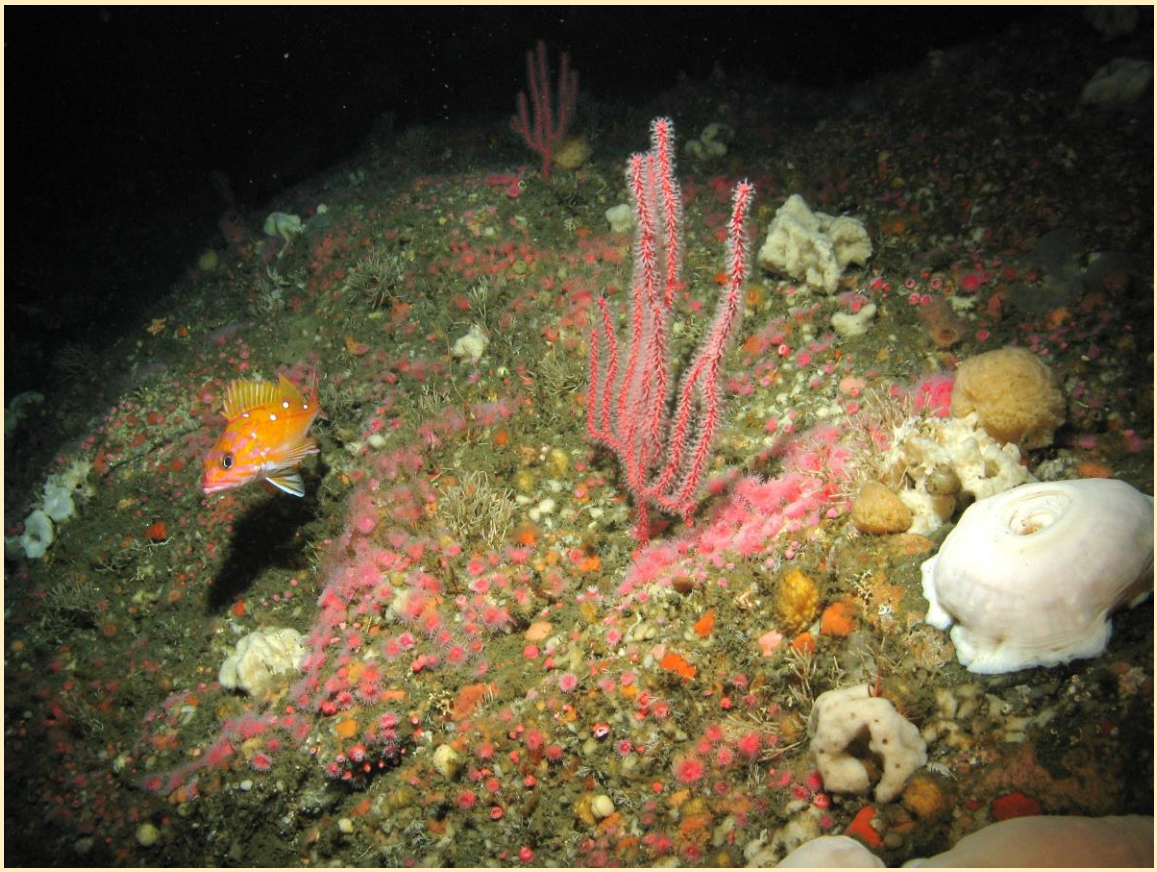
A report to NOAA Deep-Sea Coral Research and Technology Program
December 2014

Characterization of deep-coral and sponge communities in the Gulf of the Farallones National Marine Sanctuary: Rittenburg Bank, Cochrane Bank and the Farallon Escarpment.



NOAA Technical Memorandum NOS NCCOS 190
December 2014

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Cover Image:
A new genus and species of gorgonian octocoral *Chromoplexaura markii* and juvenile rosy rockfish (*Sebastes rosaceus*) at 86 meters depth in Rittenburg Bank, Gulf of the Farallones National Marine Sanctuary. Photo courtesy: NOAA

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Characterization of deep-coral and sponge communities in the Gulf of the Farallones National Marine Sanctuary: Rittenburg Bank, Cochrane Bank and the Farallon Escarpment.

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Rittenburg Bank

Cochrane Bank

Farallon Escarpment

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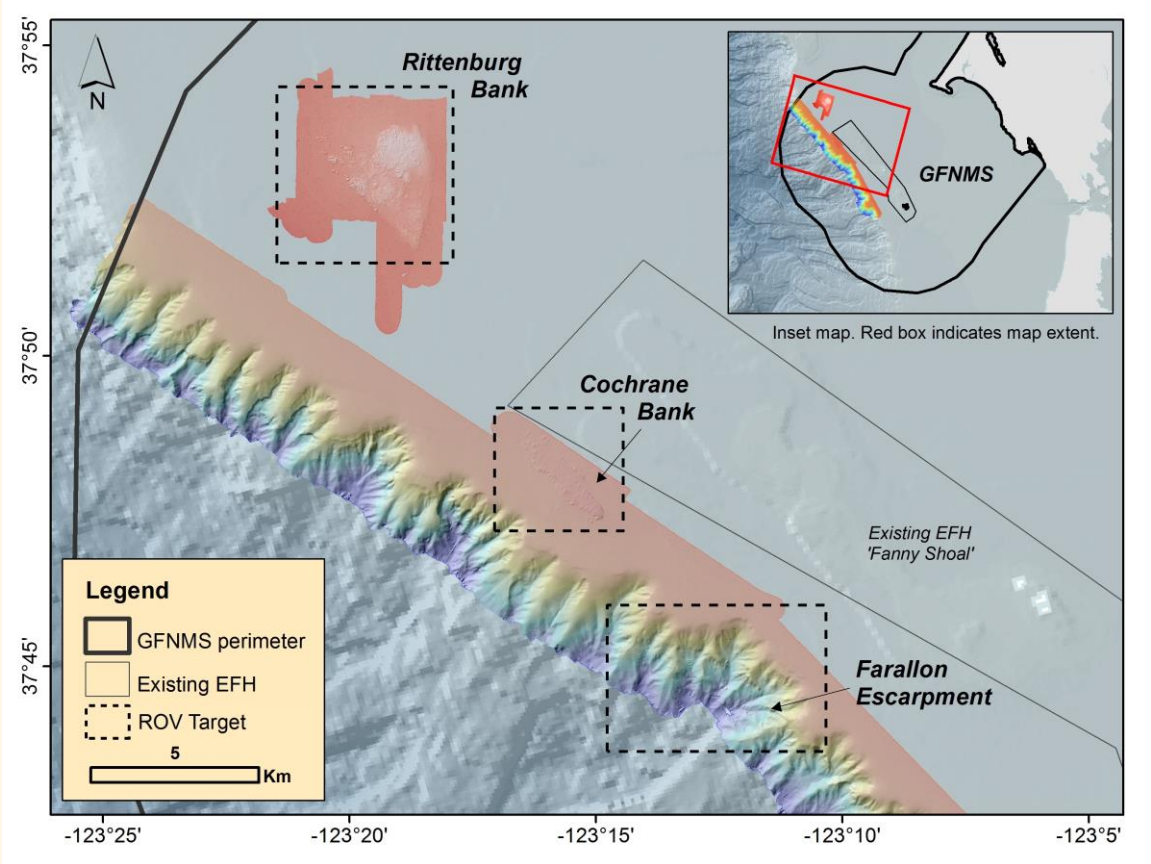
OVERVIEW

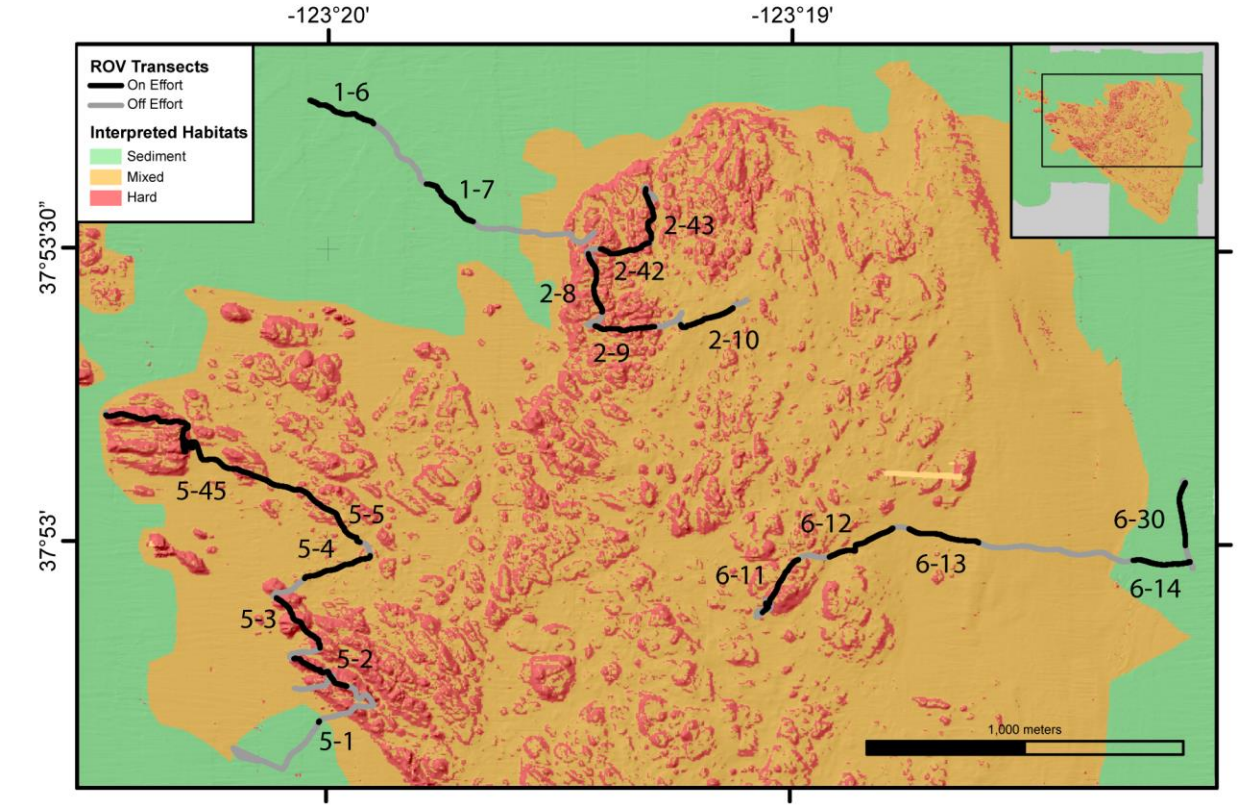
Benthic surveys were conducted in the Gulf of Farallones National Marine Sanctuary (GFNMS) aboard R/V *Fulmar*, October 3-11, 2012 using the large observation-class remotely operated vehicle (ROV) *Beagle*. The purpose of the surveys was to groundtruth mapping data collected in 2011, and to characterize the seafloor biota, particularly corals and sponges, in order to support Essential Fish Habitat designations under Magnuson-Stevens Act (MSA) and other conservation and management goals under the National Marine Sanctuaries Act (NMSA). ROV transects of uniform speed and distance (120 meters) were conducted over substrate classes predicted by ruggedness (Sappington et al. 2007) and backscatter intensity from the multibeam echosounder mapping data (Cochrane 2008). The three classes were low/soft, low/hard, and high/hard. The classes are reported here as sediment, mixed, and hard. Transects allowed quantification of organism abundance and density from oblique and down-looking video and still cameras mounted on the ROV. Sessile invertebrates 10 cm or larger were counted.

A total area of 25,416 m^2 of sea floor was surveyed during 34 ROV transects. The overall goals and deep-sea coral (DSC) and sponge research priorities for GFNMS were: (1) to locate and characterize DSC and sponge habitats in priority areas; (2) to collect information to help understand the value of DSCs and sponges as reservoirs of biodiversity, or habitat for associated species, including commercially important fishes and invertebrates; (3) to assess the condition of DSC/sponge assemblages in relation to potential anthropogenic or environmental disturbances; and (4) to make this information available to support fisheries and sanctuary management needs under MSA and NMSA requirements.



Overview map showing the GFNMS mapping extent (2011, in rainbow) and ROV targets (2012, black dashed lines).

GENERAL LOCATION AND DIVE TRACK



A map of Rittenburg Bank showing ROV transects in black, labeled by dive and transect number.

