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Characterization of Deep-Sea Coral and Sponge Communities in Greater Farallones National Marine Sanctuary: Point Arena South Essential Fish Habitat Conservation Area and New Amendment 28 Areas

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Cover Photo:
Clockwise from top left: California deep-sea sea star (*Rathbunaster californicus*) and a splitnose rockfish (*Sebastes diploproa*); a primnoid coral, *Parastenella ramosa*; a new predatory sponge, *Asbestopluma* sp. nov.; the ROV manipulator claw collecting a black coral. Photo: Ocean Exploration Trust/NOAA

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Abstract

This report summarizes samples collected during a remotely operated vehicle (ROV) cruise conducted in October 2019 on board E/V *Nautilus*. Areas sampled in Greater Farallones National Marine Sanctuary included areas proposed for fisheries management zoning in the Point Arena South (PAS) Essential Fish Habitat Conservation Area (EFH). Dive planning targeted habitats and biological communities of corals, sponges, and fishes in relation to the new, 2020 configuration of PAS EFH (hereafter referred to as PAS), which includes areas once closed to commercial bottom trawling and now opened to bottom trawling, once opened to bottom trawling and now closed, or that remain closed to commercial bottom trawling. Particular interest was given to enumerating deep-sea corals and sponges (DSCS) in these areas as they are long-lived, slow-growing species that are vulnerable to impacts from bottom trawling. Fish species were also enumerated. These data provide the most recent assessment and characterization for a portion of these areas before the final ruling on Amendment 28 went into effect on January 1, 2020 (50 C.F.R. part 660).

A total of seven sponge specimens were collected on this mission, some of which could potentially be new species, such as the large yellow "plate"-shaped sponge and the "palm frond" morphology of the predatory sponge *Asbestopluma*, documented on both dives. Six coral collections were made, including three types of red *Swiftia* sp. gorgonians (two had fan-shaped morphology and one had branched morphology) with different polyp colors. A high diversity of fishes, particularly groundfish, were documented across the entire PAS area.

The findings from this cruise will be provided to NOAA's National Marine Fisheries Service to help them identify biologically complex areas of the seafloor that are most sensitive to bottom trawling and aid in the ongoing management of this designated essential fish habitat conservation zone. Habitat data from these surveys will be used to confirm substrate prediction models that can be used to predict DSCS habitats where there is a dearth of visual observations.

Key Words

Greater Farallones National Marine Sanctuary, deep-sea coral, deep-sea sponge, Point Arena South Essential Fish Habitat Conservation Area, Amendment 28

Introduction & Cruise Objectives

In October 2019, Greater Farallones National Marine Sanctuary (GFNMS) conducted a joint seafloor characterization cruise with staff from Cordell Bank National Marine Sanctuary (CBNMS) using remotely operated vehicles (ROVs) owned and operated by Ocean Exploration Trust. ROV dives were divided between GFNMS and CBNMS to survey and characterize previously unexplored seafloor in each sanctuary. Specifically, the dive areas in GFNMS were areas proposed for fisheries management zoning in the Point Arena South Essential Fish Habitat Conservation Area (PAS EFH). This report summarizes samples collected during the cruise, habitats and biological communities of corals, sponges, and fishes in relation to the new, 2020 configuration of PAS EFH (hereafter referred to as PAS), which includes areas once closed to bottom trawling and now opened to bottom trawling, once opened to bottom trawling and now closed, or that remain closed to commercial bottom trawling (Figure 1). Particular interest was given to enumerating corals and sponges in these areas as they are long-lived, slow-growing species that are vulnerable to impacts from bottom trawling. Fish species were also enumerated. These data provide the most recent assessment and characterization for a portion of these areas before the final ruling on Amendment 28 went into effect on January 1, 2020 (50 C.F.R. part 660).

The science and management objectives in GFNMS were:

1) Conduct visual transects using ROV *Hercules* to confirm substrate types modeled from multibeam and backscatter data and classify habitats, and identify corals, sponges, and fish throughout the PAS and adjacent areas.
    a. Transects targeted fisheries management zones that were either newly opened, newly closed, or remained closed to commercial bottom trawling by the Amendment 28 action (NOAA Fisheries, 2020), which reconfigured Essential Fish Habitats in the sanctuary beginning January 1, 2020.
    b. See Figure 1 for PAS management zones, reconfigured beginning January 1, 2020.
2) Assess impacts from bottom trawling and identify areas for future research on deep-sea coral and sponge habitats that will serve as sentinel sites for ocean acidification monitoring and identification of other climate impacts within an upwelling region.
3) Collect deep-sea coral and sponge specimens for taxonomy to:
    a. Expand GFNMS's species inventory
    b. Identify new species
4) Aid in the existing management of this designated essential fish habitat conservation zone and in the determination of future fisheries management zones, such as Habitat Areas of Particular Concern.

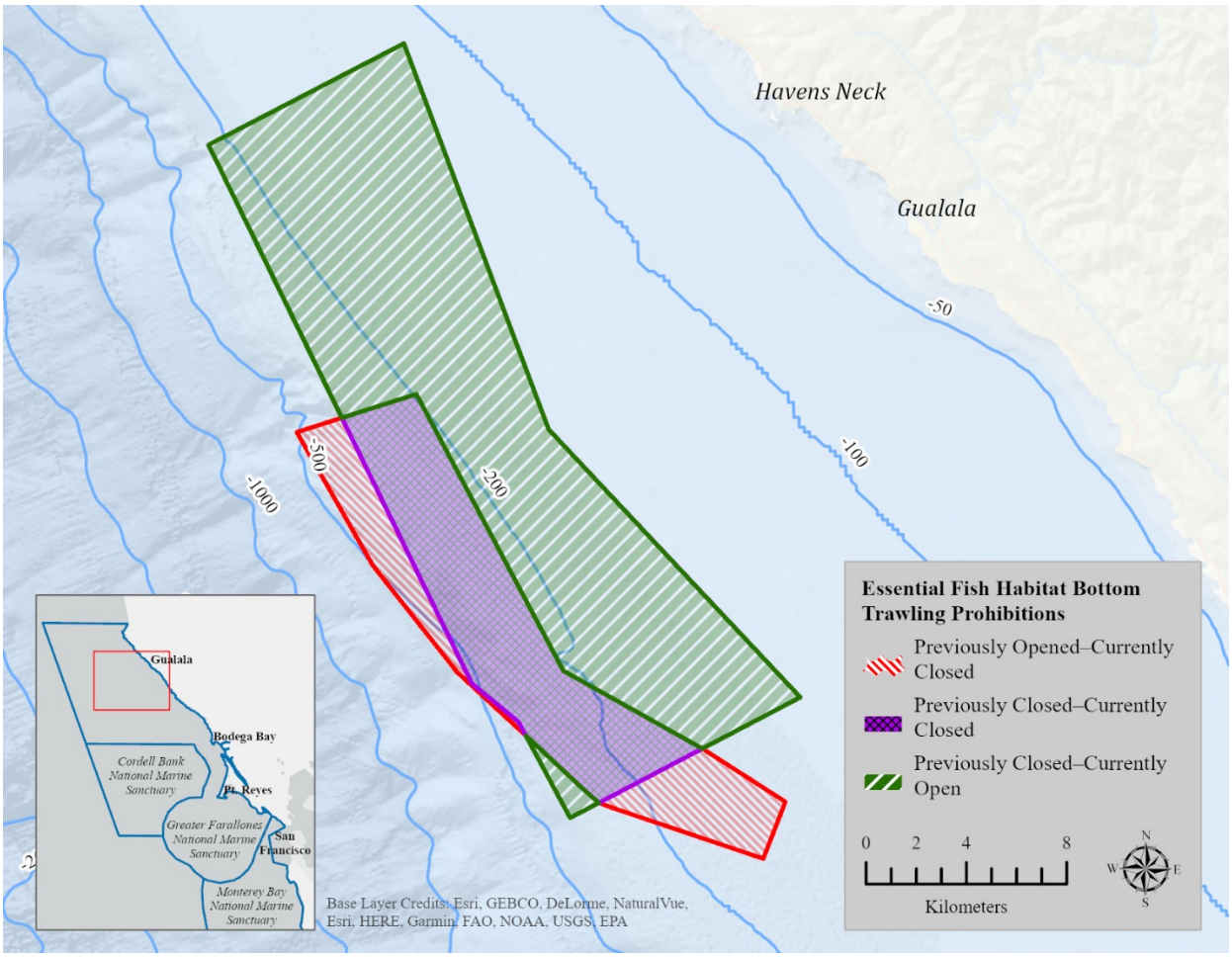


Figure 1. Point Arena South essential fish habitat conservation zones (PAS) that prohibit commercial bottom-contact trawling gear per Amendment 28 revisions. Green, forward hatch area indicates the portion of PAS that was closed to bottom trawling gear prior to Amendment 28 and, as of January 2020, is now open to bottom trawling. Red, backward hatch area indicates the portion of PAS that was open to bottom trawling gear prior to Amendment 28 and, as of January 2020, is now closed to bottom trawling. Purple, crosshatch area indicates the portion of PAS that was closed to bottom trawling gear prior to Amendment 28 and remains closed to bottom trawling.

In 2015, the GFNMS boundary nearly doubled in size, thus requiring further exploration of deep-sea habitats west of Sonoma and Mendocino Counties. PAS is 85 km (32 mi) west of Havens Neck near the northern Sonoma County border and approximately 150 km (90 mi) northwest of San Francisco (Figure 1). At the time of the sanctuary expansion, there were 637 km² (242 mi²) protected from bottom trawling within the expansion area, the majority of which were in PAS. Prior to its reconfiguration in January 2020, PAS was approximately 260 km² (96 mi²). In 2018, the Pacific Fisheries Management Council proposed that several areas within the GFNMS expansion area be opened to bottom trawling, the majority of which were in PAS. Little was known about PAS seafloor habitat other than through bycatch of corals and sponges and a brief exploration of a small portion of the western area of PAS by NOAA's National Marine Fisheries Service (NMFS) in 2018, which revealed rich and biologically diverse coral, sponge, and fish communities (T. Laidig, personal communication). Since the reconfiguration of PAS in January 2020, 93.5 km² (36.1 mi²) are now protected from bottom trawling.

Dive Sites, ROV Video Analysis, & Specimen Collections

Dive Sites

Quantitative transects were designed for the dive areas using predictive habitat maps interpreted from multibeam bathymetry and backscatter data (methods from Cochrane, 2008) collected by E/V *Nautilus* in 2016 and 2017. Transects were plotted to capture hard-rugose substrate, mixed rocky substrate with intermittent soft sediment (hard-flat), and soft-flat substrate. Areas with hard substrate and high slope are potentially suitable habitats for corals and sponges. We targeted sampling in each of the reconfigured PAS management zones for bottom trawling:

1) areas that were closed to bottom trawling prior to Amendment 28 (January 1, 2020) and are now open (green, forward hatch zones in Figure 2);
2) areas that remain closed to bottom trawling (purple, crosshatch zones in Figure 2); and
3) areas that were open to bottom trawling prior to Amendment 28 and are now closed (red, backward hatch zones in Figure 2).

