations	Pt Arena Ref site, CDFG protocol	½ hour data collection, weather too poor to operate
9 Aug	No operations	Pt Arena Harbor/Transit to Bodega	Winds high and not predicted to calm, discontinue data collection, transit for demob
10 Aug	ROV Demob	Bodega Harbor	End of cruise.