STATION OVERVIEW

Project	Gulf of the Farallones National Marine Sanctuary Deep Coral Cruise
Chief Scientists	P. Etnoyer and J. Roletto
Contact Information	Peter.Etnoyer@noaa.gov, NCCOS, CCEHBR Jan.Roletto@noaa.gov, NOS, GFNMS
Purpose	Survey deep coral communities at GFNMS, northern California
Vessel	R/V *Fulmar*, Marine Applied Research and Exploration ROV *Beagle*
Science Observers	P. Etnoyer, G. Cochrane, E. Salgado, G. Williams, J. Roletto, K. Reyna
External Video Tapes	Two SD video cameras, one forward facing and one downward facing; One HD video camera with depth, temperature, salinity, and geo-position.
Digital Still Photos	918
Positioning System	Ship: GPS; ROV: USBL
CTD Sensor, DO Sensor	Yes, Yes
pH Sensor	No
Specimens collected	Yes, archived at California Academy of Sciences
Taxonomy Analysts	Gary Williams, Peter Etnoyer, Henry M. Reiswig, William. C. Austin, Mercer Brugler, and Santiago Herrera
Other	Logbook, MS Access database, X-keys for geology, GIS database of deep-sea corals
Report Analysts	P. Etnoyer, E. Salgado, G. Cochrane, K. Graiff, J. Roletto. and K. Reyna
Date Compiled	12 May 2013

STATION OVERVIEW

DIVE SUMMARY FOR SITE

Total Dives: 5
Depth Range (m): 71 to 111 meters

Date	Dive #	Method	Start Time (UTC)	End Time (UTC)	Start Latitude	Start Longitude	End Latitude	End Longitude
3-Oct-2012	1	ROV	19:03:19	20:58:51	37.89676	-123.33462	37.89199	-123.32346
4-Oct-2012	2	ROV	17:03:03	21:03:23	37.88954	-123.31839	37.89330	-123.32156
8-Oct-2012	5	ROV	17:05:30	21:55:38	37.87691	-123.33488	37.88708	-123.34132
9-Oct-2012	6	ROV	16:49:19	19:07:34	37.88508	-123.30231	37.88149	-123.31739
9-Oct-2012	7	ROV	19:53:49	20:41:28	37.87929	-123.33331	37.87968	-123.33333

TRANSECT SUMMARY

Dive #	Transect Name	Minimum Depth (m)	Maximum Depth (m)	Start Longitude	Start Latitude	End Longitude	End Latitude	Verified Substrate Class
1	RB-6	104	106	-123.33166	37.89517	-123.33383	37.89571	low-soft
1	RB-7	101	106	-123.32802	37.89237	-123.32975	37.89354	low-soft
2	RB-8	80	90	-123.32387	37.89159	-123.32356	37.88980	high-hard
2	RB-9	71	89	-123.32162	37.88942	-123.32389	37.88949	high-hard
2	RB-10	74	82	-123.32076	37.88939	-123.31861	37.88999	high-hard
2	RB-42	80	87	-123.32268	37.89167	123.32175	37.89188	high-hard
2	RB-43	82	90	-123.32177	37.89276	-123.32190	37.89339	high-hard
5	RB-45	86	101	-123.33985	37.88683	-123.34108	37.88689	high-hard
5	RB-1	104	110	-123.33362	37.87829	-123.33509	37.87692	low-soft
5	RB-2	78	98	-123.33248	37.87916	-123.33450	37.87998	high-hard
5	RB-3	83	105	-123.33353	37.88032	-123.33502	37.88168	high-hard
5	RB-5	94	102	-123.33204	37.88318	-123.33369	37.88442	high-hard
5	RB-4	99	105	-123.33404	37.88238	-123.33188	37.88294	low-hard
6	RB-11	82	98	-123.31757	37.88134	-123.31636	37.88286	high-hard
6	RB-12	90	97	-123.31507	37.88297	-123.31301	37.88373	low-hard
6	RB-13	94	97	-123.31225	37.88370	-123.31002	37.88334	low-hard
6	RB-14	110	111	-123.30431	37.88282	-123.30204	37.88264	low-soft
6	RB-30	110	111	-123.30242	37.88507	-123.30230	37.88327	low-soft
7	sampling	79	98	-123.33331	37.87929	-123.33331	37.87929	high-hard

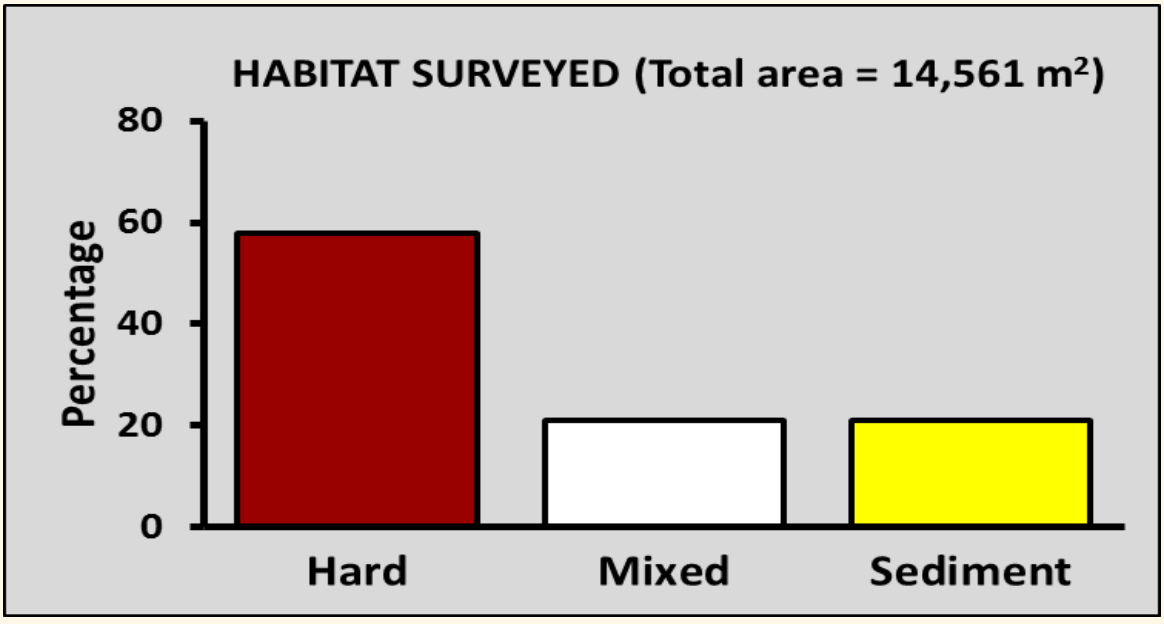
STATION OVERVIEW

PHYSICAL ENVIRONMENT

A total area of 14,561 m^2 of sea floor was surveyed during 18 remotely operated vehicle (ROV) transects on Rittenburg Bank. The survey was conducted between October 3 and 9, 2012 using the Marine Applied Research and Exploration Group ROV *Beagle* deployed from the Office of National Marine Sanctuaries research vessel *Fulmar* on Rittenburg Bank, within GFNMS off northern California, northwest of San Francisco. Habitat types were identified, classified, and logged periodically during transects using the X-keys system.

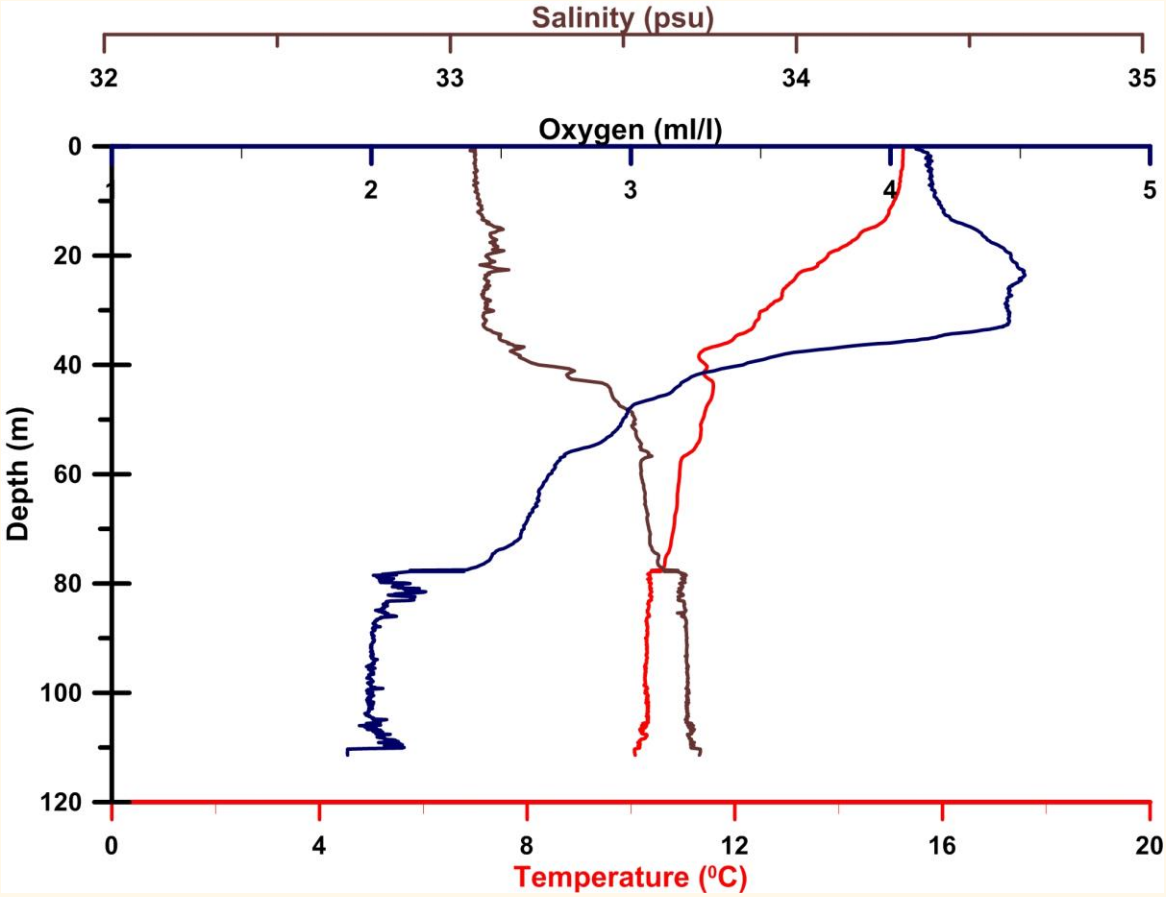
Rittenburg Bank is an arrowhead-shaped, or heart-shaped, rocky feature located in the northwest corner of the GFNMS. It is located furthest to the east and nearest to shore of the two shelf features surveyed. Rittenburg is the larger of the two features, approximately 5 km from the shelf break, further from the break than Cochrane Bank. Maps of Rittenburg Bank are provided on pages 1 and 2. The multibeam bathymetry, acoustic backscatter, and sea floor character data are publicly available online through the United States Geological Survey (USGS) website, and described in detail in Dartnell et al. 2014.

Habitat types were classified as (1) Hard (58% of the total area surveyed was high relief/hard bottom), including boulders, cobbles, and rock; (2) Mixed (21% of the total area surveyed was low relief/hard bottom), including a combination of sand and mud with boulder, cobbles, gravel, or rock; and (3) Sediment (21% of the total area surveyed was low relief/soft bottom), which consisted entirely of sand and mud. Geologic observations of Rittenburg Bank suggest weathering consistent with an ancient shoreline.



PHYSICAL ENVIRONMENT

The ROV *Beagle* was equipped with a Sea-Bird SBE 19plusV2 CTD and SBE 43 dissolved oxygen (DO) sensor during each dive, which collected data on depth, conductivity, temperature, and dissolved oxygen during descent and at depth along the track lines. The figure below is representative of conditions observed on Rittenburg Bank during the survey. Temperature ranged from 15.3°C at the sea surface to 10.1°C on the sea floor at 111 meters depth. Dissolved oxygen was 4.15 ml/l at the surface. DO increased to 4.5 ml/l at 23 to 30 m depth, and then decreased to 1.90 ml/l on the sea floor. During the dives, temperatures averaged 10.3 °C along the track lines, with fluctuations of <1°C. Salinity (as estimated from conductivity) ranged from 33.0 psu at the sea surface to 33.7 psu on the sea floor. Salinity variations of <0.5 psu were recorded with depth changes along the dive track lines.

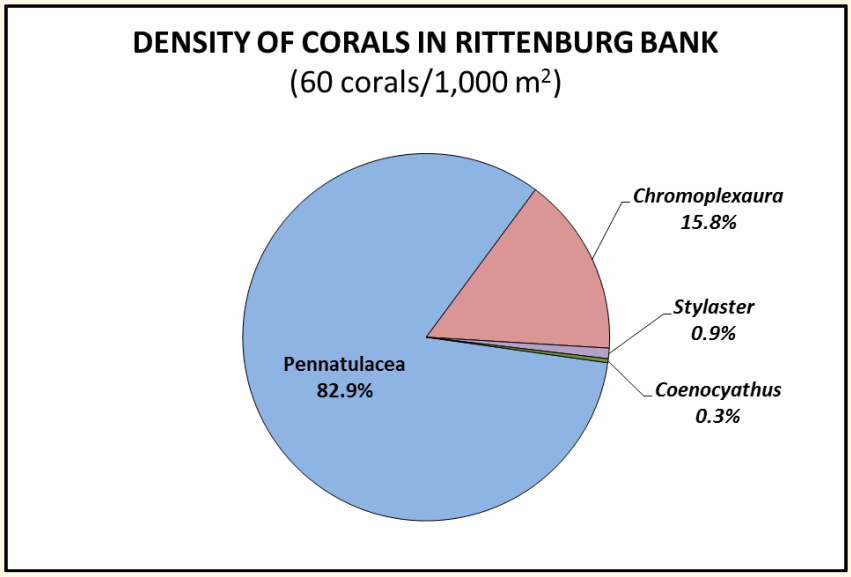


The CTD data show a stratification of the water column in which a warmer, less saline surface layer begins to interface with a colder thermocline and a more saline layer at 30-40 meter depth. An inflection point occurs at this depth, where oxygen concentrations also begin to decline. The dissolved oxygen peak near 20 meters depth is typical for the Northeast Pacific region (Shulenberger and Reid 1981) and consistent with the depth of the Deep Chlorophyll Maximum (Millán-Núñez et al. 1997). Temperature and salinity values begin to stabilize at 75-80 meters and oxygen reaches a minimum of 1.7 ml/l near the seafloor. This profile is typical of late-summer/early-fall conditions (Rago et al. 2006).