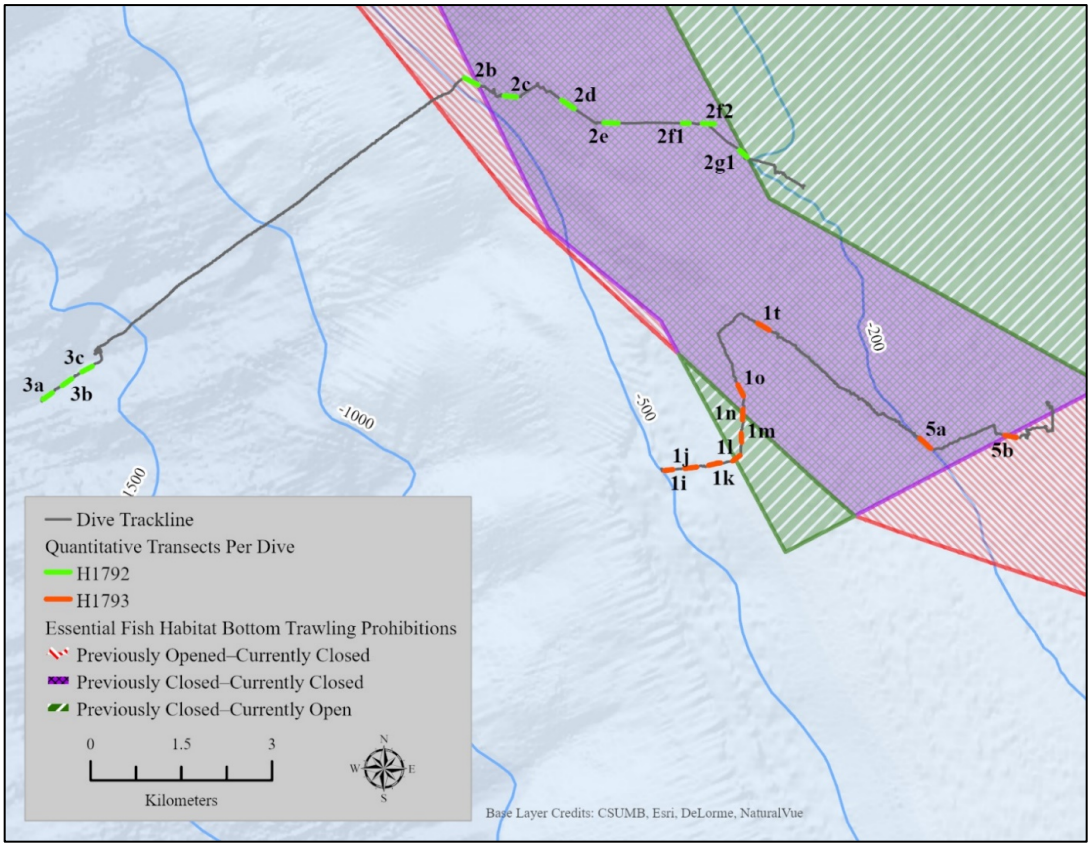


Figure 2. Locations of the twenty quantitative transects selected for analysis from 22 hours of seafloor video from dive H1792 (green) and 20 hours of video from dive H1793 (orange) in each of the reconfigured PAS management zones.

From October 6–8, 2019, seafloor surveys using ROV *Hercules* off of the E/V *Nautilus* (owned and operated by the Ocean Exploration Trust) were conducted in the PAS area of GFNMS. The first dive, H1792, collected 22 hours of video from the seafloor in Point Arena South reaching a large range of depths of 1854 to 190 meters. The second dive, H1793, surveyed the southern portion of Point Arena South, collecting 20 hours of seafloor video at depths of 496 to 147 meters (Table 1 and Figure 2).

Table 1. Dive summaries including dive duration, ROV depths, and sample numbers.

Dive Number	Site Name	Date Start Dive (UTC)	Total Dive Time (hrs)	Total Bottom Time (hrs)	Bottom Depth Range (m)	Sample ID range
H1792	Point Arena South	10/6/2019	24.01	22.08	1854–190	NA116-023–NA116-032
H1793	Southern Point Arena South	10/7/2019	20.85	19.99	496–147	NA116-033–NA116-042

ROV Video Analysis

Ten quantitative transects were sampled on each dive to target a variety of habitat types, depths, and locations in relation to PAS boundaries (Figure 2). While on transect, the ROV pilot strived to maintain a consistent speed and height from the bottom, targeting about 1 meter off the bottom and at a speed of 0.5 to 1 knot. The quantitative transects were used for classifying substrate (habitat type), species identification, and counts of corals, sponges, and fishes. Substrate type was classified using a two-code classification scheme based on particle size and vertical relief as described in Stein et al. (1992). Distinct changes in substratum types greater than or equal to 10 seconds in duration along the transect were recorded, thus establishing "habitat patches" that were summarized into three classes to account for substrate and rugosity: 1) soft-flat (mud or sand), 2) hard-flat (low-relief hard substrata that could be combined with mud or sand), and 3) hard-rugose (high-relief hard substrata like rock ridge and boulders) (Cochrane, 2008).

Video annotation included identification of individual corals, sponges, and fishes to the lowest taxonomic level. Annotations were recorded by time, georeferenced using the ROV's navigation data, and joined to conductivity, temperature, and depth (CTD) and O_2 sensor data. Some sponges were classified by general morphology (e.g., flat, foliose, barrel, and vase) when taxonomic identification was difficult. The maximum size of corals and sponges (to the nearest 5 cm) was determined using a set of paired scaling lasers, spaced 10 cm apart, and color of individuals was recorded. Condition of each coral and sponge was determined to be healthy (<10% of organism is dead), unhealthy (10–50% of organism is dead), or dead (>50% of organism dead). Densities of corals, sponges, and fish were estimated by dividing the total number of each taxon by the area of each transect. Marine debris was also identified and georeferenced. Species abundance and distribution were quantified from the ROV video imagery and are reported by dive number in this report. Coral, sponge, and fish data were grouped by transects based on location with respect to PAS boundaries and depth ranges.

Video files that were "off transect" were quantitatively reviewed to record coral, sponge, and fish taxa that were not quantified on transects. Locations with notable biodiversity, habitat types, or other interesting observations were recorded as presence observations to be georeferenced and related to the boundaries of PAS. Two rockfish species, cowcod (*Sebastes levis*) and yelloweye (*S. ruberrimus*), were of particular interest and were counted and georeferenced in the Point Arena area. In the early 2000s, yelloweye and cowcod (along with five other species of rockfish) were formally declared overfished throughout their range by NMFS. Cowcod populations are now considered to be rebuilt and their coast-wide distribution is of interest to fisheries biologists with NMFS and the University of California Santa Barbara Marine Science Institute (T. Laidig and M. Love, pers. comm.). Yelloweye rockfish are of interest because their populations are currently "rebuilding" at year 16 of the 25-year plan (NMFS, 2020). There is also some indication that the general removal of large fish predators such as yelloweye rockfish can alter species composition, allowing populations of smaller fishes, such as the pygmy rockfish (*Sebastes wilsoni*) and squarespot rockfish (*S. hopkinsi*), to expand (Baskett et al., 2006).

Specimen Collections

Numerous samples and specimens were collected during the two dives in PAS. Sixteen invertebrate specimens were collected for taxonomy by California Academy of Sciences (CAS) and the Museum of Comparative Zoology at Harvard University. Appendix A includes a table of specimens collected and archived at CAS, as well as environmental parameters at the time of collection and a map showing locations where specimens were collected. Full taxonomy for the sponge collections are pending. Other samples collected included two water samples for eDNA to be processed by NMFS, two water samples to be processed by Bodega Marine Lab for pH and aragonite saturation, and one push core sediment sample (approximately 25 cm) to be processed by Bodega Marine Lab for climatology and to assess prey species for corals. The ROV CTD continuously sampled water temperature, dissolved oxygen, and salinity. Contact authors for complete environmental data.

Summary of Dive H1792: Point Arena South

Dive H1792 collected 22 hours of video from the seafloor in Point Arena South, reaching a large range of depths (1854 to 190 meters). Other details about the dive are listed in Table 2.

Table 2. H1792 dive details.

ROV Details	
Date and time ROV in water (UTC)	10/6/19 8:12 PM
Date and time ROV on deck (UTC)	10/7/19 8:13 PM
Date and time ROV on bottom (UTC)	10/6/19 9:28 PM
Date and time ROV off bottom (UTC)	10/7/19 7:33 PM
ROV maximum depth (m)	1854
ROV off bottom depth (m)	190
ROV average depth (m)	706
Total dive time (hrs)	24.01
Total bottom time (hrs)	22.08
CTD Details (Seafloor)	
Average temperature (°C)	5.8
Minimum temperature (°C)	2.3
Maximum temperature (°C)	8.7
Average O_2 concentration (ml/L)	0.9
Minimum O_2 concentration (ml/L)	-0.1
Maximum O_2 concentration (ml/L)	1.8
Average O_2 saturation (%)	10.8
Minimum O_2 saturation (%)	-0.7
Maximum O_2 saturation (%)	22.6

Coral, sponge, fish, and habitat data have been summarized below for two groups of transects (Table 3):

1) Transects 3a, 3b, and 3c were located in deeper portions of the dive (>1000 m). This area was not considered as part of PAS and was not part of the Amendment 28 EFH process.
2) Transects 2b, 2c, 2d, 2e, 2f1, 2f2, and 2g1 were located inside PAS areas closed to commercial bottom trawling as part of the Amendment 28 process.

Table 3. H1792 transect details and status of Amendment 28 process. White colored rows are transects not part of PAS, the red color row is a transect in PAS previously opened and currently closed, and purple color rows are transects in PAS previously closed and currently closed.

Transect Name	Date (UTC)	Start Time (UTC)	End Time (UTC)	Transect Area (m^2)	Depth Range (m)	EFH Amendment 28 Status
3a	10/6/2019	10:14:00 PM	10:34:21 PM	1107	1852–1838	Not in PAS
3b	10/6/2019	10:47:49 PM	11:04:53 PM	938	1820–1801	Not in PAS
3c	10/6/2019	11:28:55 PM	11:43:49 PM	984	1785–1753	Not in PAS
2b	10/7/2019	6:09:24 AM	6:30:30 AM	2738	488–483	closed
2c	10/7/2019	9:33:53 AM	9:56:25 AM	1781	453–446	closed
2d	10/7/2019	12:44:30 PM	1:00:16 PM	2197	308–306	closed
2e	10/7/2019	1:40:00 PM	1:55:20 PM	1569	290–264	closed
2f1	10/7/2019	3:06:00 PM	3:15:48 PM	878	217–216	closed
2f2	10/7/2019	3:31:20 PM	3:48:20 PM	2318	213–192	closed
2g1	10/7/2019	5:19:20 PM	5:34:05 PM	1405	192–190	closed

H1792: Habitat

A total area of 15,914 m^2 was surveyed on 10 transects during dive H1792 (Figures 3 and 4). The first three transects (3a, 3b, 3c) were at the deepest depth range (1852–1753 meters) for this dive and were not part of the Amendment 28 PAS reconfiguration process. The seafloor habitat was 100% soft-flat (mud) substrate.

Seven transects (2b, 2c, 2d, 2e, 2f1, 2f2, 2g1) surveyed PAS areas closed to commercial bottom trawling at depths of 488–190 meters. The habitat types of transects 2b–2f1 were primarily soft-flat or hard-flat substrates. The soft-flat substrate was all mud. Hard-flat habitats were characteristically low-relief, unconsolidated rocks mixed with mud or consolidated, flat rock that was often covered in a mud veneer. The shallowest transects, 2f2 and 2g1, did not have any soft-flat substrate. Transect 2f2 was 100% hard-rugose substrate made up of high-relief, hard rock mixed with boulders or cobbles and transect 2g1 was 73% hard-flat and 27% hard-rugose substrate.

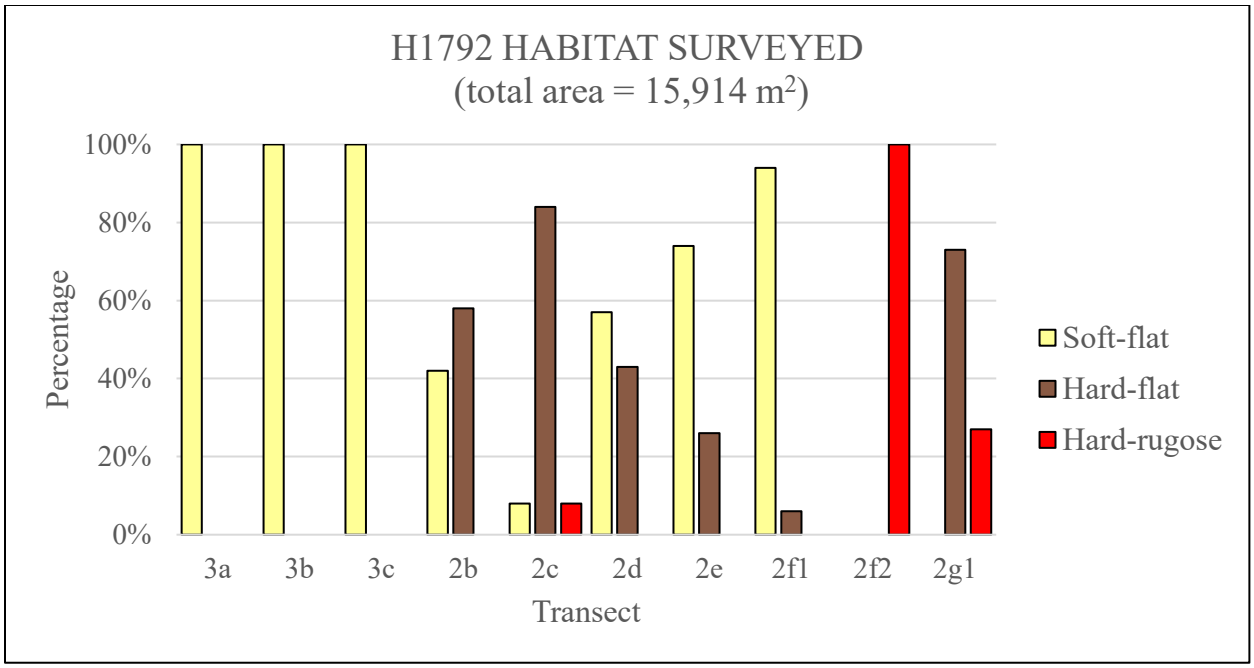


Figure 3. Percent of confirmed substrate types summarized into three categories (soft-flat, hard-flat, hard-rugose) from ROV video analysis of each quantitative transect from dive H1792.

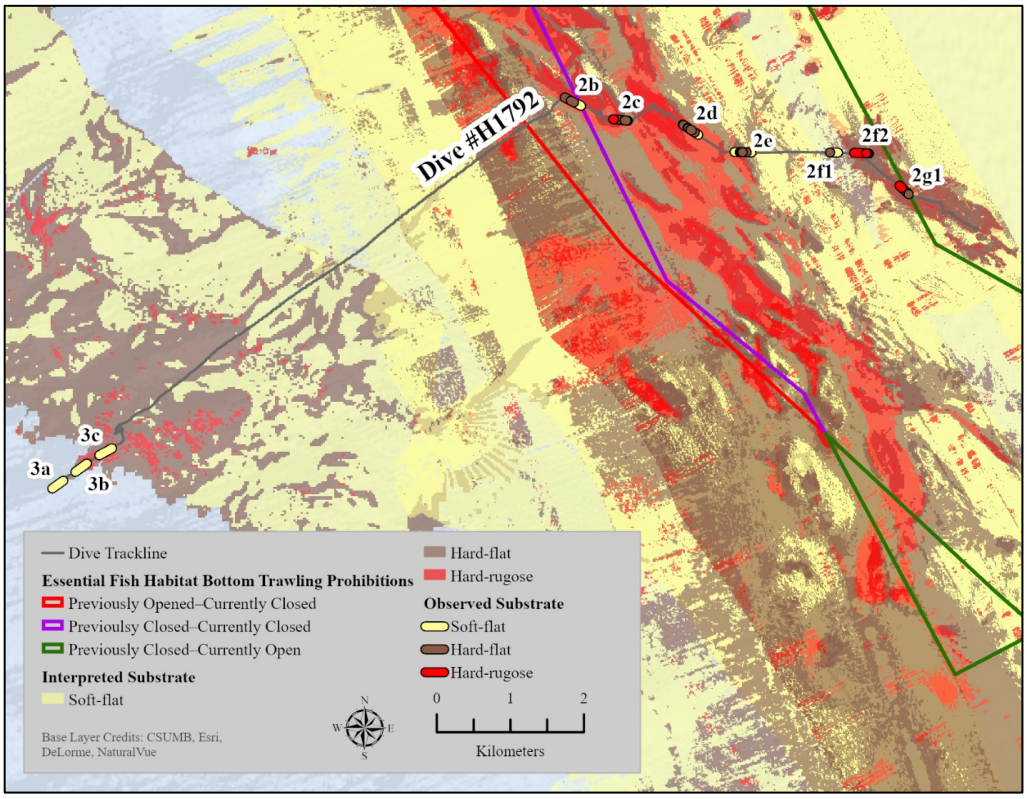


Figure 4. Dive H1792 quantitative transects depicting observed substrate summarized as soft-flat, hard-flat, and hard-rugose overlaid on interpreted substrate using the habitat modeling method of Cochrane (2008).

H1792: Corals and Sponges

The seafloor was 100% mud bottom on transects 3a–3c; therefore, the only corals observed were sea pens, *Halipteris californica*, and sea pens that could not be identified to genus (Pennatulacea spp.). The estimated density of *H. californica* and Pennatulacea spp. was seven individuals per 100 m^2 and 18 individuals per 100 m^2, respectively. Sea pens were often very tall, reaching a maximum height of 150 cm (Table 4a). Approximately 73% (n=162) of *H. californica* had associated *Asteronyx* sp. brittle stars, which are commonly seen associated with these sea pens.

The hard-flat and hard-rugose substrates observed on transects 2b–2g1, located inside PAS areas closed to commercial trawling, provided habitat for corals and sponges. However, the total count of corals was low (n=59) given the large amount of area surveyed (12,885 m^2) (Table 4b). The rock substrate was often covered in a mud veneer, which could explain why few corals and sponges were observed on transects.

The primary habitats of mud mixed with mud-veneer-covered rock accounts for mushroom corals (*Heteropolypus ritteri*) having the highest density of all corals observed on transects. Additionally, there were two observations of a *Swiftia* sp. gorgonian with a red-branched morphology, one observation of a small (15 cm tall) bubblegum coral (*Paragorgia arborea*), one observation of the soft coral *Clavularia* sp., and numerous cup corals that are most likely undercounted from the video due to their small size and limited detectability (Table 4b).

Sponges were more abundant and diverse than corals. Both Demospongiae and Hexactinellida (glass) sponges were observed, as well as sponges that could only be identified by morphology. A new species of the predatory sponge *Asbestopluma* with a “palm frond” morphology and a generally small size range (10–15 cm tall) was seen, accounting for 4% of total coral and sponge observations. An unknown species of white sponge with a branching morphology was the most abundant type of sponge observed on transects and one specimen was collected for further identification. The barrel sponge *Rhabdocalyptus dawsoni* and other unknown species of barrel sponges were also common and relatively large, up to 70 cm tall. Sponges with a flat morphology were also common, including the shelf sponge *Poecillastra* sp. (16% of total corals and sponges) and an unknown species of white, upright, flat sponges (15% of total corals and sponges) (Table 4b).

To generate a complete species list of DSCS for dive H1792, coral and sponge species were identified but not quantified from all ROV video not considered quantitative transects. The complete list can be found in Appendix B. At the deepest extent of dive H1792, multiple species of noteworthy corals were observed, including bamboo corals (Isididae), black corals (*Bathypathes patula* and *Parantipathes* sp.), and primnoids (*Callogorgia kinoshitae* and *Parastenella ramosa*). Notable sponge observations included an area within the existing PAS near the start of transect 2c at depths of approximately 475–457 meters of mud and boulder habitat with numerous bright yellow “plate” morphology sponges. A piece of a yellow “plate” sponge was collected for further identification. Also in this area was an abundance of large and dead glass sponges that appeared to be *Heterochone calyx*. The rock habitat and dead sponges in this area were heavily covered in mud sediment. Live, tall, barrel and vase-shaped sponges were observed among the dead sponges and boulders.

Table 4a. Coral and sponge taxa observed on transects 3a–3c, which are not within PAS and are open to commercial bottom trawling.

Common Name	Scientific Name	Total Number	Percent of Total	Density per 100 m2	Height Range (cm)	Depth Range (m)
CORALS						
Sea pens	*Halipteris californica*	222	29%	7.3	5–150	1753–1851
	Pennatulacea	543	71%	17.9	5–140	1753–1851
	TOTAL CORALS	765				

Table 4b. Coral and sponge taxa observed on transects 2b–2g1, which are within PAS closed to commercial bottom trawling.

Common Name	Scientific Name	Total Number	Percent of Total	Density per 100 m^2	Height Range (cm)	Depth Range (m)
CORALS						
Bubblegum	*Paragorgia arborea*	1	0.4%	0.01	15	268
Gorgonian	*Swiftia* sp.	2	1%	0.02	30	447
Soft coral	*Clavularia* sp.	1	0.4%	0.01	5	450
	Heteropolypus ritteri	33	13%	0.26	5–40	306–487
Other	Scleractinia	22	8%	0.17	5	212
	TOTAL CORALS	59				
SPONGES						
Demospongiae	*Asbestopluma* sp. nov.	10	4%	0.08	10–15	449–486
	Poecillastra sp.	43	16%	0.33	5–50	191–451
	Rhizaxinella gadus	4	2%	0.03	20–25	308–450
Hexactinellida	*Farrea* sp.	1	0.4%	0.01	15	450
	Rhabdocalyptus dawsoni	17	6%	0.13	5–70	191–486
	Staurocalyptus sp. (white)	2	1%	0.02	15–25	447–450
Morphological	Barrel	23	9%	0.18	15–65	191–451
	Branching	55	21%	0.43	10–40	190–488
	Shelf	3	1%	0.02	15–35	192–452
	Upright flat	39	15%	0.30	5–15	192–212
	Vase	6	2%	0.05	20	192–488
	TOTAL SPONGES	203				

H1792: Fishes

Fish species observed on transects 3a–3c are common for the deep depths sampled. Eelpouts (Zoarcidae) accounted for 56% of all fish observations. Grenadiers (Macrouridae) were the next most abundant fish group observed at an estimated density of one individual per 100 m^2 (Table 5a). Grenadiers are very difficult to identify from video imagery and were therefore all classified as unknown Macrouridae. The potential species known for the region and depth range are giant grenadier (*Albatrossia pectoralis*), threadfin grenadier (*Coryphaenoides filifer*), and Pacific grenadier (*Coryphaenoides acrolepis*). Other fish species observed on transects included Pacific flatnose (*Antimora microlepis*), snailfish (Liparidae), and roughtail skate (*Bathyraja trachura*).

High diversity and abundances of fish species were recorded on transects 2b–2g1, located inside PAS closed to commercial bottom trawling (Table 5b). At least 5 species of flatfish (22% of total fish) and at least 15 species of rockfish (52% of total fish) were observed. Notably, there were very large (up to 60 cm length) cowcod (*Sebastes levis*, n=17) and yelloweye rockfish (*S. ruberrimus*, n=16) on transects. High-relief rock areas on transects 2f2 and 2g1 provided ideal habitat for many of the large cowcod, yelloweye, canary *(S. pinniger*), bocaccio (*S. paucispinis*), and lingcod (*Ophiodon elongatus*). The water column was also dense with krill, at times limiting visibility of the ROV's cameras. Other fish taxa seen in high counts included Pacific hake (*Merluccius productus*) and spotted ratfish (*Hydrolagus colliei*).

There were large boulder and high-relief, consolidated rock habitats located after the end point of transect 2f2 and still within PAS. We consider these areas to be fish "hotpots" with numerous, large lingcod (*O. elongatus*), large yelloweye (*S. ruberrimus*), cowcod (*S. levis*), bocaccio (*S. paucispinis*), and canary (*S. pinniger*). At the request of NMFS, we quantified and made size estimates for cowcod and yelloweye. Eight cowcod and 12 yelloweye rockfish were counted off transect on dive H1792. There was also a high density of krill in the water column. At the eastern end of dive H1792 was a high-relief rock feature (~190 meters) with large yelloweye and bocaccio, and one cowcod. As of January 2020, this area is no longer in PAS, and is now opened to commercial bottom trawling. Of note, this high-relief rock area appears to be too steep for the use of bottom trawl gear.

Table 5a. Fish taxa observed on transects 3a–3c, which are not within PAS and are open to commercial bottom trawling.

Group	Scientific Name	Common Name	Total Number	Percent of Total	Density per 100 m^2	Length Range (cm)	Depth Range (m)
Eelpout	Bothrocara brunneum	twoline eelpout	2	2%	0.07	55–60	1783–1839
	Lycodes diapterus	black eelpout	13	10%	0.43	15–30	1754–1850
	Zoarcidae	eelpout	55	44%	1.82	10–25	1757–1852
Grenadier	Macrouridae	grenadier	35	28%	1.16	20–65	1761–1847
Morids	Antimora microlepis	Pacific flatnose	8	6%	0.26	30–50	1758–1850
Skate	Bathyraja trachura	roughtail skate	2	1%	0.07	60–120	1756–-1806
Snailfish	Liparidae	snailfish	11	9%	0.36	10–15	1754–1805
		TOTAL FISH	126				

Table 5b. Fish taxa observed on transects 2b–2g1, which are within PAS closed to commercial bottom trawling.