BIOLOGICAL ENVIRONMENT: CORALS

A total of 2002 individual anthozoans, comprising at least six taxa, were enumerated from 18 quantitative, 120-meter transects conducted during Dives 1, 2, 5, 6, and 7 on Rittenburg Bank.

We estimated an average density of 60 corals per 1000 m^2 of sea floor on Rittenburg Bank. Including anemones among the Cnidaria, we estimated 138 total anthozoans per 1000 m^2 of sea floor.



Colors in pie diagram match colors in table below.

Metridium spp. accounted for over 56% of the anthozoan density; 36% were sea pens in genera *Virgularia, Stylatula* and *Ptilosarcus* in order of abundance. Sea pens occurred predominately in soft substrate, while the rest of the anthozoans occurred in hard and mixed substrates.

Three coral specimens were collected from Rittenburg Bank and archived at California Academy of Sciences - *Chromoplexaura markii* (formerly known as *Euplexaura markii)* and *Stylaster californicus*. The specimens were identified from samples and expert examination of photographs (see Appendix I at end of report). All other anthozoan identifications at Rittenburg Bank were based on expert examination of photographs and video.

Rittenburg Bank Corals

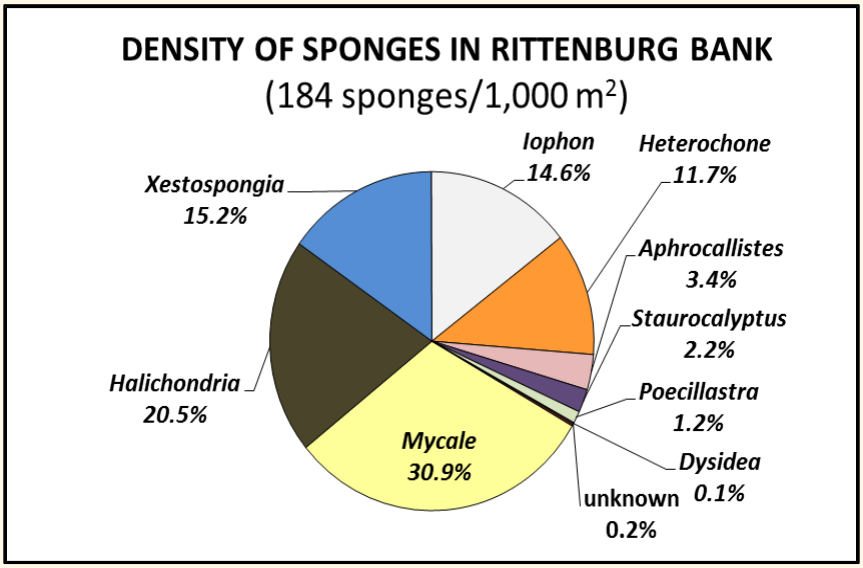
Scientific name	Common name	Count
Corals		
All Pennatulacea	Sea pens	719
Chromoplexaura markii	Red sea fan	137
Stylaster californicus	Pink lace coral	8
Coenocyathus sp.	Cluster cup coral	3
Other benthic cnidarians		
Metridium sp.	White plume anemone	1133
Stomphia sp.	Orange anemone	2

The biological samples were identified by Dr. Gary C. Williams of California Academy of Sciences. Dr. Williams identified both corals based on morphology. He revised the taxonomy of *Euplexaura markii* to a new genus and species *Chromoplexaura markii* (Williams 2013).

BIOLOGICAL ENVIRONMENT: SPONGES

A total of 2673 individual sponges, comprising at least nine taxa, were enumerated from 18 quantitative, 120-meter transects conduct during Dives 1, 2, 5, 6, and 7 on Rittenburg Bank.

We estimated an average density of 184 sponges per 1000 m^2 of sea floor. The yellow vase sponge *Mycale* sp. accounted for over 30% of the sponge density. Also numerous were *Halichondria panicea* (20.5%), *Xestospongia diprosopea* (15.2%), and *Iophon piceus* var. *pacifica* (14.6%).



Colors in pie diagram match colors in table below.

Most of the sponges occurred in hard and mixed substrates. Eleven sponge specimens were collected from Rittenburg Bank. Henry M. Reiswig from the Royal British Columbia Museum identified *Staurocalyptus fasciculatus* and *Heterochone calyx*. William C. Austin from Khoyatan Marine Laboratory identified *Xestospongia diprosopea*, *Mycale* cf. *lingua*, *Iophon piceus* var. *pacifica*, and *Halichondria panicea.* See Appendix I for collection and archive information. The highest density of sponges on all banks (0.86 colonies per square meter) was found on dive 5, transect RB-45, at a rocky outcrop feature referred to as "Sponge Heaven" by our observers.

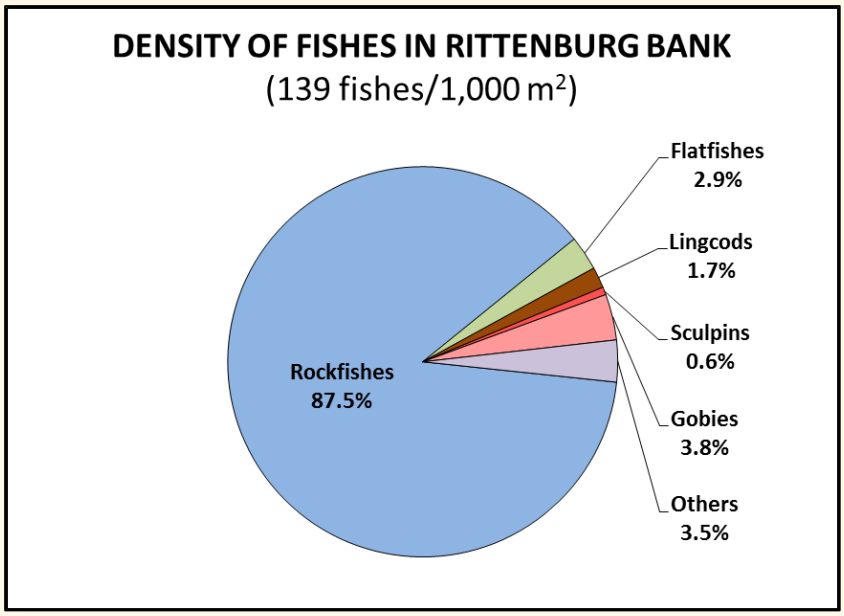
Rittenburg Bank Sponges

Scientific name	Common name	Count
Mycale sp.	Yellow vase sponge	825
Halichondria panicea	Brown potato sponge	549
Xestospongia diprosopea	Aureoled grey lobe sponge	407
Iophon piceus var. *pacifica*	White finger/ catcher's mitt	390
Heterochone sp.	Honeycomb vase sponge	313
Aphrocallistes sp.	Foliose goblet sponge	90
Staurocalyptus fasciculatus	Barrel-boot Sponge	59
Poecillastra sp.	Shelf sponge	31
Dysidea fragilis	Grey vase sponge	3
Unknown porifera orange	Orange lobe	6

Mycale sp., *Halichondria panicea, Xestospongia diprosopea*, *Iophon piceus* var. *pacifica*, *Heterochone* sp., and *Staurocalyptus fasciculatus*, were identified by experts based on morphology of specimens and examination of photographs (see Appendix I). *Aphrocallistes* sp., *Poecillastra* sp., *Dysidea fragilis* and other sponge taxa at Rittenburg Bank were based on expert examination of photographs and video.

BIOLOGICAL ENVIRONMENT: FISHES

At least 35 taxa of fishes were identified from 18 120-meter transects conducted during Dives 1, 2, 5, 6 and 7 on Rittenburg Bank. Fish counts were estimated from still images taken along each transect (50 per transect), therefore represent minimum counts and densities. A total of 868 images were used for fish observations. We estimated an average density of 139 fish per 1000 m^2. Rockfish accounted for the majority of fish observed (87.5%). The remainder of the fish assemblage included gobies (3.8%), flatfish (2.9%), lingcod (1.7%), and others (3.5%).



Colors in pie diagram match colors in tables below.

Rittenburg Bank Fishes

Scientific name	Common Name	Count
Sebastes wilsoni	Pygmy rockfish	580
Sebastes (juvenile)	Juvenile rockfish	475
Sebastes flavidus	Yellowtail rockfish	179
Sebastes rosaceus	Rosy rockfish	145
Unknown sebastomus	Sebastomus	108
Sebastes spp.	Unidentified rockfishes	100
Sebastes ruberrimus	Yelloweye rockfish	67
Sebastes pinniger	Canary rockfish	32
Sebastes hopkinsi	Squarespot rockfish	16
Sebastes chlorostictus	Greenspotted rockfish	13
Sebastes entomelas	Widow rockfish	11
Sebastes helvomaculatus	Rosethorn rockfish	8
Sebastes paucispinis	Bocaccio	8
Sebastes constellatus	Starry rockfish	7
Sebastes elongatus	Greenstriped rockfish	7
Sebastes maliger	Quillback rockfish	6
Sebastes miniatus/pinniger	Vermilion/canary rockfish	3
Sebastes miniatus	Vermilion rockfish	2
Sebastes saxicola	Stripetail rockfish	2
Sebastes nebulosus	China rockfish	1
Sebastes ovalis	Speckled rockfish	1

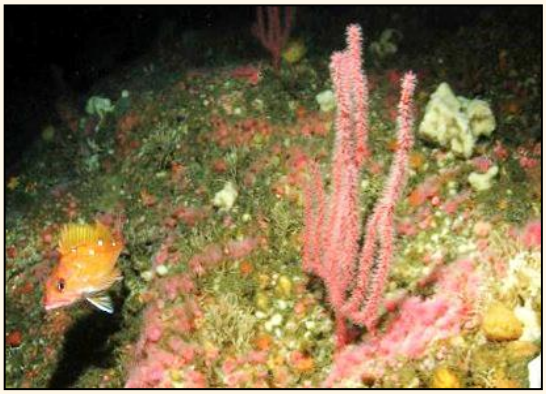
BIOLOGICAL ENVIRONMENT: FISHES *(continued)*

Rittenburg Bank Fishes (con't.)			
	Scientific name	**Common Name**	**Count**
	Microstomus pacificus	Dover sole	13
	Glytocephalus zachirus	Rex sole	3
	Parophrys vetulus	English sole	3
	Lyopsetta exilis	Slender sole	1
	Ophiodon elongatus	Lingcod	35
	Cottoidae	Unidentified sculpin	12
	Paricelius hopliticus	Thornback sculpin	1
	Rhinogobiops nicholsii	Blackeye goby	77
	Citharichthys spp.	Unidentified sanddabs	26
	Paricelius hopliticus	Thornback sculpin	9
	Hexagrammos decagrammus	Kelp greenling	7
	Rhinogobiops nicholsii	Blackeye goby	5
	Xeneretmus triacanthus	Blue spotted poacher	4
	Ronquilus jordani	Northern ronquil	4
	Unknown fish	Unidentified fishes	3
	Zaniolepis latipinnis	Longspine combfish	2
	Anarrhichthys ocellatus	Wolf-eel	2
	Unknown Agonidae	Unidentified poachers	2
	Zaniolepis spp.	Combfishes	1
	Chirolophis decoratus	Decorated warbonnet	1
	Hydrolagus colliei	Spotted ratfish	1
	Raja rhina	Longnose skate	1
	Rathbunella sp.	Unidentified ronquil	1

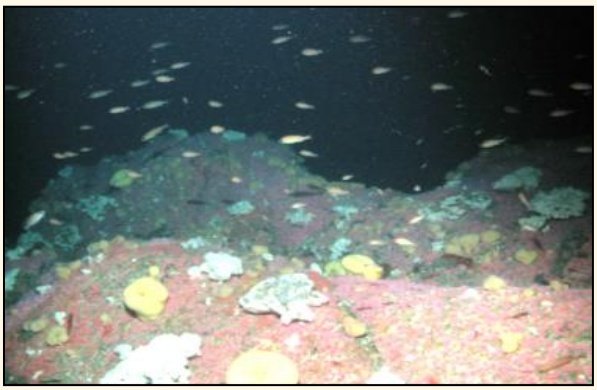
Fish were considered to be in association with the host invertebrate when exhibiting one or more of the following behaviors: hovering, or resting on the bottom, within one fish body length, or in direct contact with the invertebrate (Stone 2006). Of all fish counted in Rittenburg Bank, 8.5% were found in association with a coral or sponge. The fishes most commonly found in association with corals and/or sponges on Rittenburg Bank were rockfish. Rosy rockfish (*Sebastes rosaceus*) had the largest number of associations (n=41), and were observed in association 28% of the time. Yelloweye rockfish (*Sebastes ruberrimus*) were in association 42% of the time. Notably, over half of the associated Yelloweye displayed juvenile coloration, suggesting that Rittenburg Bank's biogenic habitats are important for the recruitment of juvenile Yelloweye rockfish. Yelloweyes are federally designated as an "overfished" species, which means that less than 25% of their estimated pre-fishery population currently exists (NMFS, 2014). Corals with the highest frequencies of associated fish were: *Stylaster*, 27%; and *Chromoplexaura*, 17% of total. Sponges with the highest frequencies of fish association were *Poecillastra*, 42%; *Staurocalyptus*, 38%; and *Mycale*, 25%.

Fish counts and distribution data were uploaded to the Essential Fish Habitat Data Catalog (http://efh-catalog.coas.oregonstate.edu/overview/), using the X-keys data logging format. All video and still-image annotations of corals and sponges have been submitted to NOAA's National Database of Deep-Sea Corals and Sponges, maintained by the Deep-Sea Coral Research and Technology Program.

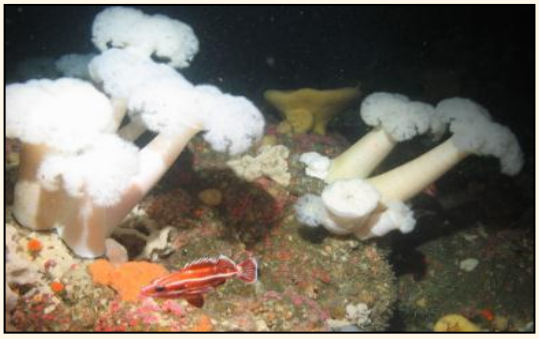
IMAGE GALLERY



Sebastes rosaceus, *Chromoplexaura markii,* and *Halichondria panicea* at 86 meters depth.



Juvenile rockfish over rocky habitat with *Mycale*, *Xestospongia diprosopea,* and *Iophon piceus* sponges.



Juvenile *Sebastes ruberrimus* with *Metridium* anemones, biogenic habitat, and exposed rock.

Schooling *Sebastes flavidus* with *Sebastes ruberrimus* and sponges.

Staurocalyptus fasciculatus with *Sebastes flavidus* and *Sebastes pinniger*.

Heterochone calyx and *Iophon piceus* var. *pacifica* with *Sebastes wilsoni* and *Sebastes rosaseus*, 85 meters depth.

RELEVANT WORK AND LITERATURE

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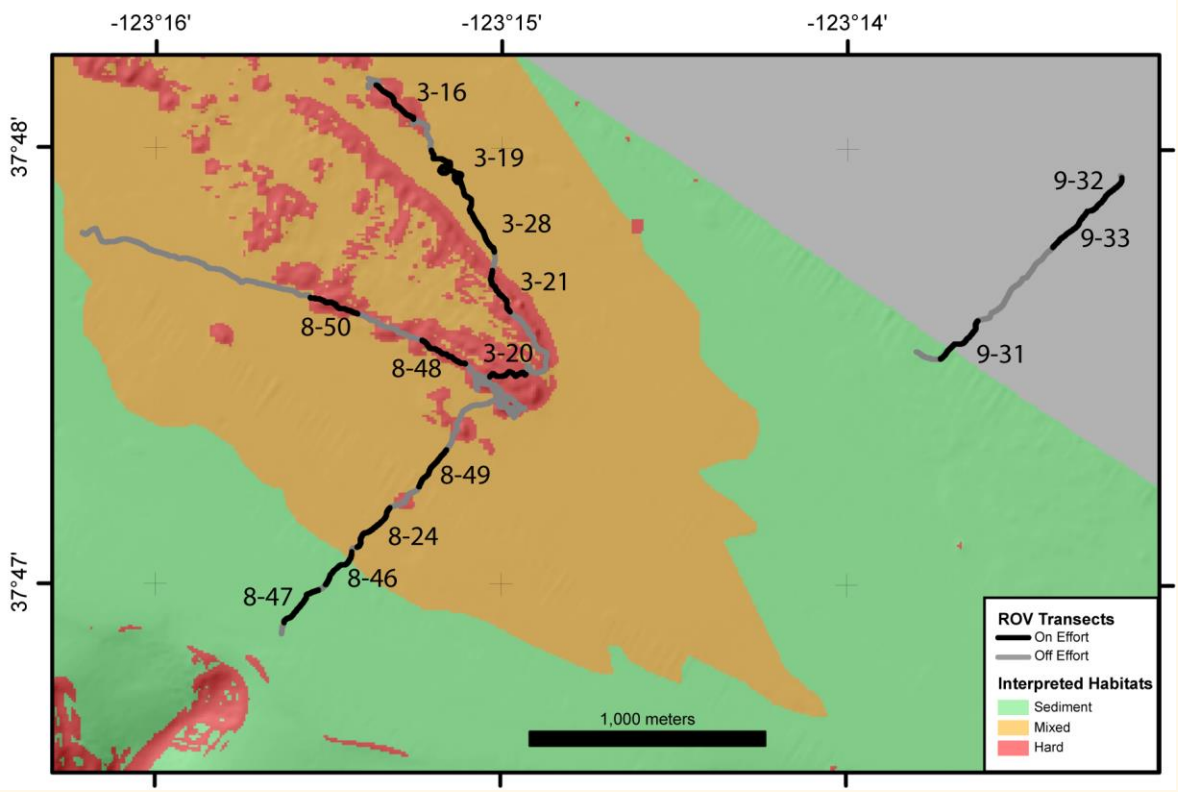
Williams, G. 2013. New taxa and revisionary systematics of alcyonacean octocorals from the Pacific coast of North America (Cnidaria, Anthozoa). ZooKeys 283: 15-42.

ADDITIONAL COMMENTS

Approximately 0.24% of Rittenburg Bank was surveyed. Five man-made debris items (four pieces of monofilament line and one fishing net, possibly a trawl or gillnet) were documented during the 18 quantitative, 120-meter transects conducted during Dives 1, 2, and 5-7 on Rittenburg Bank, within the Gulf of the Farallones National Marine Sanctuary, using the *Beagle* ROV from Marine Applied Research and Exploration.

Rittenburg Bank had the highest density of sponges in comparison to Cochrane Bank and Farallon Escarpment. The habitat at Rittenburg Bank appears to be highly suitable for corals and sponges, with 10.1 % being rugose, hard substrate. Many small corals and sponges were observed, suggesting recent recruitment to the coral and sponge populations. A new species of gorgonian coral was identified from material collected during the survey in Rittenburg Bank (Williams 2013). Highest densities of large sponges were observed in areas of highest rugosity and were not likely to have been impacted by bottom trawls. A reduction in trawl effort (a consequence of fishery closures in the region enacted over a decade ago) may have contributed favorably to the abundance and condition of corals and sponge observed.

GENERAL LOCATION AND DIVE TRACK



A map of Cochrane Bank showing ROV transects as black lines, labeled by dive and transect number.

STATION OVERVIEW

Project	Gulf of the Farallones National Marine Sanctuary Deep Coral Cruise
Chief Scientists	P. Etnoyer and J. Roletto
Contact Information	Peter.Etnoyer@noaa.gov, NCCOS, CCEHBR Jan.Roletto@noaa.gov, NOS, GFNMS
Purpose	Survey deep coral communities at GFNMS, northern California
Vessel	R/V *Fulmar*, Marine Applied Research and Exploration ROV *Beagle*
Science Observers	P. Etnoyer, G. Cochrane, E. Salgado, G. Williams, J. Roletto, K. Reyna
External Video Tapes	Two SD video cameras, one forward facing and one downward facing; One HD video camera with depth, temperature, salinity, and geolocation.
Digital Still Photos	714
Positioning System	Ship: GPS; ROV: USBL
CTD Sensor, DO Sensor	Yes, Yes
pH Sensor	No
Specimens collected	Yes, archived at California Academy of Sciences
Taxonomy Analysts	Gary Williams, Peter Etnoyer, Henry M. Reiswig, William. C. Austin, Mercer Brugler, and Santiago Herrera
Other	Logbook, MS Access database, X-keys for geology, GIS database of deep-sea corals
Report Analysts	P. Etnoyer, E. Salgado, G. Cochrane, K. Graiff, J. Roletto. and K. Reyna
Date Compiled	12 May 2013

STATION OVERVIEW

DIVE SUMMARY FOR SITE

Total Dives: 3
Depth Range (m): 79-142 meters

Date	Dive #	Method	Start Time UTC	End Time UTC	Start Latitude	Start Longitude	End Latitude	End Longitude
5-Oct-2012	3	ROV	16:33:57	20:35:42	37.78998	-123.24901	37.80241	-123.25620
10-Oct-2012	8	ROV	16:50:55	21:03:56	37.79679	-123.26955	37.77774	-123.25975
11-Oct-2012	9	ROV	16:14:28	17:30:01	37.79110	-123.22714	37.79901	-123.21999

TRANSECT SUMMARY

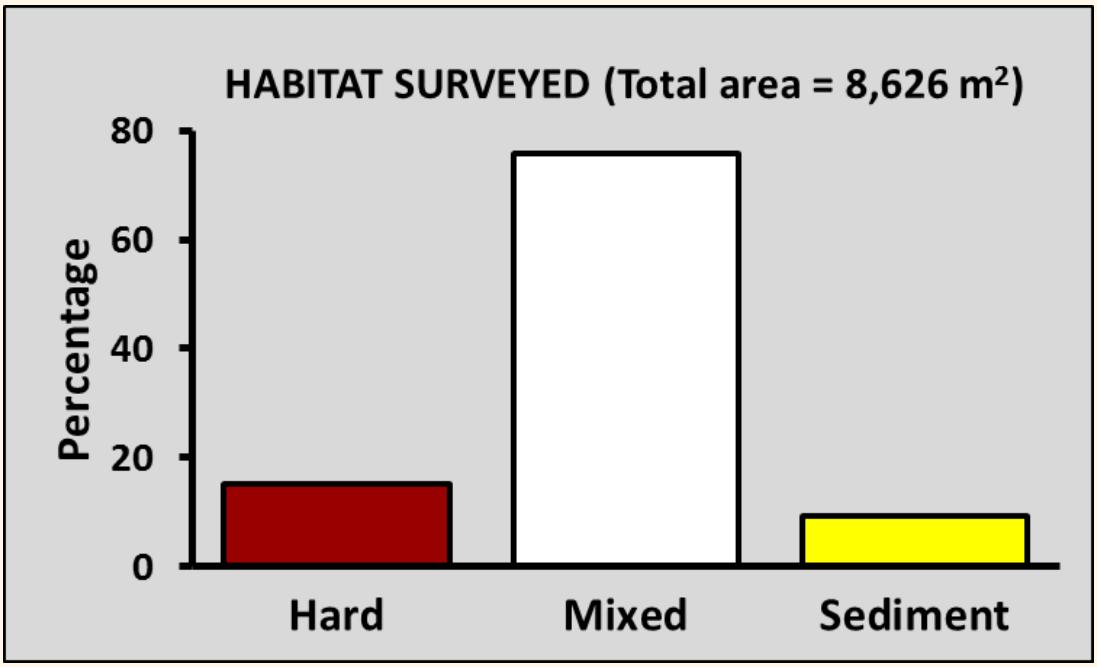
Dive #	Transect Name	Minimum Depth (m)	Maximum Depth (m)	Start Longitude	Start Latitude	End Longitude	End Latitude	Verified Substrate Class
3	CB-16	89	98	-123.25591	37.80231	-123.25434	37.80100	low-hard
3	CB-19	107	107	-123.25350	37.79990	-123.25184	37.79866	low-hard
3	CB-20	87	101	-123.25061	37.79126	-123.24881	37.79138	low-hard
3	CB-21	88	97	-123.24958	37.79363	-123.25061	37.79523	low-hard
3	CB-28	104	107	-123.25128	37.79733	-123.25016	37.79576	low-hard
8	CB-24	127	136	-123.25514	37.78611	-123.25671	37.78480	low-hard
8	CB-46	136	138	-123.25845	37.78323	-123.25687	37.78453	low-soft
8	CB-47	140	142	-123.26026	37.78178	-123.25868	37.78308	low-soft
8	CB-48	90	102	-123.25175	37.79167	-123.25375	37.70260	high-hard
8	CB-49	115	127	-123.25248	37.78840	-123.25365	37.78722	low-hard
8	CB-50	95	108	-123.25693	37.79368	-123.25905	37.79435	high-hard
9	FS-31	99	103	-123.22874	37.79203	-123.22712	37.79329	low-hard
9	FS-32	79	99	-123.21877	37.79980	-123.21724	37.80113	low-hard
9	FS-33	97	99	-123.22348	37.79632	-123.22187	37.79760	low-hard