Group	Scientific Name	Common Name	Total Number	Percent of Total	Density per 100 m^2	Length Range (cm)	Depth Range (m)
Eelpout	Lycodes cortezianus	bigfin eelpout	9	1%	0.07	30–45	307–488
	Lycodes diapterus	black eelpout	4	0.2%	0.03	20–30	447–485
	Zoarcidae	eelpout	1	0.1%	0.01	15	447
Flatfish	Atheresthes stomias	arrowtooth flounder	1	0.1%	0.01	40	451
	Embassichthys bathybius	deepsea sole	1	0.1%	0.01	25	487
	Glytocephalus zachirus	rex sole	49	3%	0.38	20–35	216–487
	Lyopsetta exilis	slender sole	86	5%	0.67	15–25	216–306
	Microstomus pacificus	Dover sole	193	12%	1.50	20–40	265–488
	Pleuronectidae	flatfishes	34	2%	0.26	15–35	216–485
Rockfish	Sebastes aurora	aurora rockfish	53	3%	0.01	20–30	447–488
	Sebastes babcocki	redbanded rockfish	2	0.1%	0.02	30–40	206–308
	Sebastes chlorostictus	greenspotted rockfish	46	3%	0.36	20–50	190–268
	Sebastes diploproa	splitnose rockfish	30	2%	0.23	15–25	281–308
	Sebastes elongatus	greenstriped rockfish	23	1%	0.18	15–25	216–289
	Sebastes entomelas	widow rockfish	1	0.1%	0.01	40	204
	Sebastes helvomaculatus	rosethorn rockfish	37	2%	0.29	10–30	190–307
	Sebastes levis	cowcod	17	1%	0.13	50–60	191–209
	Sebastes melanostomus	blackgill rockfish	2	0.1%	0.02	30	447–486
	Sebastes paucispinis	bocaccio	25	2%	0.19	40–60	190–308
	Sebastes pinniger	canary rockfish	40	2%	0.31	40–50	191–209
	Sebastes ruberrimus	yelloweye rockfish	16	1%	0.12	20–60	193–211
	Sebastes saxicola	stripetail rockfish	76	5%	0.59	15–25	216–307
	Sebastes zacentrus	sharpchin rockfish	22	1%	0.17	15–25	191–268
	Sebastes spp.	rockfishes	99	6%	0.77	10–50	190–452
	Sebastolobus alascanus	shortspine thornyhead	8	0.5%	0.06	25–45	450–487
	Sebastolobus spp.	thornyheads	319	20%	2.48	10–25	284–488
	Sebastomus spp.	unidentified *Sebastomus*	31	2%	0.24	10–25	190–308
Skate	Raja rhina	longnose skate	9	0.5%	0.07	50–100	190–486
Other	Agonidae	poacher	23	1%	0.18	20–25	273–308
	Anoplopoma fimbria	sablefish	1	0.1%	0.01	70	448
	Eptatretus sp.	hagfish	22	1%	0.17	25–40	190–483
	Hydrolagus colliei	spotted ratfish	106	7%	0.82	30–80	190–307
	Icelinus spp.	icelinus sculpins	15	1%	0.12	15–20	192–307
	Merluccius productus	Pacific hake	117	7%	0.91	35–50	264–488
	Ophiodon elongatus	lingcod	120	7%	0.93	35–120	190–307
		TOTAL FISH	1638				

H1792: Marine Debris

All anthropogenic debris was georeferenced and counted throughout dive H1792 (Table 6 and Figure 5).

Table 6. Anthropogenic debris observed during dive H1792.

Marine Debris Type	Total Observations	Depth Range (m)
Anthropogenic rubbish (cans, refuse, etc.)	19	1838–191
Line not identified as longline or monofilament	11	455–189
Cable	2	193–190
Gill net	1	195
Monofilament line	1	195
Tracks from manmade objects	1	306
TOTAL	35	

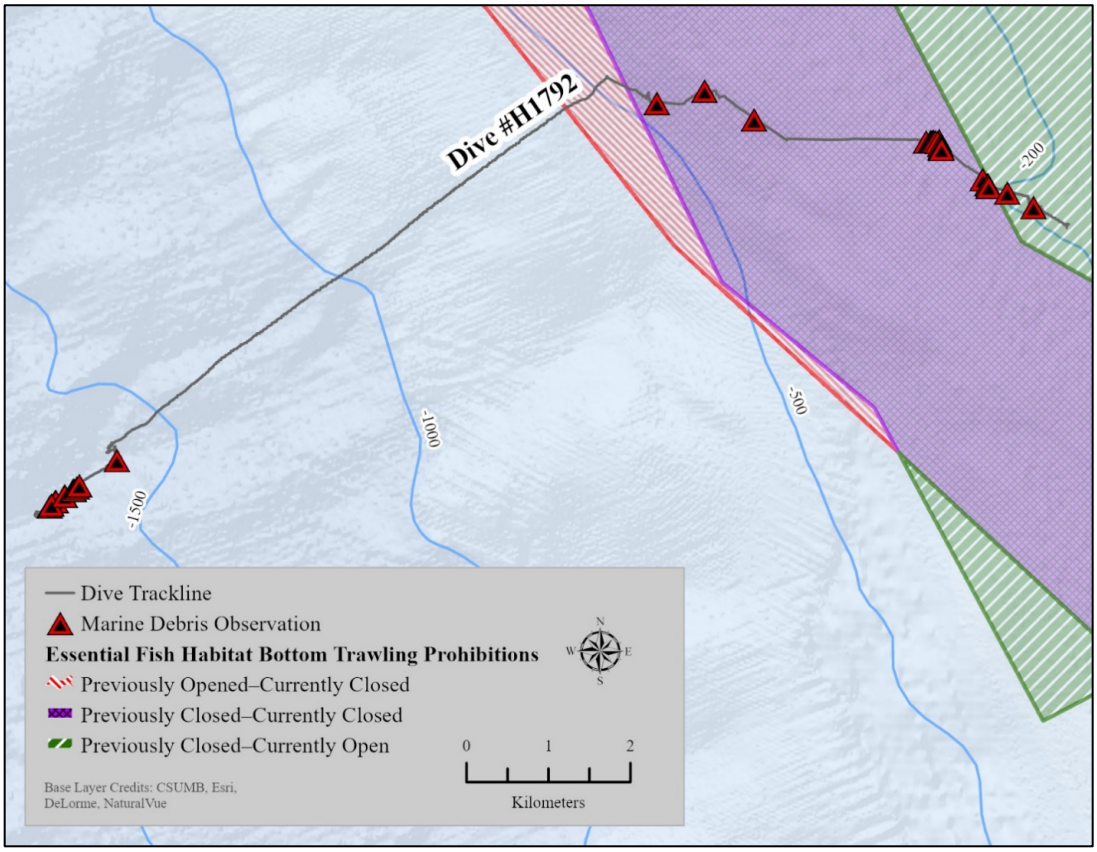


Figure 5. Locations of marine debris referenced in Table 6 along dive H1792.

H1792: Collections

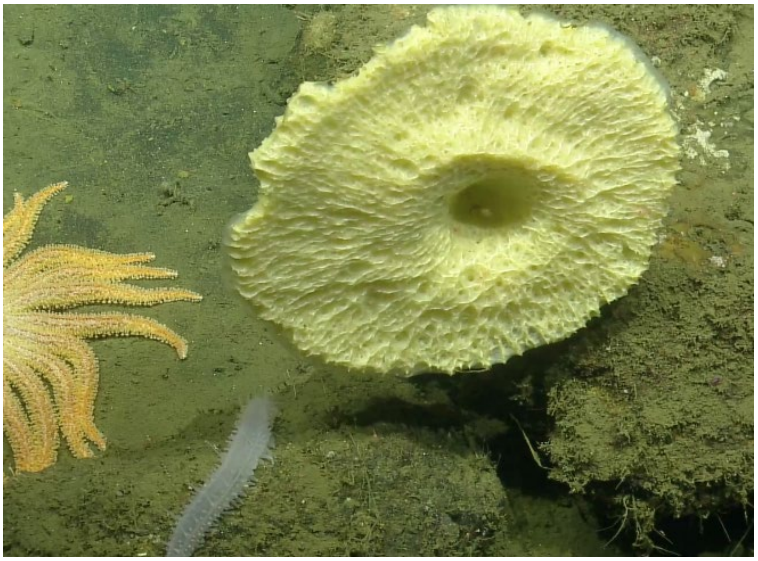
Three collections of corals and three collections of sponges were made on dive H1792 for taxonomy and are archived at the California Academy of Sciences (San Francisco, California) (Table 7). Full taxonomy information for the sponge collections are pending. For more information on environmental conditions at the times of collection, see Appendix A.

Table 7. List of coral and sponge specimens collected on dive H1792.

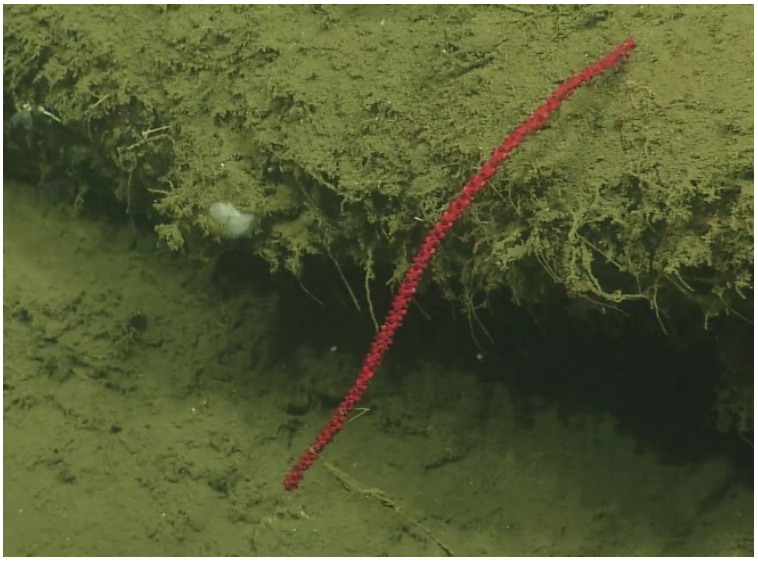
Sample ID #	Species/Genus/Class	Latitude	Longitude	Depth (m)
NA116-024	*Parantipathes* sp.	38.5767	-123.8151	1709
NA116-026	*Parastenella ramosa*	38.5766	-123.8159	1708
NA116-029	*Swiftia simplex*	38.6159	-123.7409	469
NA116-030	Demospongiae	38.6156	-123.7395	453
NA116-031	Demospongiae	38.6155	-123.7393	456
NA116-032	Demospongiae	38.6116	-123.7002	209

H1792: Representative Images

All images below: Ocean Exploration Trust/NOAA

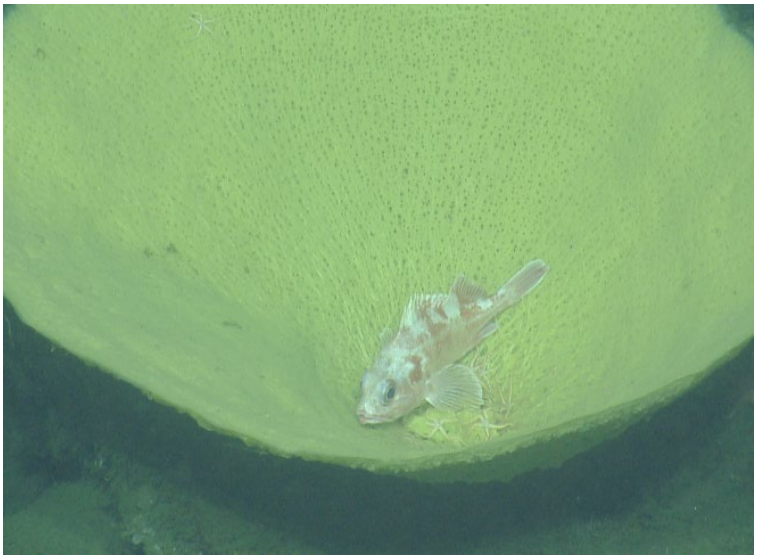


Bright yellow “plate” morphology sponges were common and a sample was collected for species identification (Sample ID: NA116-031).

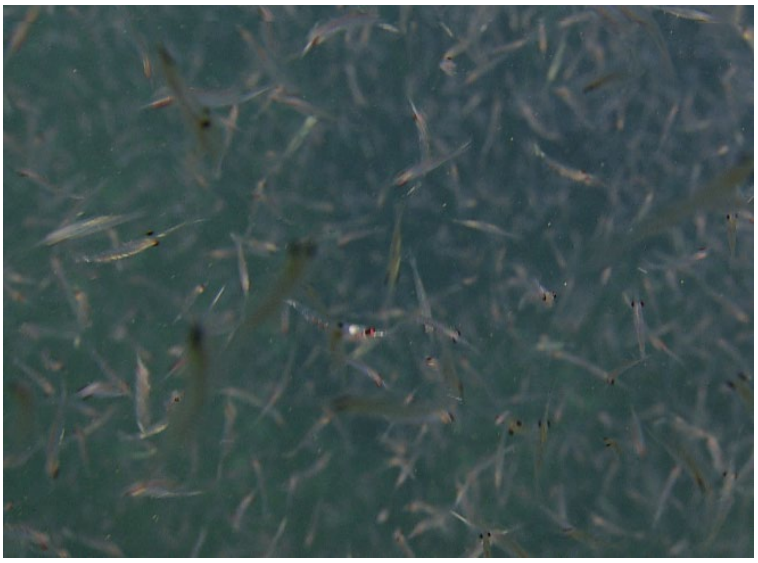


Few gorgonians were observed, but this *Swiftia simplex* was collected for species identification (Sample ID: NA116-029).

At the deeper extent of the dive, primnoid corals, such this *Parastenella ramosa*, were common. A sample was collected for species identification (Sample ID: NA116-026).



Sponges can provide habitat for fish and other invertebrates. An aurora rockfish (*Sebastes aurora*) rests inside a large yellow vase sponge with associated brittle stars.



Large swarms of krill were observed in the water column and often limited visibility.

High-relief, rocky areas provided habitat for large groundfish like bocaccio (*Sebastes paucispinis*), canary (*S. pinniger*), cowcod (*S. levis*), and lingcod (*Ophiodon elongatus*).

Summary of Dive H1793: Southern Point Arena South

Dive H1793 surveyed the southern portion of Point Arena South, collecting 20 hours of seafloor video from 496 to 147 meters. Other details about the dive are listed in Table 8.

Table 8. H1793 dive details.

ROV Details	
Date and time ROV in water (UTC)	10/7/19 11:10 PM
Date and time ROV on deck (UTC)	10/8/19 8:01 PM
Date and time ROV on bottom (UTC)	10/7/19 11:33 PM
Date and time ROV off bottom (UTC)	10/8/19 7:32 PM
ROV maximum depth (m)	496
ROV off bottom depth (m)	147
ROV average depth (m)	249
Total dive time (hrs)	20.85
Total bottom time (hrs)	19.99
CTD Details (Seafloor)	
Average temperature (°C)	7.9
Minimum temperature (°C)	5.7
Maximum temperature (°C)	8.9
Average O_2 concentration (ml/L)	1.5
Minimum O_2 concentration (ml/L)	0.4
Maximum O_2 concentration (ml/L)	2.1
Average O_2 saturation (%)	18.1
Minimum O_2 saturation (%)	4.3
Maximum O_2 saturation (%)	25.5

Coral, sponge, fish, and habitat data have been summarized below for three groups of transects (Table 9):

1) Transects 1i, 1j, 1k were not inside PAS.
2) Transects 1l, 1m, 1n were located inside PAS opened to commercial bottom trawling.
3) Transects 1o, 1t, 5a, 5b were located inside PAS closed to commercial bottom trawling.

Table 9. H1793 transect details and status of Amendment 28 process. White colored rows are transects not part of PAS, green colored rows are transects in PAS previously closed and currently open, purple color rows are transects in PAS previously closed and currently closed, and the red row is a transect in PAS previously opened and currently closed.

Transect Name	Date (UTC)	Start Time (UTC)	End Time (UTC)	Transect Area (m^2)	Depth Range (m)	EFH Amendment 28 Status
1i	10/7/2019	11:44:19 PM	11:53:23 PM	866	495–492	Not in PAS
1j	10/8/2019	12:08:42 AM	12:24:22 AM	1141	483–468	Not in PAS
1k	10/8/2019	12:39:40 AM	12:54:32 AM	999	440–397	Not in PAS
1l	10/8/2019	1:14:15 AM	1:25:45 AM	1123	366–347	Open
1m	10/8/2019	1:46:47 AM	1:56:58 AM	1543	343–342	Open
1n	10/8/2019	2:11:11 AM	2:23:04 AM	1380	335–330	Open
1o	10/8/2019	2:49:46 AM	3:04:57 AM	1931	325–317	Closed
1t	10/8/2019	6:38:34 AM	6:55:24 AM	1975	238–235	Closed
5a	10/8/2019	1:49:05 PM	2:06:36 PM	2533	207–201	Closed
5b	10/8/2019	4:10:45 PM	4:27:32 PM	1367	158–156	Closed

H1793: Habitat

A total area of 14,859 m^2 was surveyed on 10 transects on dive H1793 (Figures 6 and 7). The first three transects (1i, 1j, 1k) were at the deepest depth range (495–492 meters) for this dive and not in PAS. The seafloor was primarily mud and sand (soft-flat) sediment (100% of habitat for transect 1j). Hard-flat substrates were present on transects 1i and 1k and consisted of mud with boulders or cobbles.

Three transects (1l, 1m, 1n) were located inside PAS open to commercial bottom trawling from depths of 366–330 meters. Transect 1l was 100% mud and sand (soft-flat) sediment and transects 1m and 1n were characterized by hard-flat substrates that consisted of mud with cobbles or boulders (Figures 6 and 7).

Four transects (1o, 1t, 5a, 5b) were located inside PAS closed to commercial bottom trawling from depths of 325–156 meters. The area on transect 1o was 100% hard-flat substrate, consisting of mud with cobbles or boulders. Over 80% of the total area on transects 1t, 5a, and 5b was hard-flat substrate, consisting of mud with rock covered in a mud veneer and flat-rock with mud. The hard-rugose substrates on transects 5a and 5b were consolidated flat-rock with cobbles and boulders and some high-relief rock ridge on transect 5b (Figures 6 and 7).

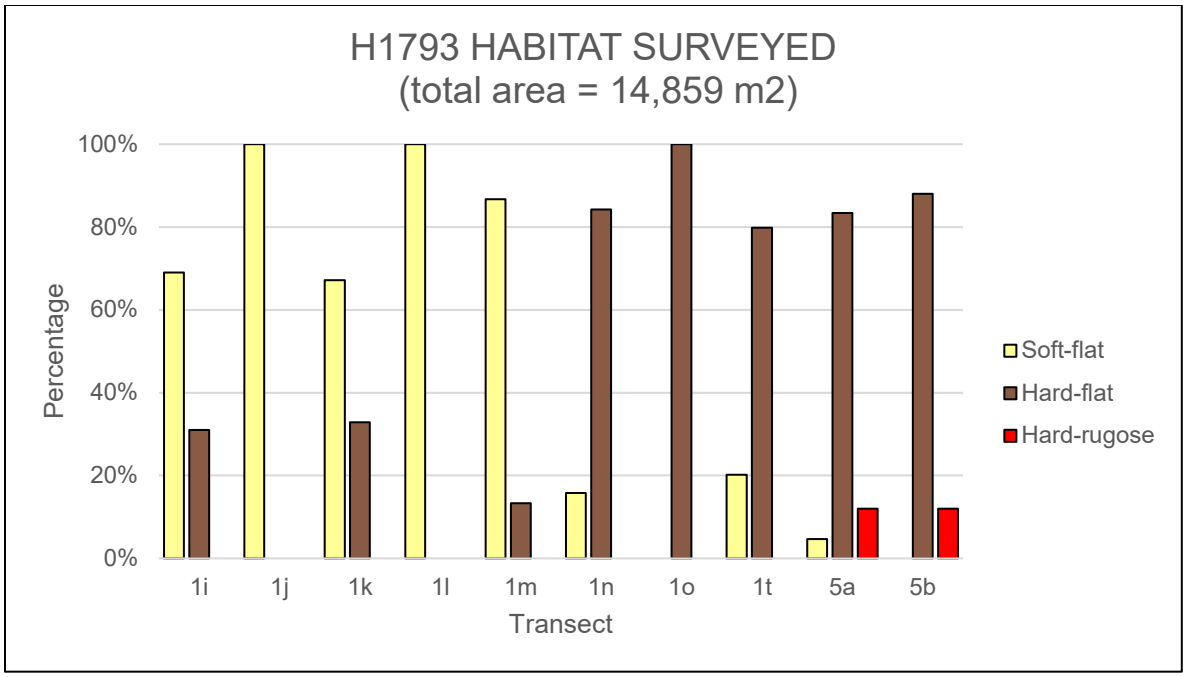


Figure 6. Percent of confirmed substrate types summarized into three categories (soft-flat, hard-flat, hard-rugose) from ROV video analysis of each quantitative transect from dive H1793.

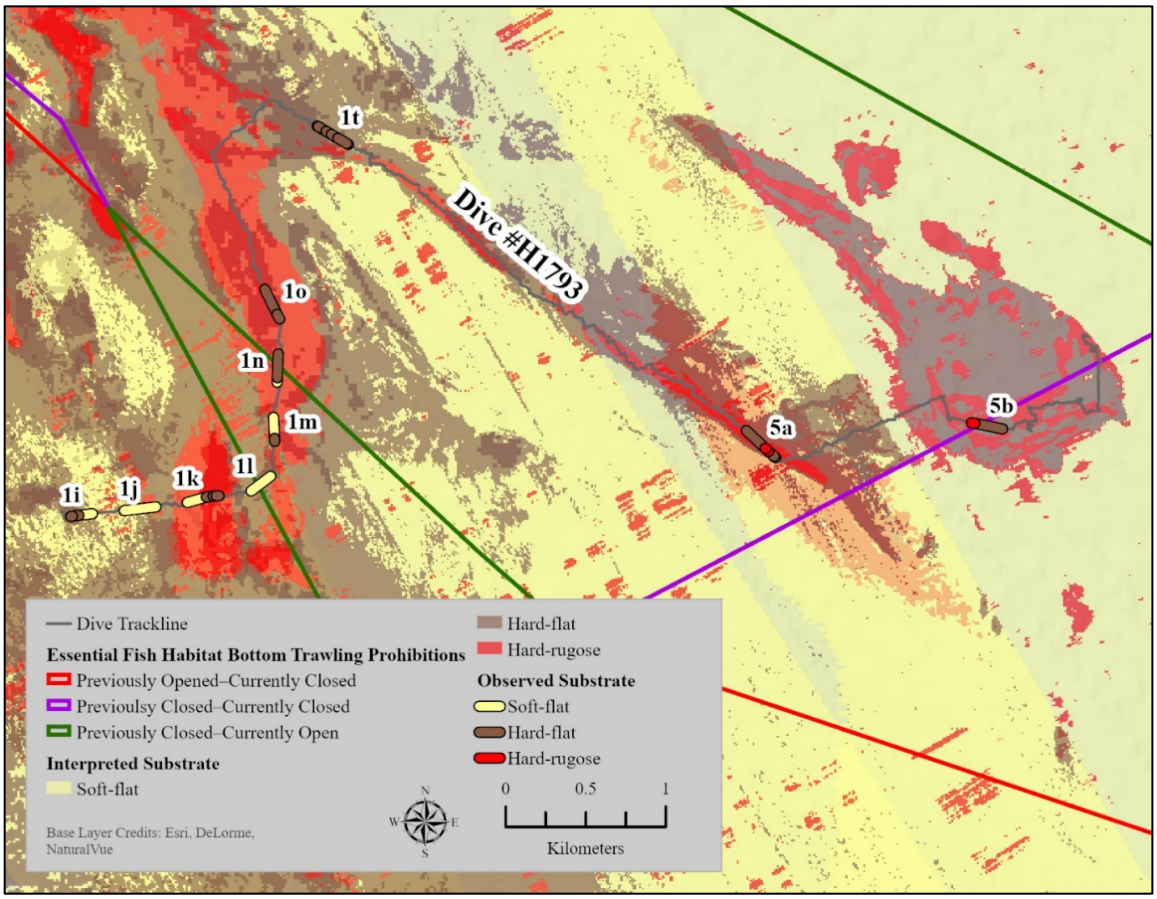


Figure 7. Dive H1793 quantitative transects depicting observed substrate summarized as soft-flat, hard-flat, and hard-rugose overlaid on interpreted substrate using the habitat modeling method of Cochrane (2008).

H1793: Corals and Sponges

Total counts and densities of corals and sponges were low (n=21) on transects 1i, 1j, and 1k, which were conducted in an area west of PAS (Table 10a). The primary habitat on these transects was mud and sand sediment, and no sea pen species were observed on these transects. Areas with hard-flat substrate had very few corals and sponges, possibly because the rocks were covered in sediment. We did observe white Picasso sponges (*Staurocalyptus* sp.), which are typically found at these depths and on rock substrate.