STATION OVERVIEW

PHYSICAL ENVIRONMENT

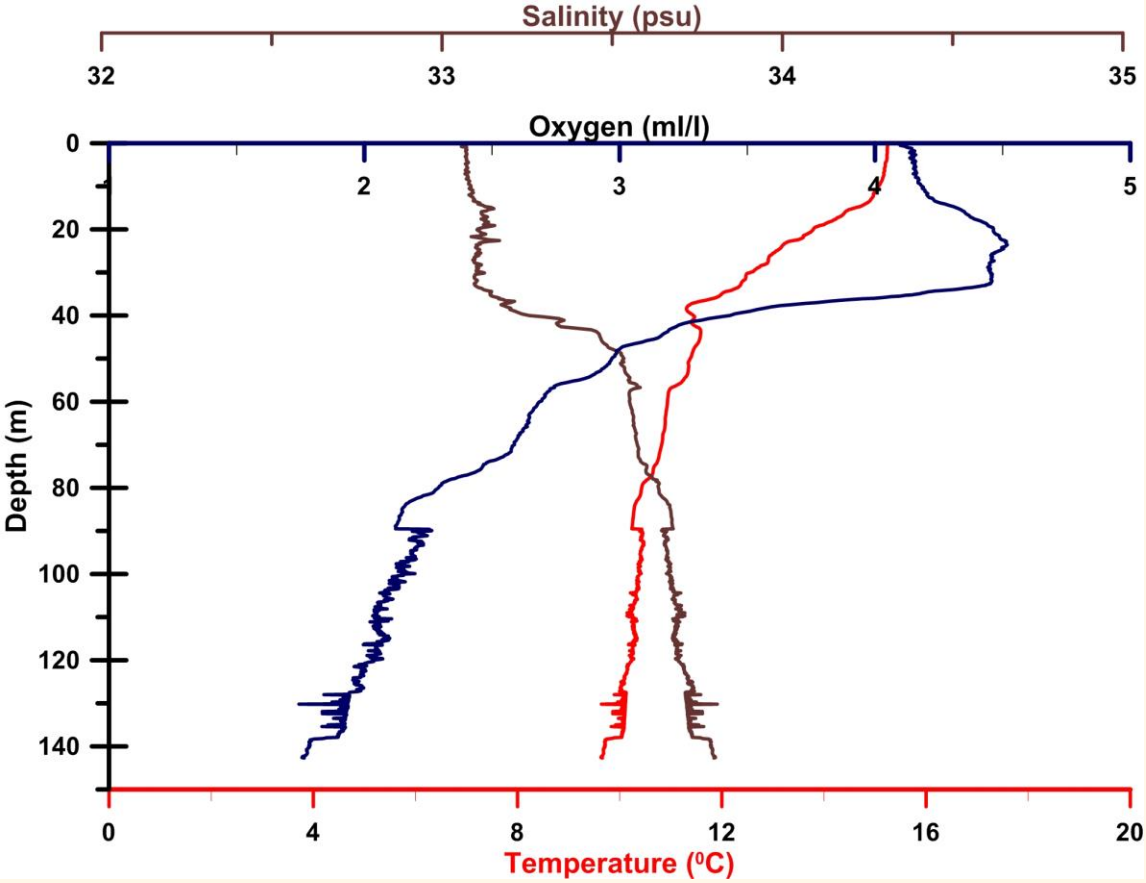
Cochrane Bank is a rocky feature near the continental shelf break, located 6 kilometers south of Rittenburg Bank, and 4 kilometers northwest of Fanny Shoal. It is smaller and narrower than Rittenburg Bank, with less relief. The high relief rock present on Cochrane Bank is predominantly consolidated bedrock. Strong currents and flocculent material were evident in the water column during surveys at Cochrane Bank. The multibeam bathymetry, acoustic backscatter, and sea floor character data are publicly available online through the United States Geological Survey (USGS) website, and described in detail in Dartnell et al. 2014.

A total area of 8,626 m^2 of sea floor was surveyed during 14 quantitative transects conducted during dives 3, 8, and 9 on Cochrane Bank and the area between the bank and Fanny Shoal, within GFNMS. Approximately 0.28% of Cochrane Bank was surveyed. Habitat types on transect were classified as: (1) Hard (15.2% of the total area surveyed was high-relief hard bottom), including boulders, cobbles, and rock; (2) Mixed (75.7% of the total area surveyed was low-relief hard bottom), including a combination of mud and sand with boulder, cobbles, or rock; and (3) Sediment (9.2% of the total area surveyed was low-relief soft bottom), which consisted entirely of sand and mud.



PHYSICAL ENVIRONMENT

The ROV was equipped with a Sea-Bird SBE 19plusV2 CTD and SBE 43 dissolved oxygen sensor during each dive, which collected data on depth, conductivity, temperature and dissolved oxygen during descent and along the track lines. The below figure illustrates water column conditions on Cochrane Bank during the survey. Temperature ranged from 15.3°C at the sea surface to 9.6°C on the sea floor at 142 m depth. Dissolved oxygen averaged 4.15 ml/l at the surface, increased to 4.4 ml/l at 25 to 30 m depth, and then decreased to 1.76 ml/l on the sea floor. During the dives, temperatures averaged 10.2 °C along the track lines, with fluctuations of < 1°C. Salinity (as estimated from conductivity) ranged from 33.0 psu at the sea surface to 33.8 psu on the sea floor. Salinity variations of < 0.5 psu were recorded with depth changes along the dive track lines.

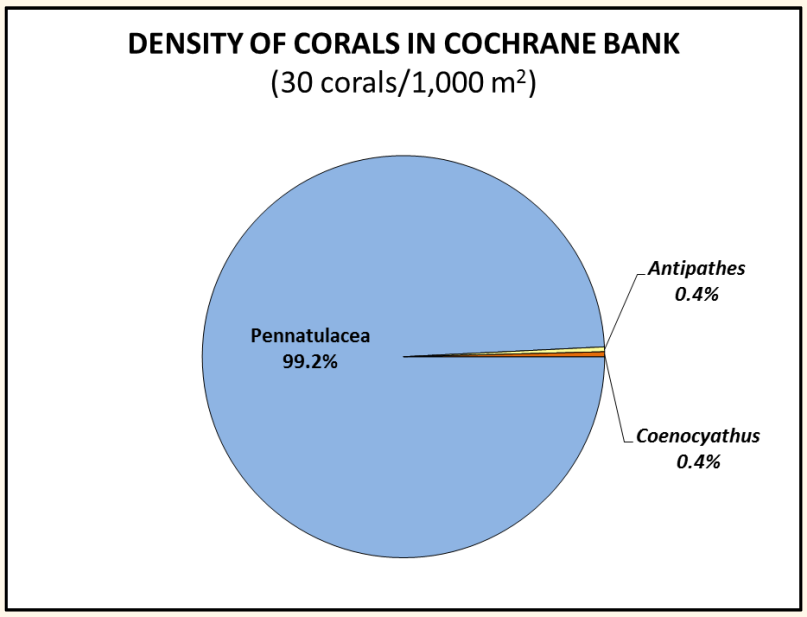


The CTD data show a stratification of the water column in which a warmer, less saline surface layer begins to interface with a colder intermediate thermocline, and a slightly more saline layer at 30-40 meters depth. An inflection point occurs at this depth, where oxygen concentrations also begin to decline. Dissolved oxygen peaks near 30 meters depth, which is typical for the Northeast Pacific region (Shulenberger and Reid 1981) and consistent with the depth of the Deep Chlorophyll Maximum (Millán-Núñez et al. 1997). Temperature and salinity values stabilize near 80-85 meters and oxygen continues to decrease to near hypoxic (1.4 ml/l) levels (PISCO 2014) near the seafloor. This profile is typical of late-summer/early-fall conditions (Rago et al. 2006).

BIOLOGICAL ENVIRONMENT: CORALS

A total of 1,275 individual anthozoans, comprising at least five taxa, were enumerated from 14 quantitative, 120-meter transects conducted during Dives 3, 8 and 9 on Cochrane Bank. We estimated an average density of 30 corals per 1000 m^2 of sea floor. Sea pens occurred predominately in mixed and soft substrate, while the rest of the anthozoans occurred in hard and mixed substrates. *Metridium* anemones accounted for over 79% of the anthozoan density.

Soft sediment transects contained only sea pen corals; predominately *Virgularia* in large patches, with more sporadic occurrences of *Stylatula* and *Ptilosarcus*.



Colors in pie diagram match the table below.

The only coral specimen collected from Cochrane Bank was a piece of large black coral *Antipathes dendrochristos*. The coral was identified based on tissue specimen and expert examination of photographs (see Appendix I at end of report). All the other anthozoan identifications at Cochrane Bank were based on expert examination of photographs and video.

Cochrane Bank Anthozoans

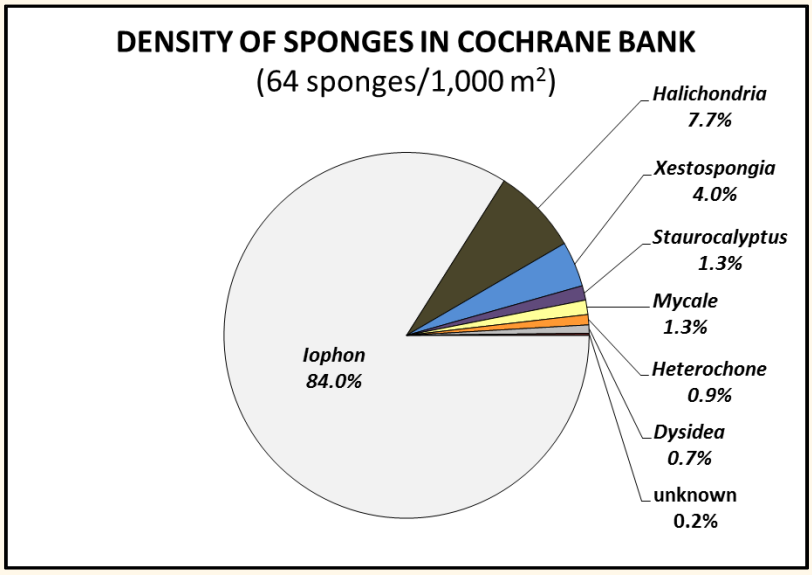
Scientific name	Common name	Count
Corals		
Pennatulacea	Sea pens	254
Antipathes dendrochristos	Christmas tree coral	1
Coenocyathus sp.	Cluster cup coral	1
Other benthic cnidarians		
Metridium sp.	White plume anemone	1018
Stomphia sp.	Orange anemone	1

The large black coral *Antipathes dendrochristos* was collected, preserved in ethanol, and archived at California Academy of Sciences. Dr. Mercer Brugler at the American Museum of Natural History in New York confirmed taxonomic identity of the species using morphology and mithochondrial DNA, referenced to type material from Southern California (Opresko 2005). The observation and diagnosis of this species indicate a range extension for the taxon, and represent the northernmost occurrence of *Antipathes dendrochristos* to date.

BIOLOGICAL ENVIRONMENT: SPONGES

A total of 549 individual sponges, comprising at least nine taxa, were enumerated from 13 quantitative, 120-meter transects conducted during Dives 3, 8, and 9 on Cochrane Bank, within the Gulf of the Farallones National Marine Sanctuary, using the *Beagle* ROV from Marine Applied Research and Exploration.

We estimated an average density of 64 sponges per 1000 m^2 of sea floor. The white finger sponge, *Iophon piceus* var. *pacifica* accounted for 84% of the sponge observations. Also numerous were *Halichondria panicea* (7.7%) and *Xestospongia diprosopea* (4%). Most of the sponges occurred in hard and mixed substrates.



Colors in pie diagram match the table below.

One sponge specimen was collected from Cochrane Bank - *Dysidea fragilis*. Biological samples collected elsewhere and observed at Cochrane Bank included *Heterochone calyx*, *Iophon piceus* var. *pacifica, Mycale* cf. *lingua*, *Halichondria panicea, Xestospongia diprosopea*, and *Staurocalyptus fasciculatus.* The sponges were identified based on specimen collections and expert examination of reference photographs (see Appendix I at end of report). Other sponge taxa at Cochrane Bank were based on expert examination of photographs and video.

Cochrane Bank Sponges

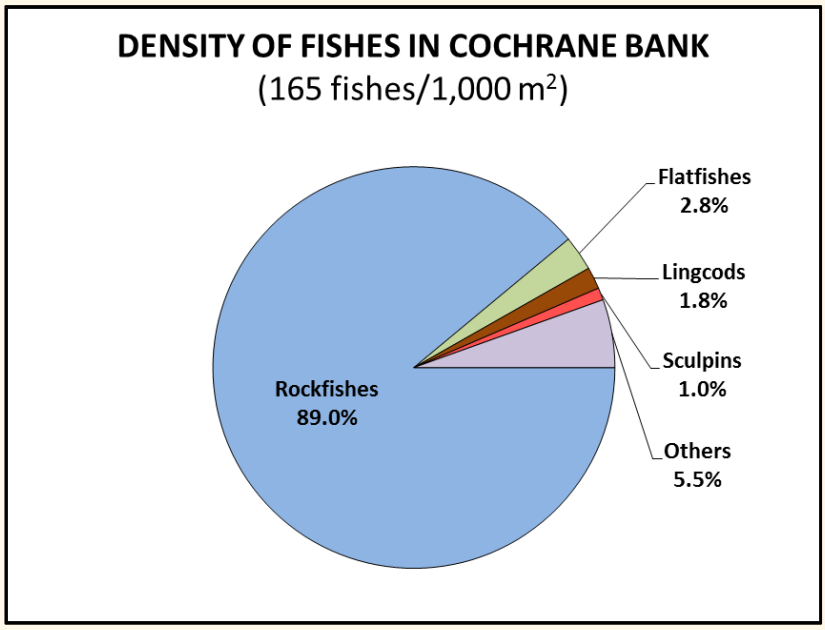
Scientific name	Common name	Count
Iophon piceus var. *pacifica*	White finger/ catcher's mitt	461
Halichondria panacea	Brown potato sponge	42
Xestospongia diprosopea	Aureoled grey lobe sponge	22
Staurocalyptus fasciculatus	Barrel-boot sponge	7
Mycale sp.	Yellow vase sponge	7
Heterochone sp.	Honeycomb vase sponge	5
Dysidea fragilis	Grey vase sponge	4
Unknown porifera yellow	Golden fan	1

Dr. William C Austin, from the Khoyatan Marine Laboratory, identified *Dysidea fragilis* based on morphology. See Appendix I for collection and archive information.

BIOLOGICAL ENVIRONMENT: FISHES

At least 27 taxa of fishes were identified from 14 quantitative, 120-meter transects conducted during Dives 3, 8, and 9 on Cochrane Bank. Fish counts were estimated from still images taken along each transect (50 per transect), and therefore represent minimum counts and densities. There were 714 images used for fish observations at Cochrane Bank.

We estimated an average density of 165 fish per 1000 m^2. Rockfish in at least 14 species comprised the majority of fish observed (89%). The remainder of the fish assemblage included flatfish (2.8%), lingcods (1.8%), sculpins (1%), and various others (5.5%).



Colors in pie diagram match the tables below.