On transects 1l, 1m, and 1n, located in PAS open to commercial bottom trawling, total counts and densities of corals and sponges were low (n=15), despite the presence of hard-flat substrates of mud with cobbles or boulders (Table 10b). It is possible the low counts of corals and sponges are because the rocky substrate was covered in sediment. The most abundant sponges observed (n=6 and 40% of total corals and sponges) were large barrel sponges, *Rhabdocalyptus dawsoni*, with a maximum height of 60 cm.

The greatest diversity and density of sponges on H1793 were seen on transects 1o, 1t, 5a, and 5b, located inside PAS closed to commercial bottom trawling (Table 10c). However, only three total coral observations were made. The hard rock substrates on transects 5a and 5b provided suitable habitat for unknown species of upright flat and shelf sponges (33% of total corals and sponges). Other sponge taxa with overall similar densities for these transects were barrel sponges (*Rhabdocalyptus dawsoni*), shelf sponges (*Poecillastra* sp.), club sponges (*Rhizaxinella gadus*), and unknown species of branching sponge.

To generate a complete species list of DSCS for dive H1793, coral and sponge species were identified, but not quantified, from all ROV video not considered quantitative transects. The complete list can be found in Appendix B. There was low diversity of corals and sponges in the portions of dive H1973 not included in the quantifiable transects. During the last few hours of the dive, there were some small, red, fan-shaped *Swiftia* sp. Also, at the end of the dive, there were a few areas of high-relief rock with numerous vase- and plate-shaped sponges.

Table 10a. Coral and sponge taxa observed on transects 1i, 1j, and 1k, which are not within PAS and are open to commercial bottom trawling.

Common Name	Scientific Name	Total Number	Percent of Total	Density per 100 m²	Height Range (cm)	Depth Range (m)
CORALS						
Gorgonians	*Swiftia* sp. (fan)	1	5%	0.03	10	404
	Swiftia simplex	8	38%	0.27	15–30	414–495
Soft coral	*Heteropolypus ritteri*	2	9%	0.07	5–15	398–409
	TOTAL CORALS	11				
SPONGES						
Demospongiae	*Asbestopluma* sp. nov.	1	5%	0.03	20	495
	Poecillastra sp.	1	5%	0.03	25	495
Hexactinellida	*Staurocalyptus* sp. (white)	3	14%	0.10	15–40	495
Morphological	Branching	2	10%	0.07	10–15	400–402
	Vase	3	14%	0.10	15–20	398–495
	TOTAL SPONGES	10				

Table 10b. Coral and sponge taxa observed on transects 1l, 1m, and 1n, which are within PAS now open to commercial bottom trawling.

Common Name	Scientific Name	Total Number	Percent of Total	Density per 100 m²	Height Range (cm)	Depth Range (m)
CORALS						
Soft coral	*Heteropolypus ritteri*	3	20%	0.07	10–25	332–333
	TOTAL CORALS	3				
SPONGES						
Demospongiae	*Asbestopluma* sp. nov.	1	7%	0.02	10	331
	Poecillastra sp.	2	13%	0.05	10	332–333
Hexactinellida	*Rhabdocalyptus dawsoni*	6	40%	0.15	30–60	332–333
Morphological	Shelf	3	20%	0.07	10–25	331–333
	TOTAL SPONGES	12				

Table 10c. Coral and sponge taxa observed on transects 1o, 1t, 5a, and 5b, within PAS now closed to commercial bottom trawling.

Common Name	Scientific Name	Total Number	Percent of Total	Density per 100 m²	Height Range (cm)	Depth Range (m)
CORALS						
Gorgonian	*Swiftia* sp. (fan)	1	1%	0.01	10	157
Soft coral	*Heteropolypus ritteri*	2	2%	0.03	20–25	318–325
	TOTAL CORALS	3				
SPONGES						
Demospongiae	*Asbestopluma* sp. nov.	3	3%	0.04	10–15	319–322
	Poecillastra sp.	13	12%	0.17	5–20	202–322
	Polymastia sp.	3	3%	0.04	5–10	318–325

Common Name	Scientific Name	Total Number	Percent of Total	Density per 100 m^2	Height Range (cm)	Depth Range (m)
	Rhizaxinella gadus	14	12%	0.18	5–25	318–323
Hexactinellida	*Rhabdocalyptus dawsoni*	17	15%	0.22	20–60	202–325
Morphological	Barrel	3	3%	0.04	15	319
	Branching	16	14%	0.20	10–15	157–321
	Foliose	1	1%	0.01	10	236
	Mound	1	1%	0.01	10	157
	Shelf	4	3%	0.05	5–40	157–206
	Upright flat	33	30%	0.42	5–25	157–158
	TOTAL SPONGES	108				

H1793: Fish

Dover sole (*Microstomus pacificus*) accounted for 48% of total fish observed on transects 1i, 1j, and 1k, which are not within PAS, with an estimated density of five fish per 100 m^2 (Table 11a). The next most abundant fish were rex sole (*Glytocephalus zachirus*) and thornyhead rockfish (*Sebastolobus* spp.), which were found within large areas of soft sediment habitat within the species' known depth ranges. Other fish species observed included three species of rockfish, two species of skates and eelpouts, and other fishes like sablefish (*Sebastes ruberrimus*), Pacific hake (*Merluccius productus*), hagfish (*Eptatretus* sp.), and poachers.

The diversity and abundance of fish increased on transects 1l, 1m, and 1n, which are in PAS now open to commercial bottom trawling (Table 11b). There were at least six species of rockfish observed. The most abundant rockfish were splitnose rockfish *(Sebastes diploproa*), with an estimated density of five fish per 100m^2. Flatfish species accounted for the next greatest density (about three flatfish per 100m^2) and included petrale sole (*Eopsetta jordani*), rex sole (*Glytocephalus zachirus*), slender sole (*Lyopsetta exilis*), and Dover sole (*Microstomus pacificus*).

The greatest diversity and highest counts of fish on dive H1793 were observed on transects 1o, 1t, 5a, and 5b, located inside PAS closed to commercial bottom trawling (Table 11c). At least 12 species of rockfish were observed, accounting for 91% of total fish observed on transect. The most abundant species was sharpchin rockfish (*Sebastes zacentrus*), with an estimated density of 13 fish per 100m^2. The consolidated rock habitat on these transects was primarily layered, low-relief, flat rock, often covered in a thin mud veneer, providing ideal habitat for sharpchin rockfish. Other rockfish observed in high densities were splitnose rockfish (*Sebastes diploproa*), stripetail rockfish (*Sebastes saxicola*), and rosethorn rockfish (*Sebastes helvomaculatus*). There was one observation of a large (60 cm) cowcod (*Sebastes levis*) and six large (30–70 cm) yelloweye rockfish (*Sebastes ruberrimus*). At least four species of flatfish and a variety of other fishes including Pacific hake (*Merluccius productus*), sculpins (Cottidae), hagfish (*Eptatretus* sp.), and spotted ratfish (*Hydrolagus colliei*) were observed (Table 11c).

Twelve large cowcod (>50 cm) were observed from video not considered quantitative transects. The majority of individuals were found between transects 1t and 5a at depths of about 240–200 meters in low- to moderate-relief habitat in the portion of PAS that remains closed to

commercial bottom trawling. A total of 63 yelloweye rockfish were counted from video not considered a quantitative transect, within PAS closed to commercial bottom trawling; nine of these individuals had juvenile coloration. Per a request from NMFS, we counted and georeferenced cowcod and yelloweye rockfish, but counts are not included in the densities calculated from quantifiable transects reported in Tables 11a–11c. Other fish observed in very high abundances, but not within quantifiable transects, included chillipepper rockfish (*Sebastes goodie*), sharpchin rockfish (*Sebastes zacentrus*), and Pacific hake (*Merluccius productus*).

Table 11a. Fish taxa observed on transects 1i, 1j, and 1k, which are not within PAS and are open to commercial bottom trawling.

Group	Scientific Name	Common Name	Total Number	Percent of Total	Density per 100 m^2	Length Range (cm)	Depth Range (m)
Eelpout	*Lycodes cortezianus*	bigfin eelpout	3	1%	0.10	35–40	420–435
	Lycodes diapterus	black eelpout	13	4%	0.43	25–40	431–494
	Zoarcidae	eelpout	1	0.3%	0.03	20	427
Flatfish	*Atheresthes stomias*	arrowtooth flounder	1	0.3%	0.03	35	401
	Glytocephalus zachirus	rex sole	50	15%	1.66	25–35	397–482
	Lyopsetta exilis	slender sole	2	1%	0.07	25	400–417
	Microstomus pacificus	Dover sole	161	48%	5.36	25–40	399–495
Rockfish	*Sebastes diploproa*	splitnose rockfish	13	4%	0.43	20–25	400–482
	Sebastes melanostomus	blackgill rockfish	8	2%	0.27	30–40	407–479
	Sebastes saxicola	stripetail rockfish	1	0.3%	0.03	25	401
	Sebastolobus spp.	thornyheads	49	15%	1.63	10–25	399–495
Skate	*Raja kincaidii*	sandpaper skate	1	0.3%	0.03	50	469
	Raja rhina	longnose skate	5	1%	0.17	50–80	413–483
Other	Agonidae	poacher	3	1%	0.10	20	410–428
	Sebastes ruberrimus	sablefish	7	2%	0.23	35–50	478–495
	Eptatretus sp.	hagfish	3	1%	0.10	30–45	414–481
	Merluccius productus	Pacific hake	15	4%	0.50	35–50	413–495
		TOTAL FISH	336				

Table 11b. Fish taxa observed on transects 1l, 1m, and 1n, which are within PAS now open to commercial bottom trawling.

Group	Scientific Name	Common Name	Total Number	Percent of Total	Density per 100 m^2	Length Range (cm)	Depth Range (m)
Eelpout	*Lycodes cortezianus*	bigfin eelpout	8	2%	0.20	25–40	330–360
Flatfish	*Eopsetta jordani*	petrale sole	14	3%	0.35	25–30	334–366
	Glytocephalus zachirus	rex sole	22	5%	0.54	20–30	331–364
	Lyopsetta exilis	slender sole	31	7%	0.77	15–20	330–361
	Microstomus pacificus	Dover sole	66	14%	1.63	20–35	331–366
	Pleuronectidae	flatfishes	11	2%	0.27	15–30	331–366
Rockfish	*Sebastes aurora*	aurora rockfish	1	0.2%	0.03	20	357

Group	Scientific Name	Common Name	Total Number	Percent of Total	Density per 100 m^2	Length Range (cm)	Depth Range (m)
	Sebastes crameri	darkblotched rockfish	2	0.4%	0.05	25	342
	Sebastes diploproa	splitnose rockfish	208	46%	5.14	15–25	330–366
	Sebastes helvomaculatus	rosethorn rockfish	9	2%	0.22	20–25	331–342
	Sebastes melanostomus	blackgill rockfish	4	0.9%	0.10	20–35	332–342
	Sebastes spp.	rockfishes	26	6%	0.64	15–25	331–342
	Sebastolobus spp.	thornyheads	32	7%	0.79	15–25	331–365
	Sebastomus	unidentified sebastomus	1	0.2%	0.03	25	331
Skate	*Raja rhina*	longnose skate	4	0.9%	0.10	45–70	331–342
Other	*Eptatretus* sp.	hagfish	4	1%	0.10	25–40	331–358
	Hydrolagus colliei	spotted ratfish	1	0.2%	0.03	35	333
	Merluccius productus	Pacific hake	12	2%	0.30	20–25	331–358
		TOTAL FISH	456				

Table 11c. Fish taxa observed on transects 1o, 1t, 5a, and 5b, which are within PAS now closed to commercial bottom trawling.

Group	Scientific Name	Common Name	Total Number	Percent of Total	Density per 100 m^2	Length Range (cm)	Depth Range (m)
Catshark	*Apristurus* sp.	catshark	1	0.05%	0.01	40	203
Flatfish	*Atheresthes stomias*	arrowtooth flounder	1	0.05%	0.01	35	236
	Glytocephalus zachirus	rex sole	13	0.6%	0.17	20–30	206–318
	Lyopsetta exilis	slender sole	7	0.3%	0.09	20	207–325
	Microstomus pacificus	Dover sole	41	2%	0.53	20–30	157–320
	Pleuronectidae	flatfishes	30	1%	0.38	15–25	157–322
Rockfish	*Sebastes goodei*	chilipepper rockfish	9	0.4%	0.12	25–35	202–237
	Sebastes chlorostictus	greenspotted rockfish	29	1%	0.37	15–45	156–206
	Sebastes diploproa	splitnose rockfish	419	20%	5.37	15–25	317–325
	Sebastes elongatus	greenstriped rockfish	62	3%	0.79	15–25	157–238
	Sebastes helvomaculatus	rosethorn rockfish	82	4%	1.05	15–25	157–325
	Sebastes levis	cowcod	1	0.05%	0.01	60	205

Group	Scientific Name	Common Name	Total Number	Percent of Total	Density per 100 m^2	Length Range (cm)	Depth Range (m)
	Sebastes melanostomus	blackgill rockfish	2	0.1%	0.03	25–35	319–325
	Sebastes paucispinis	bocaccio	2	0.1%	0.03	50	235
	Sebastes ruberrimus	yelloweye rockfish	6	0.3%	0.08	30–70	156–203
	Sebastes saxicola	stripetail rockfish	110	5%	1.41	15–25	201–322
	Sebastes zacentrus	sharpchin rockfish	1019	48%	13.05	10–30	157–237
	Sebastes spp.	rockfishes	103	5%	1.32	10–25	157–322
	Sebastes spp. juv	juvenile rockfishes	3	0.1%	0.04	10	157
	Sebastolobus spp.	thornyheads	9	0.4%	0.12	15–20	318–325
	Sebastomus	unidentified *Sebastomus*	80	4%	1.03	10–20	156–323
Skate	*Raja rhina*	longnose skate	7	0.3%	0.09	60–80	157–322
Other	Agonidae	poacher	8	0.4%	0.10	15–20	157–320
	Cottidae	sculpins	25	1%	0.32	10–20	157–322
	Eptatretus sp.	hagfish	18	0.8%	0.231	20–40	157–318
	Hydrolagus colliei	spotted ratfish	14	0.7%	0.18	30–40	204–323
	Merluccius productus	Pacific hake	30	1%	0.38	35–45	235–319
	Ophidiidae	cuskeel	1	0.05%	0.01	30	237
	Ophiodon elongatus	lingcod	7	0.3%	0.09	35–60	157–238
	Zaniolepis frenata	shortspine combfish	1	0.05%	0.01	15	203
		TOTAL FISH	2140				

H1793: Marine Debris

All anthropogenic debris was georeferenced and counted throughout dive H1793 (Table 12 and Figure 8).

Table 12. Anthropogenic debris observed during dive H1793.

Marine Debris Type	Total Observations	Depth Range (m)
Anthropogenic rubbish (cans, refuse etc.)	9	365–145
Line not identified as longline or monofilament	4	480–152
TOTAL	13	

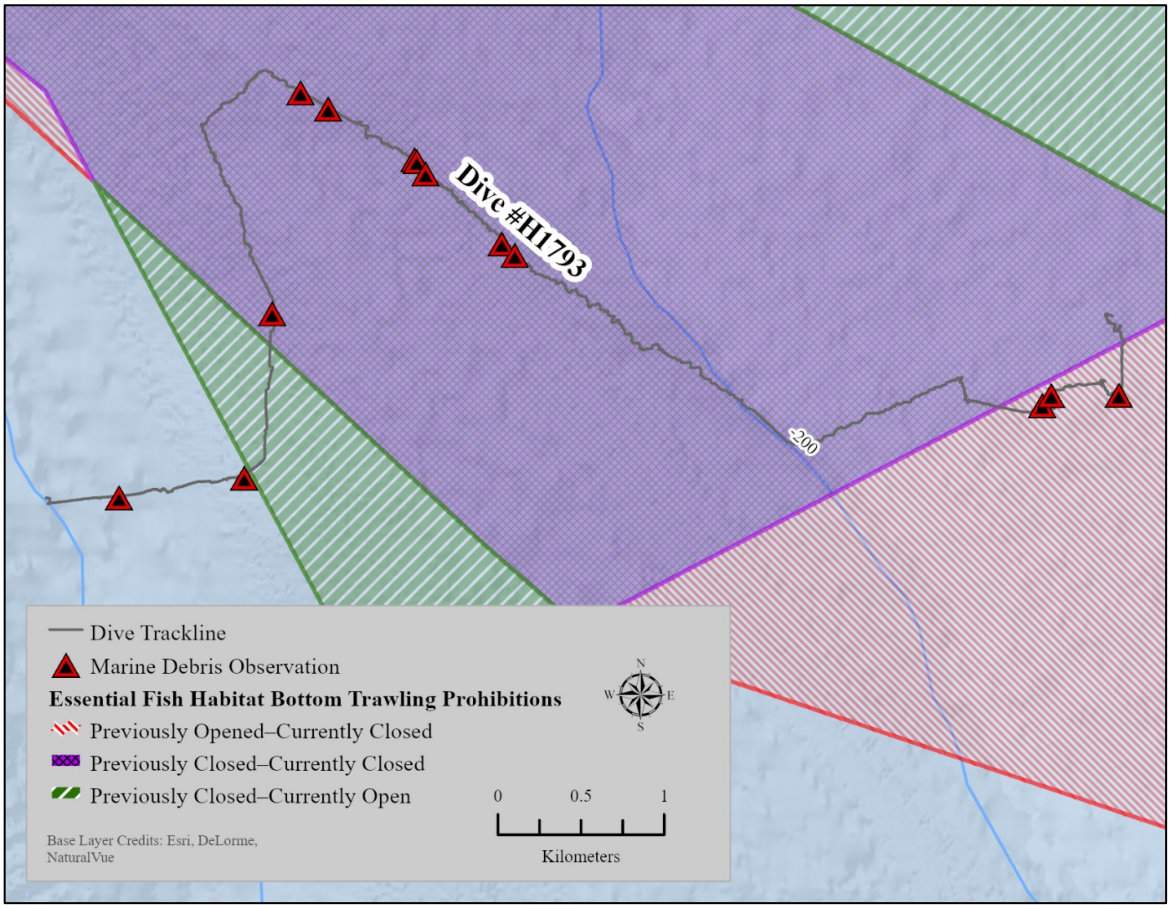


Figure 8. Locations of marine debris (referenced in Table 12) observed during dive H1793.

H1793: Collections

Three collections of corals and four collections of sponges were made on dive H1793 for taxonomy and are archived at the California Academy of Sciences (Table 13). Full taxonomy for the sponge collections are pending. For more information on environmental conditions at the times of collection, see Appendix A.

Table 13. List of coral and sponge specimens collected on dive H1793.

# Sample ID	Genus/Order/Class	Latitude	Longitude	Depth (m)
NA116-033	Demospongiae	38.5695	-123.6931	322
NA116-034	Demospongiae	38.5756	-123.6952	310
NA116-035	*Swiftia* sp.	38.5762	-123.6957	310
NA116-036	*Asbestopluma* sp. nov.	38.5762	-123.6957	310
NA116-038	Scleractinia	38.5775	-123.6822	242
NA116-040	Demospongiae	38.5659	-123.6451	164
NA116-042	*Swiftia* sp.	38.5653	-123.6394	153

H1793: Representative Images

All images below: Ocean Exploration Trust/NOAA

Layered flat rock with a mud veneer was a common habitat type.

The most abundant fish species was sharpchin rockfish (*Sebastes zacentrus*).

A red, fan-shaped gorgonian (*Swiftia* sp.) with orange polyps was collected for species identification (Sample ID: NA116-035).

A new species of the predatory sponge *Asbestopluma* with a “palm frond” morphology was collected for species identification (Sample ID: NA116-036).

Large yelloweye rockfish (*Sebastes ruberrimus*) were observed from 142–222 m.

Large cowcod rockfish (*Sebastes levis*) were observed from 241–173 m.

Summary of Findings

There are many functions that deep-sea coral and sponge (DSCS) communities provide to the ocean ecosystem. The complex morphology of DSCSs serves as biogenic habitat for marine invertebrates and fishes, providing structure for breeding, brooding, and protection from predators (Krieger & Wing, 2002). Many invertebrates, including brittle stars, basket stars, crinoids, crustaceans, and gastropods live on corals and sponges (Tissot et al., 2006). These may be prey for larger invertebrates and fish within these ecosystems. Deep-sea corals are often extremely long lived, slow growing, and fragile animals. Some species, like bamboo corals, record past environmental conditions in their skeletal structures (Hill et al., 2011), helping scientists understand how these communities may have been affected by past climate fluctuations and learn how the current changing climate will shape our marine wildlife and habitats.

Identifying the abundance and distribution of DSCSs is vital to selecting fisheries management zones, as they are often damaged by mobile, bottom-contact fishing gear, such as bottom-trawls (Chuenpagdee et al., 2003). Such damage to corals and sponges is long lasting, with predicted recovery times in the order of decades (Rooper et al., 2011). While DSCSs provide much value in the deep-sea ecosystems, they are sensitive in part because they grow extremely slowly, only a few microns to cm per year (Roark et al., 2005).

Advancement in deep-sea survey technologies, such as ROVs, has enhanced the ability to study DSCS communities. The exploration of the PAS area greatly expands the knowledge of the DSCS and fish communities in a range of depths and habitats throughout this area. Overall, the habitat types were low-relief substrates, with large expanses of soft, mud-sand sediment, as well as large expanses of loose boulders or cobbles mixed with soft sediments. Areas with consolidated flat rock were usually covered in a mud veneer. Brachiopods were often dense on the flat rock, providing additional structure to the habitat. The shallowest extents of both dives (300–150 m) had areas with high-relief hard rock. In the PAS area, the majority of the hard substrate had a mud veneer, which might account for the overall low density and diversity of corals and sponges, as the mud cover might be limiting their recruitment.

There were areas within the PAS boundaries closed to commercial bottom trawling that had large assemblages of barrel sponges and upright flat sponges. A total of seven sponge specimens were collected on this mission, some of which could potentially be new species, such as the large, yellow, “plate”-shaped sponge and the “palm frond” morphology of the predatory sponge *Asbestopluma*, documented on both dives. Six coral collections were made, including three types of red *Swiftia* sp. gorgonians (two had fan-shaped morphology and one had branched morphology) with different polyp colors. The advancements in sampling capabilities for DSCSs allows taxonomists and scientists to better describe and understand these species now and on future expeditions.

A high diversity of fishes, particularly groundfish, were documented for the entire PAS area. Species-specific habitats based on depth and substrate type were apparent. In particular, a high density of sharpchin rockfish (*Sebastes zacentrus*) was observed on consolidated flat-rock substrates and high densities of splitnose rockfish (*S. diploproa*) and stripetail rockfish (*S.*

saxicola) were observed on soft-flat sediment and hard-flat substrates. Most fish were observed on high-relief boulders and consolidated rock ridges at the shallower depths of both dives. There were multiple fish "hot spots" inside the PAS boundaries closed to commercial bottom trawling. Historic fishing (before PAS was established) in these areas was evident from the presence of derelict fishing gear, like lines and ropes tangled on the rocks. The high-relief rock features provided habitat for very large (and presumably very old) bocaccio (*S. paucispinis*), canary rockfish (*S. pinniger*), cowcod (*S. levis*), lingcod (*Ophiodon elongatus*), and yelloweye rockfish (*S. ruberrimus*). It was evident that these areas with suitable fish habitat also had very productive waters due to the presence of krill in the water column. The high density of the krill swarms often limited the ROV's camera visibility.

In January 2020, portions of PAS were opened to bottom trawling, a fishing practice that can damage sensitive DSCS communities. The findings from this cruise will be provided to NMFS to help them identify biologically complex areas of the seafloor that are most sensitive to bottom trawling and aid in the ongoing management of this designated essential fish habitat conservation zone. Habitat data from these surveys will be used to confirm substrate prediction models that can be used to predict DSCS habitats where there is a dearth of visual observations.

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Appendix A

Table A.1. Invertebrate specimens collected for taxonomy and archived at California Academy of Sciences (San Francisco, CA). Due to COVID restrictions, some archive and taxonomy information is pending. Note that description of Asbestopluma sp. nov. is in process (L. Lundten, pers. comm.). Initials of taxonomist: GW = Gary Williams, RvS = Rob van Soest, HW = Henry Reiswig, AK = Amanda Kahn, LL = Lonny Lundsten.