Cochrane Bank Fishes

Scientific name	Common name	Count
Sebastes wilsoni	Pygmy rockfish	917
Sebastes (juvenile)	Juvenile rockfish	60
Sebastes chlorostictus	Greenspotted rockfish	58
Sebastes elongatus	Greenstriped rockfish	55
Unknown sebastomus	Sebastomus	53
Sebastes spp.	Unidentified rockfishes	39
Sebastes rosaceus	Rosy rockfish	21
Sebastes pinniger	Canary rockfish	16
Sebastes flavidus	Yellowtail rockfish	12
Sebastes constellatus	Starry rockfish	9
Sebastes helvomaculatus	Rosethorn rockfish	9
Sebastes ruberrimus	Yelloweye rockfish	7
Sebastes rosenblatti	Greenblotched rockfish	2
Sebastes zacentrus	Sharpchin rockfish	2
Sebastes zacentrus/saxicola	Sharpchin/stripetail rockfish	2
Sebastes maliger	Quillback rockfish	1
Sebastes miniatus	Vermilion rockfish	1
Sebastes saxicola	Stripetail rockfish	1

BIOLOGICAL ENVIRONMENT: FISHES

Cochrane Bank Fishes (con't.)

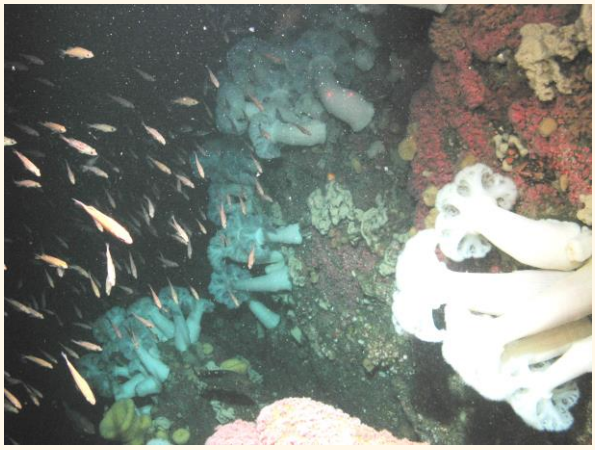
Scientific name	Common name	Count
Pleuronectiformes	Flatfishes	32
Microstomus pacificus	Dover sole	5
Parophrys vetulus	English sole	3
Ophiodon elongatus	Lingcod	25
Cottoidea	Unidentified sculpin	9
Paricelius hopliticus	Thornback sculpin	3
Icelinus spp.	Icelinus sculpins	2
Citharichthys spp.	Unidentified sanddabs	42
Rhinogobiops nicholsii	Blackeye goby	15
Hexagrammos decagrammus	Kelp greenling	4
Zaniolepis frenata	Shortspine combfish	3
Zaniolepis spp.	Combfishes	3
Hydrolagus colliei	Spotted ratfish	3
Unknown Agonidae	Unidentified poachers	2
Xeneretmus triacanthus	Blue spotted poacher	2
Unknown	Unidentified fishes	1
Raja rhina	Longnose skate	1
Raja sp.	Unidentified skate	1
Ronquilus jordani	Northern ronquil	1

Fish were considered to be in association with the host invertebrate when exhibiting one or more of the following behaviors: hovering or resting on the bottom within one fish body length, or in direct contact with the invertebrate (Stone 2006). Of all fish counted in Cochrane Bank, 2.5% were found in association with a coral or sponge. Fish species with 15 or more total observations and most frequently seen associated with corals and sponges on Cochrane Bank were rockfishes in the Sebastomus group. Rosy rockfish (*Sebastes rosaceus*) individuals were associated over half (57%) of the time. Greenspotted rockfish (*Sebastes chlorostictus*) individuals were observed in association with corals or sponges 7% of the time. One fish with fewer than 15 observations (n=8), but also seen in association with corals and sponges was the yelloweye rockfish, in association 50% or the time. Sea pens on Cochrane Bank had fish associated in 1.4% of sea pen observations. The one and only large black coral (*Antipathes dendrochristos*) observed on Cochrane Bank had two associated rockfish. Sponge taxa with 15 or more observations and the highest frequencies of association were *Halichondria*, 9% of total; and *Iophon piceus*, 5% of total.

Fish counts and distribution data were uploaded to the Essential Fish Habitat Data Catalog (http://efh-catalog.coas.oregonstate.edu/overview/), using the X-keys data logging format. All video and still-image annotations of corals and sponges have been submitted to NOAA's National Database of Deep-Sea Corals and Sponges, maintained by the Deep-Sea Coral Research and Technology Program.

IMAGE GALLERY

Dysidea fragilis sponge and *Mediaster* sea stars at 98 meters depth.



Sebastes wilsoni and juvenile rockfish, over exposed rock with sponges and *Metridium* anemones.

Sebastes chlorostictus resting on *Mycale* sponge with crinoids and exposed rock.

Antipathes dendrochristos with *Sebastes rosaceus* at 91 meters depth.

Derelict fishing net and *Metridium* anemones on rocky outcrop.

Ptilosarcus sea pen and *Virgularia* sea pens (background) in soft sediment.

RELEVANT WORK AND LITERATURE

Dartnell, P., G.R. Cochrane, and D.P. Finlayson. 2014. Bathymetry, acoustic backscatter, and seafloor character of Farallon Escarpment and Rittenburg Bank, northern California: U.S. Geological Survey Open-File Report 2014-1234, 18 p., http://doi.dx.org/10.3133/ofr20141234.

Love, M.S., M.M. Yoklavich, B.A. Black, A.H. Andrews. 2007. Age of black coral (*Antipathes dendrochristos*) colonies, with notes on associated invertebrate species. Bulletin of Marine Science. 80 (2): 391-400.

Opresko, D.M. 2005. A new species of antipatharian coral (Cnidaria: Anthozoa: Antipatharia) from the southern California Bight. Zootaxa 852: 1–10.

PISCO. 2014. What is Hypoxia? Downloaded 10/31/14 from: http://www.piscoweb.org/research/science-by-discipline/coastal-oceanography/hypoxia-new/what-hypoxia.

Rago, T., R. Michisaki, B. Marinovic, K. Whitaker. 2006. Physical, Nutrient, and Biological Measurements of Coastal Waters off Central California in October 2005. MBARI Naval Post graduate School. Marine Sciences Institute. UC Santa Cruz pp 66-70.

Shulenberger, E. and J. Reid. 1981. The Pacific shallow oxygen maximum, deep chlorophyll maximum, and primary productivity, reconsidered. Deep Sea Research. Vol 28, Issue 9: 901–919.

Stone, R.P. 2006. Coral habitat in the Aleutian Islands of Alaska: depth distribution, fine-scale species associations, and fisheries interactions. Coral Reefs, Vol. 25, Issue 2, pp 229-238.

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

Whitmire, C.E. and M. E. Clarke. 2007. State of deep coral ecosystems of the U.S. Pacific Coast: California to Washington. In S. E. Lumsden, T. F. Hourigan, A. W. Bruckner, & G. Dorr (Eds.), The State of Deep Coral Ecosystems of the United States (pp. 109-154). Silver Spring, MD.

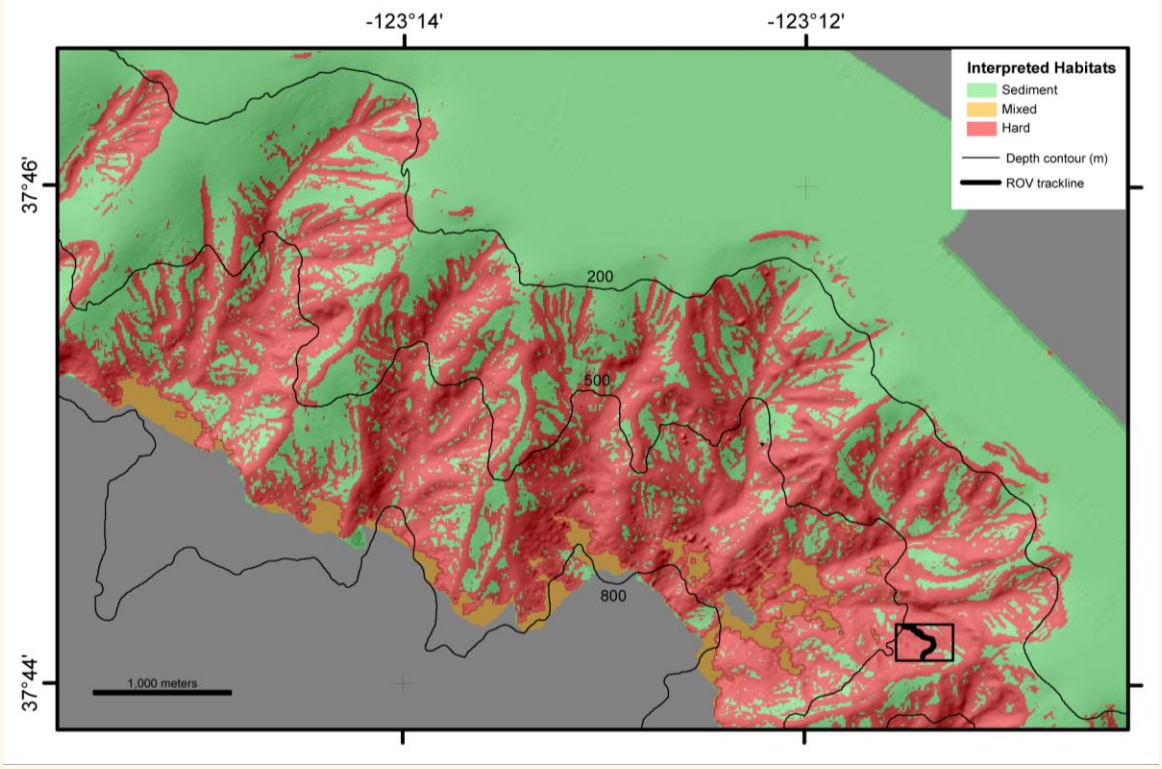
Yoklavich, M.M., H.G. Greene, G.M. Cailliet, D.E. Sullivan, R.N. Lea and M.S. Love. 2000. Habitat associations of deep-water rockfishes in a submarine canyon: an example of natural refuge. Fisheries Bulletin 98:625-641.

ADDITIONAL COMMENTS

Cochrane Bank is the deepest known rocky bank within GFNMS. Three marine-debris items (two fishing nets and one longline) were documented during surveys conducted in Cochrane Bank.

The large (1 meter tall x 3 meters wide) and presumably very old (Love et al. 2007) black coral *Antipathes dendrochristos* on Cochrane Bank represents a range extension for the species. The size, branching structure, and long life span of this species (up to 100 years) make it vulnerable to potential habitat damage by bottom fishing gear types. *A. dendrochristos* has a rating of ‘high’ for structural importance (Whitmire and Clarke 2007). The species is known for its complex vertical structure that can provide substrate and refuge to other invertebrates or fish (Love et al. 2007).

GENERAL LOCATION AND DIVE TRACK



A map of the northern Farallon Escarpment showing the ROV dive site as a black box on the lower right.

STATION OVERVIEW

Project	Gulf of the Farallones National Marine Sanctuary Deep Coral Cruise
Chief Scientists	P. Etnoyer and J. Roletto
Contact Information	Peter.Etnoyer@noaa.gov, NCCOS, CCEHBR Jan.Roletto@noaa.gov, NOS, GFNMS
Purpose	Survey deep coral communities at GFNMS, northern California
Vessel	ONMS R/V *Fulmar*, Marine Applied Research and Exploration ROV *Beagle*
Science Observers	P. Etnoyer, G. Cochrane, E. Salgado, G. Williams, J. Roletto, K. Reyna
External Video Tapes	Two SD video cameras, one forward facing and one downward facing; One HD video camera with depth, temperature, salinity, and location
Digital Still Photos	204
Positioning System	Ship: GPS; ROV: USBL
CTD Sensor, DO Sensor	Yes, Yes
pH Sensor	No
Specimens collected	Yes, archived at California Academy of Sciences
Taxonomy Analysts	Gary Williams, Peter Etnoyer, Henry M. Reiswig, William. C. Austin, Mercer Brugler, and Santiago Herrera
Other	Logbook, MS Access database, X-keys for geology, GIS database of deep-sea corals
Report Analysts	P. Etnoyer, E. Salgado, G. Cochrane, K. Graiff, J. Roletto. and K. Reyna
Date Compiled	12 May 2013