Sample ID	CAS IZ#	Dive ID	Species ID	ID Made By	Date Collected	Latitude (N)	Longitude (W)	Depth (m)	Substrate Classification	Temp (°C)	Salinity (psu)	Dissolved O_2 (ml/L)	Preliminary ID & Field Notes
NA116-024	235387	H1792	*Parantipathes* sp.	GW	10/7/2019	38.576	123.815	1709	Hard-rugose	2.5	34.5	0.6	*Parantipathes* sp. black coral on the side of rocky cliff with brown/green organism growing on it; black axis with peach polyps; section of coral covered in a greenish-brown substance; surrounded by small purple anemones; associates: brittle star, polychaete worm (long, pale, tan with a red mouth), large branched hydroid with small red anemone attached; collected eDNA water sample
NA116-026	235160	H1792	*Parastenella ramosa*	GW	10/7/2019	38.576	123.815	1708	Hard-rugose	2.44	34.5	0.7	*Parastenella ramosa* coral attached to edge of rocky cliff, surrounded by purple anemones with grey axis and light pink polyps; multiple branches; large, orange/peach amphipod associate

Sample ID	CAS IZ#	Dive ID	Species ID	ID Made By	Date Collected	Latitude (N)	Longitude (W)	Depth (m)	Substrate Classification	Temp (°C)	Salinity (psu)	Dissolved O_2 (ml/L)	Preliminary ID & Field Notes
NA116-029	235167	H1792	*Swiftia simplex*	GW	10/7/2019	38.615	123.740	469	Hard-flat	5.56	34.2	0.2	Gorgonian coral; dark red, growing on a dead sponge; red stalk and darker red polyps; also in sample: long, semi-transparent brown worm tube and a chiton on a piece of hard mud
NA116-030	235379	H1792	Demospongiae	RvS	10/7/2019	38.615	123.739	453	Hard-flat	5.82	34.1	0.3	Possible *Myxilla* sp., white sponge with striations, non-glass sponge growing on rock; fan-shaped; associates: 100+ small amphipods, several brittle stars, small pink worms, brown crinoid with pink patches; some small worms within sponge tissue, unable to extract
NA116-031		H1792	Demospongiae	RvS	10/7/2019	38.615	123.739	456	Hard-flat	5.90	34.1	0.5	Possible *Haliclona* sp., yellow sponge, disc-shaped on top with narrow base, broken into many pieces; large spicule lattice structure with fluffy tissue; shrimp associate; some krill from water column not associated with sponge

Sample ID	CAS IZ#	Dive ID	Species ID	ID Made By	Date Collected	Latitude (N)	Longitude (W)	Depth (m)	Substrate Classification	Temp (°C)	Salinity (psu)	Dissolved O_2 (ml/L)	Preliminary ID & Field Notes
NA116-032		H1792	Demospongiae	RvS	10/7/2019	38.611	123.700	209	Hard-rugose	8.58	34.0	1.7	Possible *Haliclona* sp., beige/cream color sponge (not a glass sponge), on large rock, undulating shape, hard/crunchy
NA116-033	235420	H1793	Demospongiae	RvS	10/8/2019	38.569	123.693	322	Hard-flat	6.43	34.1	0.9	Possible *Axinella* sp., soft yellow sponge, bowl shape; with shrimp and crinoid associates
NA116-034	235397	H1793	Demospongiae	RvS	10/8/2019	38.575	123.695	310	Hard-flat	7.09	34.1	1.2	Possible *Suberites* sp. sponge; cream/peach colored; globular/finger lobed shaped sponge; on rock; middle connecting part of sponge was sediment covered; associates: brittle stars, several long pink/dark red worms from sediment tubes under rock, sessile sea cucumber (CASIZ 235398)

Sample ID	CAS IZ#	Dive ID	Species ID	ID Made By	Date Collected	Latitude (N)	Longitude (W)	Depth (m)	Substrate Classification	Temp (°C)	Salinity (psu)	Dissolved O_2 (ml/L)	Preliminary ID & Field Notes
NA116-035	235170	H1793	*Swiftia* sp.	GW	10/8/2019	38.576	123.695	310	Hard-flat	7.29	34.1	1.2	Small, red gorgonian coral with orange polyps; 6–7 cm long; and large tunicate with fuzzy brown outside; several associates on tunicate, including smaller tunicates (1 clear, 1 yellow with spots), small brittle stars, small bivalve/brachiopod
NA116-036	234129	H1793	*Asbestopluma* sp. nov.	HR, AK, LL	10/8/2019	38.580	123.698	322	Hard-flat	7.12	34.1	1.2	*Asbestopluma* sp. nov., very flat thin sponge, 2 lobes; very pale peach/semi-transparent color with many amphipods inside being digested; attached to small rock with associates including black stick, sessile sea cucumber, small orange brittle star with stripes, and 2 black worm tubes (one empty)
NA116-037	235406	H1793	*Tritonia* sp.	GW	10/8/2019	38.583	123.693	237	Hard-flat	8.19	34.1	1.5	*Tritonia* nudibranch, partially clear/pale pink protrusions with white tips covering back

Sample ID	CAS IZ#	Dive ID	Species ID	ID Made By	Date Collected	Latitude (N)	Longitude (W)	Depth (m)	Substrate Classification	Temp (°C)	Salinity (psu)	Dissolved O_2 (ml/L)	Preliminary ID & Field Notes
NA116-038	235407	H1793	Scleractinia	GW	10/8/2019	38.577	123.682	242	Hard-rugose	8.32	34.0	1.6	Possible *Desmophyllum*; peach/pink cup coral with orange lower tissue/organs; broken in half
NA116-039	235403	H1793	*Laqueus californianus*	GW	10/8/2019	38.567	123.665	216	Hard-flat	8.19	34.1	1.6	*Laqueus californianus,* white brachiopod, possibly; on rock; 1 snail, 1 hermit crab; krill from water column; not considered part of the sample
NA116-040	235421	H1793	Demospongiae	RvS	10/8/2019	38.565	123.645	164	Hard-rugose	8.66	34.0	1.9	Possible *Axinella* sp. vase sponge, tan-brown; wavy, vase-shaped sponge; lip with large ossicles; squishy texture; excessively extrudes mucus when cut or squeezed, yellow crinoid on top
NA116-041	235399	H1793	*Tritonia* sp.	GW	10/8/2019	38.565	123.639	153	Hard-rugose	8.75	34.0	2.1	Possible *Tritonia* sp. nudibranch; transparent white with small orange spots, one patch of clear gills on back

Sample ID	CAS IZ#	Dive ID	Species ID	ID Made By	Date Collected	Latitude (N)	Longitude (W)	Depth (m)	Substrate Classification	Temp (°C)	Salinity (psu)	Dissolved O_2 (ml/L)	Preliminary ID & Field Notes
NA116-042	235422	H1793	*Swiftia* sp.	GW	10/8/2019	38.565	123.639	153	Hard-rugose	8.7	34.0	2.1	Gorgonian coral; bright red with orange/peach polyps; associates: encrusting sponge on part of coral, encrusting mud tube clusters with amphipods inside, numerous caprellid isopods; small brittle star

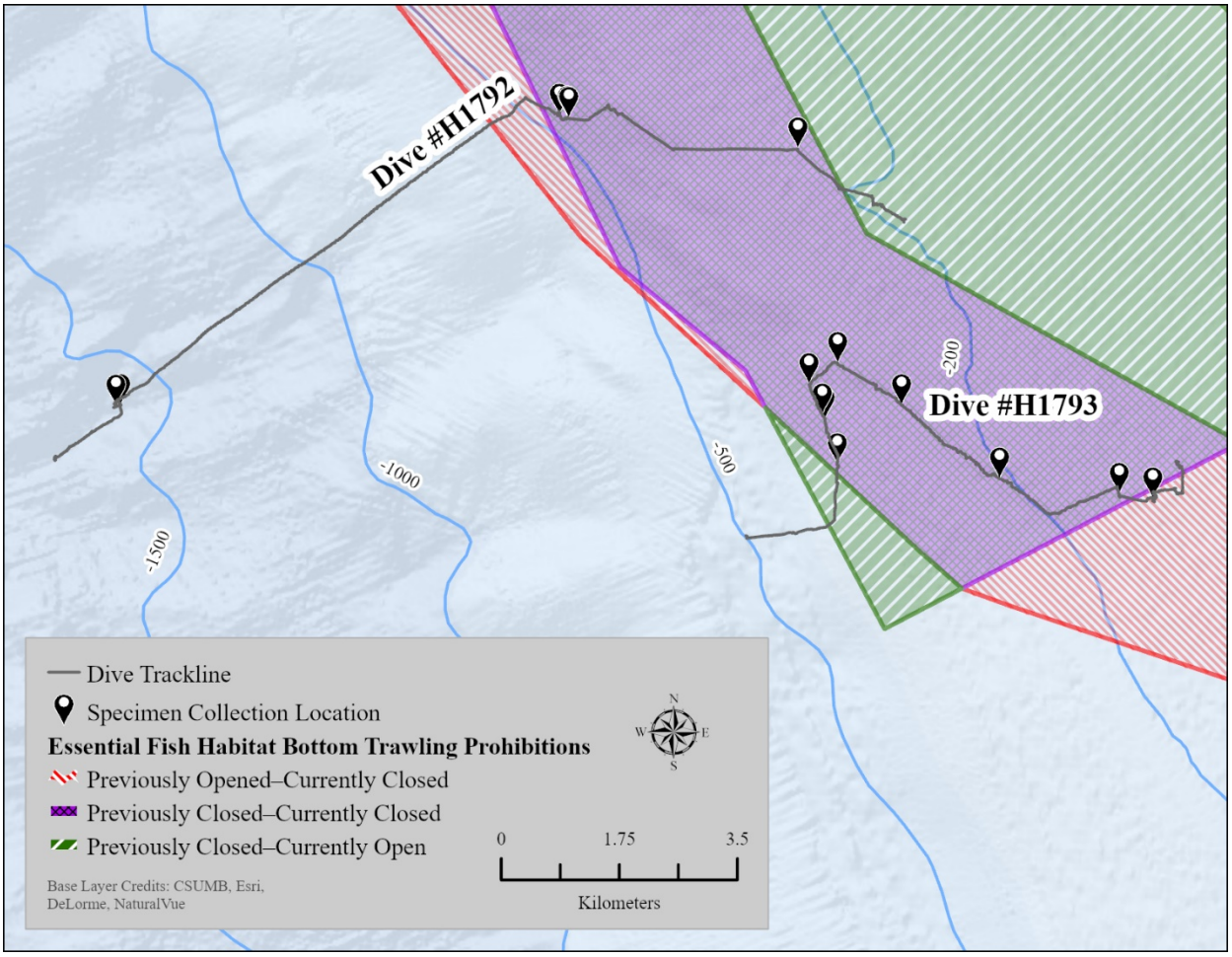

Figure A.1. Locations of specimens collected for taxonomy. Records of our deep-sea coral and sponge observations can be accessed from NOAA's Deep-Sea Coral and Sponge Database (https://deepseacoraldata.noaa.gov/).

Appendix B

Table B.1. List of coral and sponge species identified, but not quantified, from all ROV video not considered a quantitative transect for dives H1792.

Common Name	Scientific Name
CORALS	
Bamboo Coral	Isididae
Black Coral	*Bathypathes patula*
	Parantipathes sp.
Gorgonians	*Swiftia torreyi*
	Swiftia simplex
Primnoids	*Callogorgia kinoshitae*
	Parastenella ramosa
	Primnoidae
Sea Pens	*Halipteris californica*
	Virgularia sp.
Soft Coral	*Clavularia* sp.
	Heteropolypus ritteri
SPONGES	
Demospongiae	*Asbestopluma* sp.
	Rhizaxinella gadus
	Poecillastra sp.
Hexactinellida	*Farrea occa*
	Heterochone calyx
	Rhabdocalyptus dawsoni
Morphological	Barrel
	Branching
	Foliose
	Upright flat
	Vase

Table B.2. List of coral and sponge species identified, but not quantified, from all ROV video not considered a quantitative transect for dives H1793.

Common Name	Scientific Name
CORALS	
Bubblegum	*Paragorgia arborea*
Gorgonians	*Swiftia simplex*
	Swiftia sp. (fan)
Sea pens	Pennatulacea
	Virgularia sp.
Soft coral	*Heteropolypus ritteri*
Other	Scleractinia
SPONGES	
Demospongiae	*Asbestopluma* sp.

Common Name	Scientific Name
	Rhizaxinella gadus
	Poecillastra sp.
	Polymastia sp.
Hexactinellida	*Rhabdocalyptus dawsoni*
Morphological	Barrel
	Branching
	Mound
	Shelf
	Upright flat
	Vase

AMERICA'S UNDERWATER TREASURES