DIVE NUMBER: ROV 10 *STUDY AREA: Farallon Escarpment*

STATION OVERVIEW

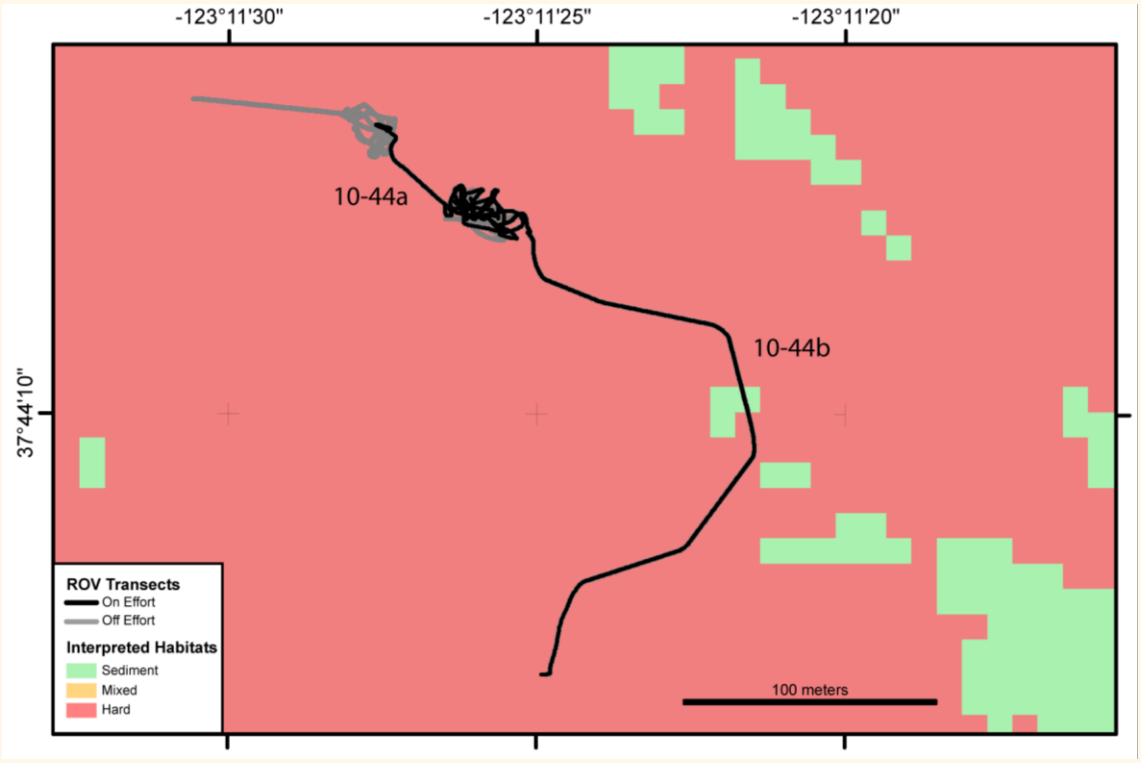
DIVE SUMMARY

Total Dives: 1
Depth Range (m): 369-453 meters

Date	Dive #	Method	Start Time UTC	End Time	Start Latitude	Start Longitude	End Latitude	End Longitude
11-Oct-2012	10	ROV	18:41:22	21:41:25	37.73848	-123.19232	37.73415	-123.18979

TRANSECT SUMMARY FOR SITE

Dive #	Transect Name	Minimum Depth (m)	Maximum Depth (m)	Start Longitude	Start Latitude	End Longitude	End Latitude	Verified Substrate Class
10	FE-44a	402	452	-123.19098	37.73714	-123.19037	37.73682	high-hard
10	FE-44b	369	411	-123.19055	37.73685	-123.18948	37.73643	high-hard



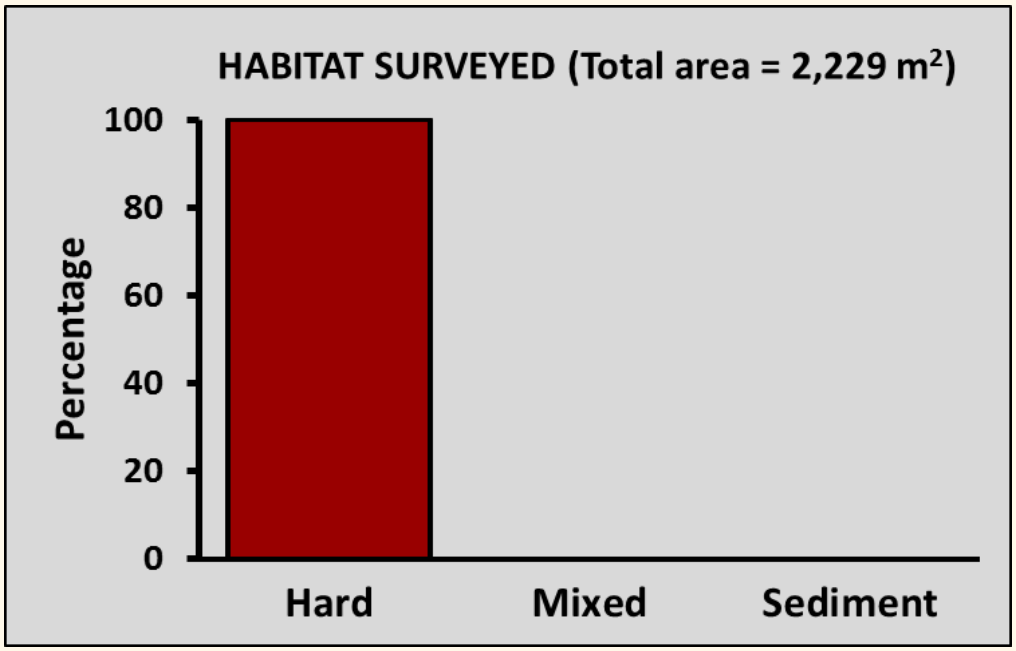
A map of the Farallon Escarpment showing the ROV dive trajectory, and two transects.

STATION OVERVIEW

PHYSICAL ENVIRONMENT

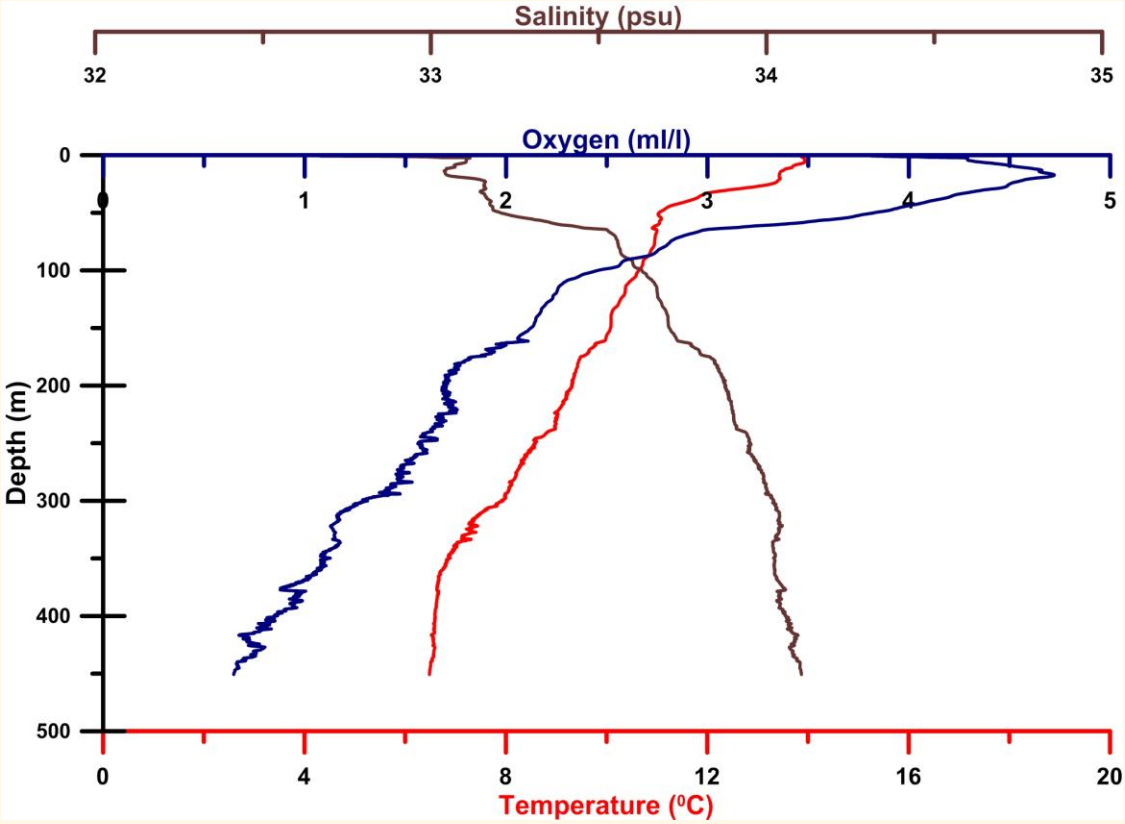
The Farallon Escarpment encompasses a steep section of the continental slope west of the Farallon Islands. The Escarpment has a large extent, covering at least 50 km^2, and the benthos remains mostly unexplored. The escarpment in the north is less than half the width (35 km) and twice the steepness gradient (30%) compared to the area in the south part of GFNMS. The escarpment is extensively dissected by submarine canyons and gullies, which stretch from the shelf break (approximately 150 m depth) down to the deep Pacific basin at 2,000 meters. In the heads of canyons, slumping and ocean currents deposit fine sediments. Exposed rock flats are covered in a thin layer of this sediment, which supports many infaunal benthic invertebrates. The multibeam bathymetry, acoustic backscatter, and sea floor character data are publicly available online through the United States Geological Survey (USGS) website, and described in detail in Dartnell et al. 2014.

A total area of 2,229 m^2 of sea floor was surveyed during Dive 10 on the Farallon Escarpment, within Gulf of the Farallones National Marine Sanctuary (GFNMS), using the *Beagle* ROV from ONMS's research vessel RV *Fulmar.* Transects during Dive 10 were designated during post-processing of image data to achieve minimum of 50 still images. Nearly 100% of the habitat surveyed was classified as high-relief hard-bottom. Less than 1% was soft sediment. The hard substrate was primarily rocky outcrop. Rocks were often covered with a thin veneer of sediment. Isolated boulder and cobble-sized clasts were also seen.



PHYSICAL ENVIRONMENT

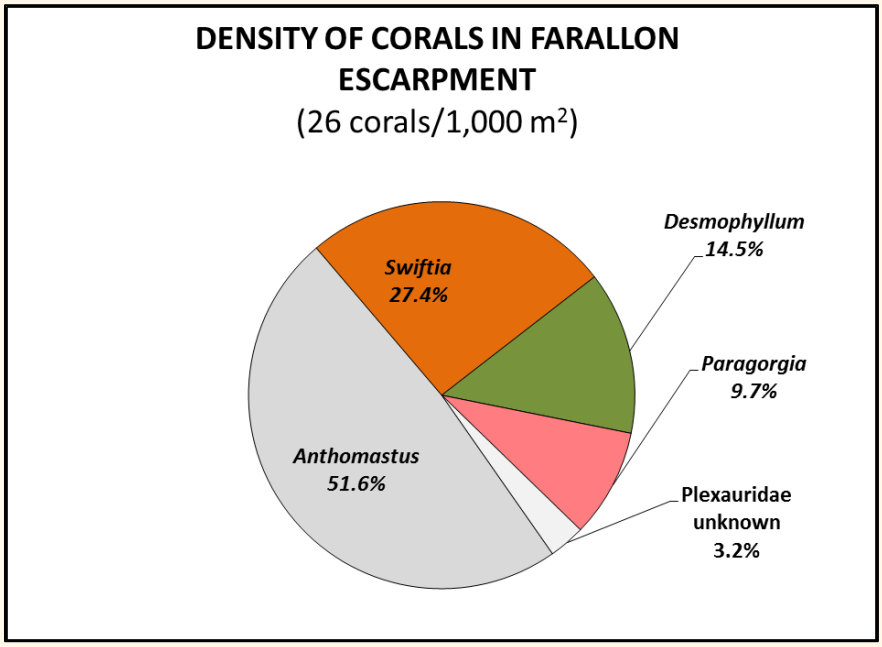
The ROV was equipped with a Sea-Bird SBE 19plusV2 CTD and SBE 43 dissolved oxygen sensor during each dive, which collected data on depth, conductivity, temperature, and dissolved oxygen during descent and along the sea floor. The below figure illustrates conditions in the study area of the Farallon Escarpment. Temperature ranged from 13.9°C at the sea surface to 6.5°C on the sea floor at 451 m depth. Dissolved oxygen averaged 4.23 ml/l at the surface, increased to 4.7 ml/l at 20 to 30 m depth, and then decreased to 0.65 ml/l on the sea floor. During the dive, temperatures averaged 6.6 °C along the track lines, with fluctuations of <0.5°C. Salinity (as estimated from conductivity) ranged from 33.0 psu at the sea surface to 34.1 psu on the sea floor. Salinity variations of < 0.5 psu were recorded with depth changes along the dive track.



The CTD data show a stratification of the water column in which a warmer, less saline surface layer begins to interface with an intermediate, colder thermocline, and a more saline layer at 30-40 meter depth. An inflection point occurs at this depth, where dissolved oxygen concentrations also begin to decline. The dissolved oxygen peak near 30 meters depth is typical for the region (Shulenberger & Reid 1981) and consistent with the depth of the Deep Chlorophyll Maximum (Millán-Núñez et al. 1997). Temperature decreases to a minimum of 6.6 ^{0}C, and dissolved oxygen falls to near anoxic (0.5 ml/l) levels (PISCO 2014) near the seafloor. This profile is typical of late-summer/early-fall conditions for the region (Rago et al. 2006).

BIOLOGICAL ENVIRONMENT: CORALS

A total of 200 individual anthozoans, comprising at least seven taxa, were enumerated from two quantitative, 120-meter transects conducted during Dive 10 on a portion of the Farallon Escarpment. We estimated an average density of 86 anthozoans per 1000 m^2 of sea floor. *Corallimorphus pilatus* accounted for 59% of the anthozoan density.



Colors in pie diagram match colors in table below.

Coral density was 26 corals 1000 m^2 of sea floor. Of these, 52% of observations were *Anthomastus ritteri*. *Swiftia* sp. (27%) and *Desmophyllum*-type cup corals were the next most abundant coral. Four bubblegum coral colonies were observed for the first time in GFNMS.

Two coral specimens, *Swiftia* sp. and *Paragorgia stephencairnsi,* were collected from the Farallon Escarpment. The specimen of *Paragorgia stephencairnsi* was identified by Santiago Herrera based on mitochondrial DNA and morphology referenced to type material.

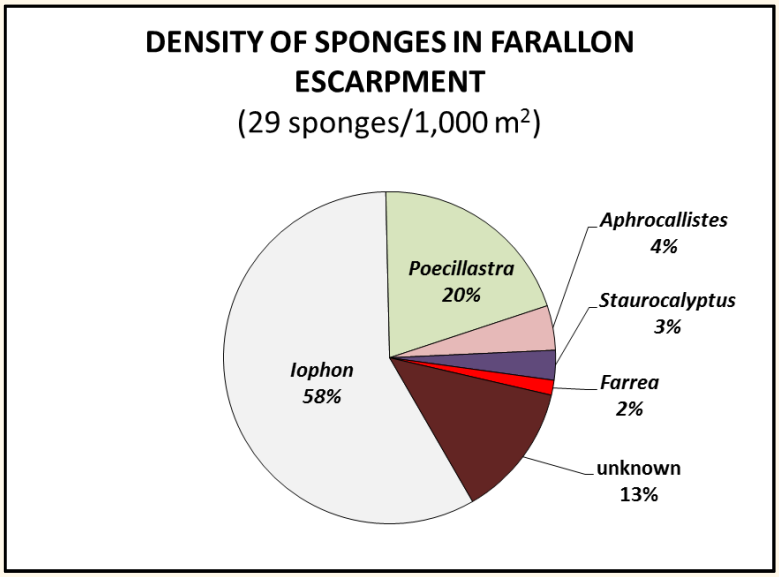
Farallon Escarpment Anthozoans

Scientific name	Common name	Count
Corals		
Anthomastus ritteri	Mushroom coral	32
Swiftia sp.	Small red sea fan	17
Desmophyllum sp.	Cockscomb coral	9
Paragorgia stephencairnsi	Bubblegum coral	6
Plexauridae unknown	Unknown red whip	2
Other benthic cnidarians		
Corallimorphus pilatus	Disk anemone	118
Liponema brevicornis	Pom-pom anemone	18

The *Swiftia* specimen was identified by Dr. Peter Etnoyer, from National Centers for Coastal Ocean Science, Charleston, SC and Dr. Gary Williams, from California Academy of Sciences, San Francisco, CA, based on gross morphology. All other anthozoan identifications were based on expert examination of photographs and video.

BIOLOGICAL ENVIRONMENT: SPONGES

A total of 69 individual sponges, comprising at least seven taxa, were enumerated from two quantitative, 120-meter transects conducted during Dive 10 on a portion of the Farallon Escarpment, within the Gulf of the Farallones National Marine Sanctuary, using the *Beagle* ROV from Marine Applied Research and Exploration. We estimated an average density of 29 sponges per 1000 m^2 of sea floor. The white finger sponge, *Iophon piceus* var. *pacifica* accounted for 58% of the sponge observations. Also numerous were *Poecillastra* sp. (20%), some unidentified pitcher sponges, and yellow sponges (13%).



Colors in pie diagram match colors in table below.

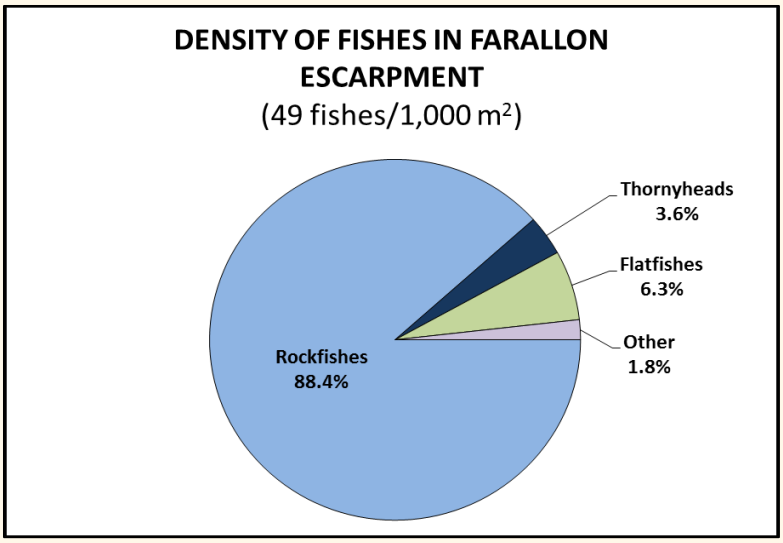
One sponge specimen was collected from the Farallon Escarpment. William C. Austin, from the Khoyatan Marine Laboratory in British Columbia, identified as *Iophon piceus* var. *pacifica* based on gross morphology. See Appendix I for collection and archive information. Other sponge taxa at the Farallon Escarpment were based on expert examination of photographs and video.

Farallon Escarpment Sponges

Scientific name	Common name	Count
Iophon piceus var. *pacifica*	White finger or catcher's mitt	40
Poecillastra sp.	Shelf sponge	14
Aphrocallistes sp.	Foliose goblet sponge	3
Staurocalyptus fasciculatus	Barrel-boot Sponge	2
Farrea occa	Lace sponge	1
Unknown pitcher sponge	Yellow pitcher	8
Unknown porifera yellow	Yellow finger	1

BIOLOGICAL ENVIRONMENT: FISHES

At least 10 taxa of fishes were identified from two transects conducted during Dive 10 on Farallon Escarpment. Fish counts were estimated from still images taken along each transect (50 per transect). The counts therefore represent minimum estimates of counts and densities. We estimated an average density of 49 fish per 1000 m^2. Rockfish of at least four species accounted for the majority of fish observed (88.4%). The remainder of the fish assemblage included flatfish (6.3%), thornyheads (3.6%), and others (1.8%).



Colors in pie diagram match colors in table below.

Farallon Escarpment Fishes

Scientific name	Common Name	Count
Sebastes spp.	Unidentified rockfishes	32
Sebastes melanostomus	Blackgill rockfish	31
Sebastes aurora	Aurora rockfish	23
Sebastes diploproa	Splitnose rockfish	12
Sebastes crameri	Darkblotched rockfish	1
Sebastolobus spp.	Thornyheads	4
Pleuronectiformes	Flatfishes	3
Embassichthys bathybius	Deep-sea sole	3
Microstomus pacificus	Dover sole	1
Eptatretus stoutii	Pacific hagfish	1
Raja rhina	Longnose skate	1

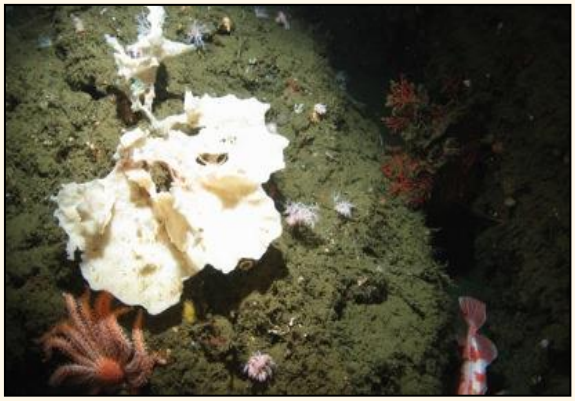
Fishes were considered to be in association with the host invertebrate when exhibiting one or more of the following behaviors: hovering or resting on the bottom within one fish body length, or in direct contact with the invertebrate (Stone 2006). Fishes in association with corals and/or sponges on the Farallon Escarpment were all rockfish species including Aurora (*Sebastes aurora*), in association 17% of the time, Blackgill (*Sebastes melanostomus*) in association 16% of the time, and unidentified rockfishes (*Sebastes* spp.), seen 22% of the time with corals or sponges. The corals most frequently associated with fish were *Swiftia*, 10%; and *Paragorgia*, 33% (n=6). No other corals were observed with associated fish. The sponge *Iophon piceus* had the highest frequency of association (15% of observations).

Fish counts and distribution data were uploaded to the Essential Fish Habitat Data Catalog (http://efh-catalog.coas.oregonstate.edu/overview/), using the X-keys data logging format. All video and still-image annotations of corals and sponges have been submitted to NOAA's National Database of Deep-Sea Corals and Sponges, maintained by the Deep-Sea Coral Research and Technology Program.

IMAGE GALLERY

Sebastes aurora and *Poecillastra* sponge, 438 meters depth. Red laser dots are 10 cm apart.

Corallimorphus pilicatus anemones on a 380 meter deep promontory flat.



Iophon piceus, *Swiftia* sea fan, *Sebastes aurora*, and *Rathbunaster californicus* sea star, 432 meters depth.

Paragorgia stephencairnsi bubblegum coral with *Sebastes melanostomus,* 424 meters depth.

Anthomastus mushroom coral with extended polyps.

Liponema brevicornis, *Sebastes aurora*, and *Rathbunaster californicus* sea star.

RELEVANT WORK AND LITERATURE

Dartnell, P., G.R. Cochrane, and D.P. Finlayson. 2014. Bathymetry, acoustic backscatter, and seafloor character of Farallon Escarpment and Rittenburg Bank, northern California: U.S. Geological Survey Open-File Report 2014-1234, 18 p., http://doi.dx.org/10.3133/ofr20141234.

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ADDITIONAL COMMENTS

No man-made debris was documented during ROV Dive 10 on the Farallon Escarpment. Only a small fraction of the Escarpment was surveyed. The geological and biological composition of Farallon Escarpment, west of Cordell Bank, Cochrane Bank, and the Farallon Islands, differed significantly from adjacent areas of the continental slope.

The single dive at the Farallon Escarpment yielded some new insight into the potential abundance and diversity of corals, sponges, and associated fish for this area. Bedrock was found on the fault scarps. Previous interpretations (NMFS 2013) of this substrate suggested primarily soft substrate. Visual groundtruthing of the deep-sea floor was not conducted until this study.

APPENDIX I

Specimens collected during ROV cruise, 3-11 October 2012, and archived at California Academy of Sciences (CAS) San Francisco, CA. Site abbreviations are RB = Rittenburg Bank, CB = Cochrane Bank, and FE = Farallon Escarpment.

Species Identification	ID Made By	Locality	Latitude	Longitude	Depth (m)	Field #	CAS Catalog #
Antipathes dendrochristos	M. Brugler	CB	37.79° N	123.25° W	91	S6	168896
Crinoidea	G.C. Williams	CB	37.80° N	123.25° W	95	On S7	190448
Dysidea fragilis	W.C. Austin	CB	37.80° N	123.25° W	98	S7	190439
Ophiuroidea	C. Piotrowski	CB	37.80° N	123.25° W	98	On S7	190450
Oxynaspis sp.	R. Van Syoc	CB	37.79° N	123.25° W	91	On S6	190382
Oxynaspis sp.	R. Van Syoc	CB	37.79° N	123.25° W	91	On S6	190372
Pugettia sp.	T. Laidig	CB	37.79° N	123.25° W	91	On S6	190384
Iophon piceus var. *pacifica*	W.C. Austin	FE	37.74° N	123.19° W	438	S21	168898
Ophiuroidea	P. Etnoyer	FE	37.74° N	123.19° W	432	On S22	190449
Paragorgia stephencairnsi	S. Herrera	FE	37.74° N	123.19° W	424	S23	190438
Swiftia sp.	P. Etnoyer	FE	37.74° N	123.19° W	432	S22	190437
Chromoplexaura markii	G.C. Williams	RB	37.89° N	123.34° W	85	S14	168895
Chromoplexaura markii	G.C. Williams	RB	37.88° N	123.32° W	89	S17	190436
Eunoe sp.	C. Piotrowski	RB	37.88° N	123.33° W	83	On S20	190440
Halichondria panicea	W.C. Austin	RB	37.89° N	123.34° W	85	S13	190452
Heterochone calyx	H.M. Reiswig	RB	37.89° N	123.34° W	85	S11	190451
Iophon piceus var. *pacifica*	W.C. Austin	RB	37.89° N	123.34° W	85	S12	190453
Mycale cf. *lingua*	W.C. Austin	RB	37.89° N	123.32° W	80	S5	190447
Mycale cf. *lingua*	W.C. Austin	RB	37.89° N	123.34° W	85	S15	190444
Staurocalyptus fasciculatus	H. M. Reiswig	RB	37.89° N	123.32° W	79-81	S2	190443
Staurocalyptus fasciculatus	H.M. Reiswig	RB	37.89° N	123.32° W	82-90	S3	190446
Stylaster californicus	G.C. Williams	RB	37.88° N	123.33° W	82	S18	168897
Xestospongia diprosopia	W.C. Austin	RB	37.89° N	123.32° W	85-90	S4	190445
Xestospongia diprosopia	W.C. Austin	RB	37.88° N	123.33° W	85	S19	190442
Xestospongia diprosopia	W.C. Austin	RB	37.88° N	123.33° W	83	S20	190440
Xestospongia diprosopia	W.C. Austin	RB	37.88° N	123.33° W	83	S20	190441

ACKNOWLEDGEMENTS

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The Gulf of the Farallones 2012 ROV survey team. From left to right (back): Gary Williams, Enrique Salgado, Hans Bruning, Dave Minard, Guy Cochrane, Jan Roletto, Dirk Rosen, Rick Botman, Steve Holtz, Andy Lauermann. Front left, kneeling: Peter Etnoyer. Right front, standing: Karen Reyna. Not pictured, Jeff Hyland and Kaitlin Graiff.

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